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# REGULATORY GUIDE

OFFICE OF STANDARDS DEVELOPMENT

## REGULATORY GUIDE 8.8

## INFORMATION RELEVANT TO MAINTAINING OCCUPATIONAL RADIATION EXPOSURE AS LOW AS IS REASONABLY ACHIEVABLE (NUCLEAR POWER REACTORS)

### A. INTRODUCTION

Paragraph 20.1(c) of 10 CFR Part 20, "Standards for Protection Against Radiation," states, in part, that licensees should, in addition to complying with the limits set forth in that part, make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to unrestricted areas, as far below the limits specified in that part as practicable. This guide outlines the information relevant to maintaining occupational doses as low as is reasonably achievable (ALARA) needed by the NRC staff in license applications and safety analysis reports for nuclear power reactors.

### B. DISCUSSION

The objective of efforts to ensure that occupational exposures are ALARA is to further reduce avoidable exposures and thereby reduce the low risks that are presumed to result from small doses. It has long been recognized by radiation control professionals that it is prudent to avoid unnecessary exposure and to hold doses as low as is reasonably achievable. This is determined by the state of technology and the economics of improvements in relation to the benefits from these improvements.

The available data suggest that past efforts have been relatively successful in that, generally, occupational exposures in NRC licensed activities have been well below the applicable limits of 10 CFR Part 20 (Refs. 1, 2). Thus, the recommendations of this guide are not intended to precipitate dramatic departures from past practice. Rather, they are intended to promote a more formal approach to keeping doses ALARA, to identify and promote continuance of good practices, and to promote further improvements where practicable.

The assumption of linearity between dose and response, recommended again by the Biological Effects of Ionizing Radiation (BEIR) Committee (Ref. 3), indicates concern about both population dose and individual doses. Thus it is not sufficient merely to control the maximum dose to individuals; the total dose to the group (measured in man-rem) must be kept as low as in reasonably achievable. It would be inappropriate to hold the individual doses to a fraction of the applicable limit if this resulted in the irradiation of more people and increased the total man-rem dose.

Effective control of radiation exposure involves the following major considerations:

1. Management commitment and support;

2. Careful design of facilities and equipment; and

3. Good radiation protection practices, including good planning and the proper use of appropriate equipment by qualified, well-trained personnel.

### C. REGULATORY POSITION

Detailed information, as outlined in subsequent sections of this guide, should be provided in the license application about each of the above major considerations.

**1. Management Philosophy and Organization**

Maintaining occupational exposures at the lowest level reasonably achievable requires management commitment. A clear statement of operating philosophy regarding occupational radiation exposure should be included in the license application (or Safety Analysis

Report) and reflected in the licensee's facility design, policy documents, and written operating procedures and close and continuing management followup.

A specific individual (i.e., the Radiation Protection Manager) should be given explicit responsibility and authority for ensuring that exposures are ALARA. He should be directly responsible to someone at a high management level. The health physics group should not be a part of operations- or production-oriented divisions.

A member of upper management should be given responsibility for ensuring that the ALARA policy is implemented. He should conduct periodic reviews of procedures and practices for achieving exposures that are as low as is reasonably achievable.

## 2. Personnel Qualification and Training

* The Radiation Protection Manager (RPM) should be an experienced professional in applied radiation protection at nuclear facilities dealing with radiation protection problems and problems similar to those at nuclear power stations. The RPM should be familiar with the design features and operations of nuclear power stations that affect the potential for exposures of persons to radiation. The RPM should have the technical competence to establish radiation protection programs and the supervisory capability to direct the work of professionals, technicians, and journeymen required to implement the radiation protection programs.

The RPM should have a bachelor's degree or the equivalent in a science or engineering subject, including some formal training in radiation protection. The RPM should have at least five years of professional experience in applied radiation protection. (A master's degree may be considered equivalent to one year of professional experience, and a doctor's degree may be considered equivalent to two years of professional experience where course work related to radiation protection is involved.) At least three years of this professional experience should be in applied radiation protection work in a nuclear facility dealing with radiological problems similar to those encountered in nuclear power stations, preferably in an actual nuclear power station.

Any person whose duties entail entering restricted areas or directing the activities of others who enter restricted areas should be instructed in the fundamentals of health physics and should be made aware of, and given the authority to implement, the licensee's commitments for maintaining doses ALARA in his areas of responsibility. His training should be commensurate with his duties and responsibilities as well as with the degree of radiation hazard anticipated. Personnel policies should include screening to ensure that radiation workers are responsible and conscientious and are qualified to perform their duties safely.

Personnel whose duties do not entail entering restricted areas should be (1) made aware of the reasons for keeping out of restricted areas and (2) denied access to restricted areas.

Personnel responsible for the design or approval of facilities including restricted areas or equipment for use in restricted areas should (1) receive instructions in the fundamentals of health physics including the importance of maintaining doses ALARA and (2) have ready access to and use a competent professional health physicist.

## 3. Facility and Equipment Design

Radiation exposures may be minimized by proper design of facilities and equipment. This requires a definite commitment by the applicant to provide preliminary and periodic design reviews by competent health physicists (with the support of other specialists) before and during construction specifically to ensure that occupational exposures will be ALARA.

Since a major portion of the occupational radiation dose is received during maintenance, inservice inspection, refueling, and nonroutine operations (including activities complicated by leakage and spillage of radioactive materials), these activities warrant special attention during design. Also, decommissioning can involve serious radiation exposures and should be considered during design. Designs should be reviewed to ensure that provisions have been included to achieve ALARA exposures in these situations. Specifically, the license application (at the construction permit stage) should provide information demonstrating that:

a. Equipment that may require servicing will be designed and located to minimize service time;

b. Instruments requiring in situ calibration will be located in the lowest practicable radiation fields;

c. Equipment and components requiring servicing will be located in or designed to be movable to the lowest practicable radiation fields;

d. The best available valves, valve packing, and gaskets will be used to minimize leakage and spillage of radioactive materials;

e. Penetrations of shielding and containment walls by ducts and other openings will be designed to minimize exposure and that shield design specifications will limit void content;

f. Radiation sources and occupied areas will be separated if possible (in particular, pipes or ducts containing potentially highly radioactive fluids will not pass through occupied areas);

g. Precautions will be provided (1) to minimize the spread of contamination and (2) to facilitate decontamination in the event spillage occurs;

h. Interior surfaces as well as the layout of ducts and pipes will be designed to minimize buildup of contamination;

*Lines indicate substantive changes from previous issue.

i. Systems that may become contaminated will be designed to include provisions for flushing or remote chemical cleaning prior to servicing;

j. The ventilation system will be designed to ensure control of airborne contaminants, especially during maintenance operations when the normal air flow patterns may be disrupted (e.g., open access portals);

k. Wherever practicable, radiation and airborne contamination monitoring equipment with remote readout will be included in areas to which personnel normally have access (where special conditions warrant, portable instrumentation may be substituted);

l. The ventilation system will be designed for easy access and service to keep doses ALARA during alterations, maintenance, decontamination, and filter changes;

m. Where practicable, shielding will be provided between radiation sources and areas to which personnel may have normal or routine access, and shielding will be designed for maintaining doses ALARA;

n. Movable shielding and convenient means for its utilization will be available for use where permanent shielding is needed but impractical;

o. Adequate shielding will be provided for radioactive wastes;

p. Remote handling equipment will be provided wherever it is needed and practicable;

q. All design features for radiation control will be designed to accommodate maximum expected (technical specification limit) failures such as fuel element cladding and steam generator failures; and

r. Sampling sites will be located so that exposures will be ALARA during such routine operations as sampling offgas, primary coolant, and liquid waste.

**4. Plans and Procedures**

Considerable dose reduction may be achieved through a carefully conceived and properly implemented planning and procedures program. As stated previously, a major portion of the occupational radiation dose is received during the activities of maintenance, inspection, refueling, and nonroutine operations. It is therefore essential that programs related to these activities involve careful planning and preparation, well-trained and qualified personnel, and specific exposure-reduction techniques as circumstances allow. Procedures governing implementation of such programs should be developed and included as routine operating procedures. As such, the license applications should include (1) at the construction permit stage, a commitment to and guidelines for providing these procedures and (2) at the operating license stage, a description of the procedures to be utilized for maintaining exposures ALARA. The procedures proposed in the applications should project exposures for various groups; identify sources, source strength, radiation levels, and contamination levels; and include plans to:

a. Minimize source strength and contamination levels by flushing tanks, lines, etc., prior to performing the operation;

b. Minimize radiation levels in the work area by use of permanent and/or movable shielding;

c. Minimize airborne contamination by proper use of the ventilation system, including purging the area before entering, temporary ducts into the work area, and other modifications as appropriate;

d. Further minimize inhalation of radioactive materials by the proper use of state-of-the-art respiratory protection;

e. Ensure that the task is completed with the least practicable time in the radiation field (the availability and use of all appropriate tools and equipment, as well as the conduct of "dry runs," are especially important);

f. Complete the task with the fewest people in the radiation field consistent with safe operation;

g. Cope as expeditiously as possible with fires, spills, equipment failure, and other accidents that may occur;

h. Use remote handling equipment and other special tools that can help reduce external dose;

i. Provide adequate supervision and monitoring to ensure that procedures are followed, that the planned and proper precautions are taken, and that all the radiation hazards are identified;

j. Provide personnel monitoring equipment such as direct-reading pocket dosimeters or pocket alarm meters that will permit early evaluation of individual doses and the association of personnel exposure with specific operations (see Regulatory Guide 8.4);

k. Provide contamination control procedures to achieve ALARA exposures;

l. Ensure that radiation and contamination monitoring instruments are tested and calibrated correctly and frequently enough to provide a high degree of confidence in the data they provide (see Regulatory Guide 8.6);

m. Conduct postoperational debriefings to improve plans, identify shortcomings, and determine whether ALARA was achieved;

n. Maintain records, including exposure data, contamination problems, airborne hazards, and internal exposure data as shown by bioassay analyses and whole body counters, that will be helpful in providing guidance for future similar operations (see Regulatory Guide 8.7);

o. Perform as much work as practicable outside radiation areas;

p. Minimize personnel radiation exposures by planning for access to and exit from work areas and by providing service lines and work area communications prior to beginning the work;

q. Consider the use of special tools or jigs that could reduce radiation exposure through simplification, reduction in time, or reduction of mistakes;

r. Post radiation levels in the work area so that the areas of highest and lowest radiation level are clearly identifiable;

s. Minimize discomfort of workers so that efficiency will be increased and less time will be spent in radiation areas; and

t. Estimate total man-rem to be expended on large jobs and set man-rem goals.

## D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC staff's plan for utilizing this regulatory guide.

With the exception of qualifications for the RPM stated in Section C.2, this guide will continue to be used by the NRC staff as in the past in the evaluation of submittals in connection with an operating license application. With regard to RPM qualifications, the qualifications stated herein will be used in the evaluation of submittals in connection with an operating license application docketed after June 1, 1976. Applicants may propose alternative methods or personnel qualifications for complying with the specific portions of the Commission's regulations.

Although the Introduction section of this guide indicates that the guide should be used in the preparation of license applications and safety analysis reports, it is the position of the NRC staff that, if the RPM at an existing nuclear power station is reassigned or the incumbent is replaced, the new manager should have qualifications equivalent to those stated in Section C.2.

## REFERENCES

1. A.W. Klement, Jr., C.R. Miller, R.P. Minx, and B. Shleien, "Estimates of Ionizing Radiation Doses in the United States 1960-2000," Environmental Protection Agency Report ORP;CSD 72-1, August 1972.

2. "Fourth Annual Report of the Operation of the U.S. Atomic Energy Commission's Central Repository of Individual Radiation Exposure Information," USAEC Report, September 1972.

3. C.L. Comar, Chmn. NAS-NRC BEIR Committee, "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," National Academy of Sciences—National Research Council, Washington, D.C., 1972.

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