
Radiation Protection Plans for Nuclear Power Reactor Licensees

Draft Report for Comment

**U.S. Nuclear Regulatory
Commission**

Office of Nuclear Reactor Regulation



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Draft Report for Comment

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**Division of Systems Integration
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555**



ABSTRACT

The purpose of this document is to provide guidance for NRC licensees and near-term licensees for the content of a RADIATION PROTECTION PLAN and on elements to be included in the comprehensive radiation protection program that the PLAN describes. Procedural details and outlines suggested for incorporation into implementing procedures are also provided. The guidance is the product of the NRC response to evaluations of the TMI accident, evaluations of industry-wide lessons learned, and significant findings derived from IE's Health Physics Appraisals. Following incorporation of public comment, this document will establish guidance and acceptance criteria for NRC staff in determining the adequacy of power reactor radiation protection programs, as described in the PLANS submitted for review.

The NRC invites comment from interested members of the public. Guidance will be promulgated in final form after these public comments are received, reviewed and appropriately accommodated.

FEBRUARY 1981

DRAFT
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FOR NUCLEAR POWER REACTOR LICENSEES
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DRAFT
CONTENTS OF RADIATION PROTECTION PLANS
FOR NUCLEAR POWER REACTOR LICENSEES

1. Introduction

The purpose of this report is to provide to NRC licensees and operating license applicants guidance necessary to develop a RADIATION PROTECTION PLAN (RPP). This report also outlines the staff's recommendations for criteria, concepts, and implementation schemes that should be included as part of operational radiation protection programs for power reactors that will be described by the RPP. It is not meant to constrain a licensee or applicant from writing an RPP and developing a program that is most appropriate for the facility and organization being addressed. It is not intended that current station Health Physics Manuals be rewritten to meet the format presented in this report.

An effective radiation protection program consists of all actions planned or taken to protect workers and the environment, to monitor radiation and radioactive materials, control distribution and releases of radioactive materials, and keep radiation exposures to individuals within the limits of 10 CFR Part 20 and at levels as low as is reasonably achievable (ALARA), during normal operations, anticipated operational occurrences and accidents. It includes facility protection policies, trained personnel, facilities, equipment, and implementing procedures. It should not be assumed that the responsibility for radiation protection rests solely with the radiation protection group. All levels of management must have a strong commitment to radiation protection, and each worker must take personal responsibility for actions necessary to implement a successful radiation protection program.

Licensees should review advances in the field of radiation protection continually, and implement as standard practices those elements which improve radiation protection programs and provide a standard of excellence above minimum regulatory requirements. Licensees and applicants should also implement radiation protection programs based on the guidance of the NRC in such information as regulatory guides, circulars, notices, bulletins, and staff positions.

The importance of and need for a strong, well-structured, well-integrated radiation protection program at reactor facilities became strongly evident from each of the special evaluations of the Three Mile Island accident. This has since been reinforced by the NRC's Health Physics Appraisal Teams' findings, which have identified significant deficiencies in the radiation protection programs of many reactor facilities. These findings have been integrated into this report. The practical goal of requiring a PLAN which meets the intent of this report is to assure that each facility has a strong, self-improving radiation protection program with full and active participation on the part of each individual, facility managers and supervisors at all levels, and the radiation protection organization.

An applicant or licensee should implement a radiation protection program based on the criteria and concepts outlined in this report, the essential elements of which should be described in the facility RADIATION PROTECTION PLAN. In many instances, this PLAN could take the form of a Station Health Physics Manual (but will not include implementing procedures). Also in many instances, many of the elements of the PLAN are incorporated into radiation protection program implementing procedures at operating facilities. The RADIATION PROTECTION PLAN, therefore, will be a concise statement of the station's radiation protection policy and program, available to all station personnel so that they can understand the program and know their responsibilities regarding radiation protection, and what is required of them to implement those responsibilities.

This report is structured by major program areas to outline first what is to be contained in a PLAN (Plan Contents), next to provide the primary criteria which the staff will use to review those contents and determine acceptability (acceptance criteria), and finally to provide specific information (procedural details) and outlines of some successful program contents for use as a development baseline or standard of measure. The elements contained in "Procedural Details" sections are not intended to be included in the general RADIATION PROTECTION PLAN, although these or similar elements should be considered in the development of an overall program and in writing implementing procedures. A definition section (Appendix G) provides functional definitions for new terms and applications unique to this guide. A reference section provides documents the staff will use as the basis for its recommendations and acceptance criteria.

This report is intended to include input from Radiation Protection Managers, radiation protection training personnel, health physicists, inspectors, utility personnel, and regulatory staff and management, and incorporate elements from significant Health Physics Appraisal findings and operating reactors lessons-learned experience. The report is being issued in draft form to encourage public input into the development of this guide, particularly with regard to "Acceptance Criteria" and "Procedural Details" sections. Comments received as a result of the comment period will be incorporated to provide a standard of excellence for all radiation protection programs. Eventually this report with comments incorporated will be converted into a regulatory guide (or series of regulatory guides). Such a guide will be used by the staff in evaluation of the adequacy of RADIATION PROTECTION PLANS for licensees and applicants and may be used by the staff in performing evaluations of radiation protection programs for licensees. Comments should be addressed to:

Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
Attention: Leader, Radiation Protection Section

Comments will be accepted until June 30, 1981.

NUREG-0761 is being developed to establish criteria that the NRC staff intends to use in determining whether an applicant or licensee meets the requirements of 10 CFR Part 20 and 10 CFR Part 50.34(b)(3). NUREG-0761 will not be a substitute for the regulations, and compliance is not a requirement. However,

the use of criteria different from those set forth herein will be accepted by the staff only if the substitute criteria provide a basis for determining that the above-cited regulatory requirements have been met.

The staff intends to require licensees (by special letter) and applicants (by Standard Review Plan) for operating licenses to prepare a RADIATION PROTECTION PLAN in accordance with the instructions in this report. Implementation of the RADIATION PROTECTION PLAN will be required by modifying each licensee's Technical Specification to be consistent with the following language:

A RADIATION PROTECTION PLAN and implementing procedures shall be prepared consistent with the requirements of 10 CFR Part 20 and consistent with the objectives and recommendations of NUREG-0761, "Radiation Protection Plans for Nuclear Power Reactor Licensees," dated _____, and shall be approved by the Plant Operations Review Committee, maintained and adhered to for all facility operations.

We expect that each PLAN will be submitted to the staff, and that the NRC will review and approve each PLAN.

The following sections outline the principal elements of a RADIATION PROTECTION PLAN and provide guidance on the extent of information to be contained in the PLAN. Implementing procedures should typically be developed to include procedures and criteria such as are provided in this report. It is not expected that submittal of implementing procedures will be required but they should be available for review and audit by the staff.

2. Management Policy

a. PLAN Content

The RADIATION PROTECTION PLAN should describe a management policy on radiation protection.

b. Acceptance Criteria

The radiation protection policy should include management commitment to:

- (1) Assure that each supervisor implements his or her responsibility to integrate appropriate radiation protection controls into all work activities;
- (2) Assure that each individual working at the facility understands and accepts the responsibility to follow all procedures and to maintain his or her radiation dose ALARA. A list of typical worker responsibilities is included in Appendix C;
- (3) Comply strictly with regulatory requirements, radiation exposure limits, and limits regarding release of radioactive materials;
- (4) Maintain a comprehensive radiation protection program to keep individual and collective radiation doses to workers below regulatory limits and as low as is reasonably achievable (ALARA).

3. Radiation Protection Organization and Functions

a. PLAN Content

This section of the PLAN should describe the plant organization, showing the titles and radiation protection functions and minimum staffing of each major position/function in the radiation protection organization and the operating and support organization during power operation. Any differences in organizational structure, interface, or responsibilities during accidents or outages (such as the use of contractor services) should be similarly shown.

This section should also explain the methods used to implement management and radiation protection agreements with contractor services that process or handle radioactive materials for the facility outside the normal plant organization or perform functions integral to the radiation protection program. Contractor services might include contaminated laundry processing, offsite repair of contaminated equipment, radiography, thermoluminescent dosimetry (TLD) processing, instrument calibration, bioassay services, training of construction and maintenance workers, and training of contract radiation protection technicians.*

There should also be a table or written discussion which describes the radiation protection organization.

b. Acceptance Criteria

The organizational structure should show clearly that the Radiation Protection Manager (RPM) has access to the Plant Manager in matters of radiation protection and is independent of operating pressures. (See NUREG-0731, "Guidelines for Utility Management Structure and Technical Resources," and Regulatory Guide 8.8 Section C.1.b.(3))

The radiation protection organization should include:

- (1) The functions of individual components within the radiation protection organization (note that radiation protection personnel should not be assigned multiple specialties, e.g., chemistry or instrument control, unless fully qualified in each specialty, including training, experience, testing, and retraining). The functional description should clearly specify that senior radiation protection technicians have the responsibility and authority to stop work or order an area evacuated (in accordance with approved procedures) when, in their judgment, the radiation conditions warrant such an action and such actions are consistent with plant safety. It should be clear that only radiation protection management, the Plant Manager, or their designated representatives on backshifts, can overrule such a stop-work order.

*If work is done at a licensee's facility under a contractor's license (e.g., radiography), the contractor is responsible for compliance with NRC regulations. If the work is done under the facility license, the facility is responsible. Note also that the facility license usually authorizes activities only at the facility site, and contractors who do work with radioactively contaminated equipment offsite (e.g., machine shop) must have their own license.

- (2) Radiation protection functions of operations, engineering, and support organization (managers and supervisors) other than the radiation protection organization.
- (3) The minimum staffing, by shift, for each component in the radiation protection organization, specifying the numbers in terms of professionals, foremen, senior and junior technicians, and technicians in qualification.* Enough radiation protection personnel should be present at the station to ensure that all routine radiation protection functions can be completed in a timely manner and that all radiation protection requirements can be met during normal operations, anticipated operational occurrences, unanticipated radiological events, and major accidents. Guidelines for minimum ratios of controlled area workers to radiation protection technicians should be established. Plans for augmented staffing during outages and accidents should be described. As a minimum, there must be an individual with the qualifications specified in Regulatory Guide 1.8 for RPM assigned to the site. There should be a qualified substitute for the RPM available to the site when the RPM is not available for extended periods due to illness, travel, or vacation. For short-term absences, a substitute qualified to carry out the RPM's emergency duties should be designated. In addition, an individual qualified as a radiation protection technician (senior technician), as specified in Regulatory Guide 1.8, or a technician qualified in accordance with a qualification program specified in technical specifications shall be onsite when there is fuel onsite after initial operation. The ratio of supervisors/foremen to technicians should be established and described.
- (4) Those functions that are performed by contractor services, such as dosimetry or instrument calibration, identifying the contractors responsible (by position), specifying their responsibilities and how they meet the standards of this guide.
- (5) Those functions that are performed by a corporate or centralized licensee organization, identifying the responsible individuals (by position) and specifying their responsibilities.
- (6) Functions and assignments during emergencies. (See NUREG-0654, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Procedures in Support of Nuclear Power Plants). Reference to an NRC reviewed Emergency Plan is acceptable.

c. Procedural (Functional) Details

Figure 1 shows a conceptual station radiation protection organization. Table 3-1 shows facility management and supervisory functions. Tables 3-2 through 3-6 show the functions for each group in the conceptual radiation protection organization. The organization and staffing may vary (with plant, age, size, and number of operating units) from plant to plant, but within the frame-

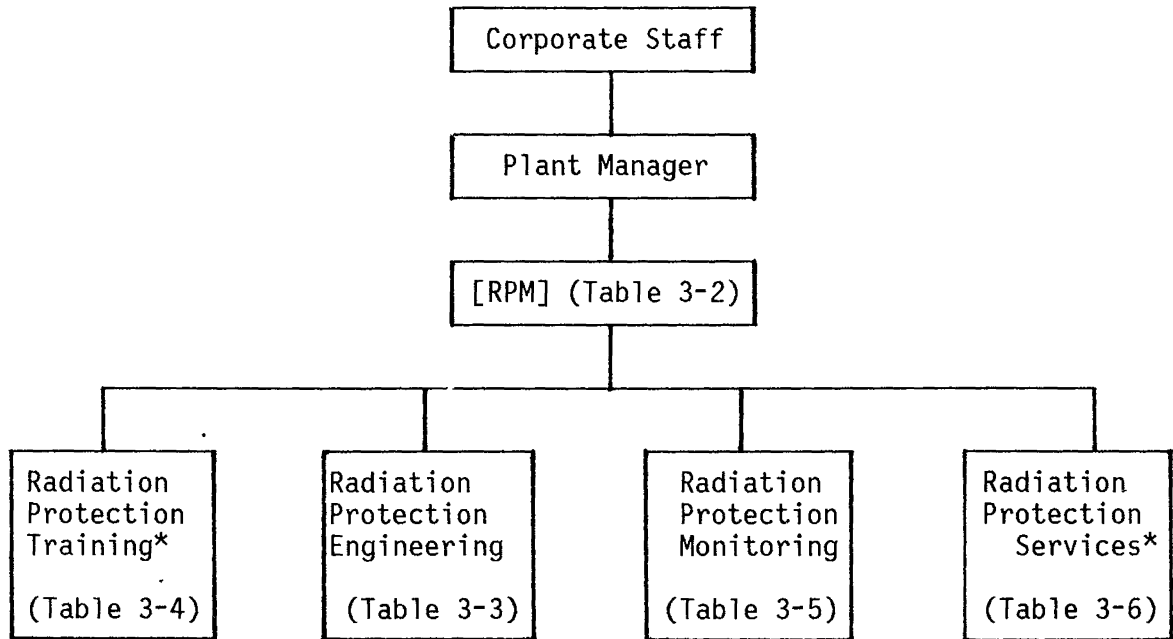
*See Appendix D for criteria for junior and senior technicians and technicians in qualification.

work of a given organization, all essential functions of the organization must be specifically designated and assigned. Table 3-7 lists examples of functions that may be assigned to the corporate radiation protection staff.

{

Figure 1

Organization and Function



*Some of these functions may be within other organizations at some facilities (e.g., counting room - chemistry; instrument calibration - instrument and control; radiation protection training - training department).

Table 3-1

Facility Organization Functions

Plant Manager

- Implement corporate radiation protection policy throughout operational organization
- Ensure overall commitment in plant organization to RADIATION PROTECTION PLAN
- Interact with and support Radiation Protection Manager on implementation of RPP
- Provide support to facility radiation protection improvement and deficiency identification program
- Establish goals and objectives for radiation protection aspects of the operations program
- Analyze and report formally the causes, concerns, and corrective actions associated with maintenance and operational radiation protection incidents.

Operational Shift Supervisors

- Provide direct interface with Radiation Protection foremen/supervisors in routine operations, corrective actions for radiation protection problems (such as spills), and in resolving radiological deficiencies associated with operations, procedures, systems, equipment, and work practices
- Notify radiation protection personnel promptly when radiation protection problems occur

Engineering Group Manager

- Provide engineering work documents with radiation protection incorporated
- Interact with Radiation Protection Engineering to assure the quality of radiation controls incorporated in work documents
- Support facility programs for system and design changes for improved radiation protection

Maintenance Supervisor

- Interface with radiation protection group to assure adequate work and procedural review and radiation protection technician support for both normal operations and outages

Table 3-1 (Continued)

- Interface with the radiation protection group for preparation for maintenance and training

Support Group Managers

- Ensure adequate numbers of personnel are properly trained to perform planned work
- Schedule radiation protection training time for worker qualification, requalification, advanced skills training, and proficiency training
- Support the RPM in implementing and supporting the facility RPP

Planning/Scheduling Manager

- Coordinate facility scheduling and temporary personnel requirements with RPM and other facility managers for the conduct of radiation protection technician (RPT) training, worker training, subcontractor training, and other radiation protection training
- Arrange for temporary personnel in conjunction with RPM to assure proper RPT monitoring of planned work for normal operations and outages

First Line Supervisors

- Ensure that personnel assigned to work in radiation areas or with radioactive material are properly trained and briefed
- Identify radiation work procedures and practices that need improvement and arrange for upgrading
- Identify the minimum number of workers necessary to complete tasks involving occupational exposure
- Assign tasks to distribute radiation doses among exposed personnel to minimize the likelihood of overexposures and to maintain individual doses ALARA
- Ensure that workers are prepared for tasks with tools, equipment, and training to minimize work time in radiation areas

Table 3-2

Radiation Protection Manager Functions

- Manage plant radiation protection program including establishing and implementing policies, and preparation, revision, and updating of the RADIATION PROTECTION PLAN
- Provide radiation protection input to facility design and operational planning (e.g., as a member of the Plant Operations Review Committee)
- Follow and analyze trends in radiation work performance of station personnel, contamination and exposure control, and job exposures, and take necessary actions to correct adverse trends
- Assign organizational emergency duties and coordinate with site Emergency Plan
- Identify and review causes, concerns, and corrective actions of incidents associated with radiation protection controls
- Provide radiation protection overview of the programs and training for radioactive waste processing and control

Table 3-3

Radiation Protection Engineering* Functions

- Review radiation work packages for jobs potentially involving significant doses
- Review maintenance procedures for adequate radiation control
- Review plans for temporary shielding
- Review design of special tools that reduce job time or separate workers from radiation sources
- Provide technical analysis support of plants for radiation protection problems
- Arrange mockups for specific tasks where practice could significantly reduce doses
- Evaluate the effectiveness of the respiratory protection program
- Conduct audits
- Provide radiation protection support for accident evaluations (See NUREG-0654" Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants.")
- Plan drills
- Review radwaste control
- Review designs and facility modifications which have radiological impact
- Estimate collective (person-rem) dose for specific tasks
- Write health physics procedures, modify as appropriate to incorporate ALARA considerations and lessons learned from experience

*In this context, radiation protection engineers are individuals who apply practical engineering aspects of radioactive contamination control and minimization of radiation exposure to facility design, operations, maintenance, and work practice.

Table 3-4

Radiation Protection Training Functions

- Develop and maintain qualification, training, and retraining programs, and program materials in radiation protection, with separate attention to emergency training
- Provide an additional capability to train Emergency Plan support personnel in the event of an accident
- Maintain Radiation Protection manuals

Table 3-5

Radiation Protection Monitoring/Surveillance Functions

- Implement operational ALARA considerations in all monitoring functions
- Maintain and calibrate fixed and portable monitoring instruments
- Observe work practices to assure compliance with radiation protection and related procedures
- Assess radiation conditions and establish Radiation Work Permit (RWP) requirements for each activity in radiation areas, airborne radioactivity areas or controlled surface contamination areas
- Provide radiation protection assessment field teams for Emergency Plan support
- Assure adequate access control for posted areas
- Identify and post radiation, high radiation, exclusion, and restricted areas, controlled surface contamination areas, airborne radioactivity areas, and radioactive material areas
- Conduct radiation and radioactivity surveys, and keep accessible records
- Provide control over the identification, storage, movement, and shipment of radioactive materials
- Maintain environmental monitoring program (may be a corporate or contractor responsibility)

Table 3-6

Radiation Protection Services Functions

Dosimetry

- Maintain and calibrate personnel monitoring equipment
- Provide adequate and appropriate monitoring equipment for normal operations, maintenance/outages, and emergency conditions
- Provide whole-body counting and other bioassay services
- Maintain complete and readily accessible exposure records, maintained by job function to allow feedback into job planning
- Provide routine TLD readout/film processing capability

Counting Room Operations

- Provide necessary services to determine quantities of gross or specific radionuclides in samples, as necessary
- Instrument Calibration
- Environmental Monitoring

Table 3-7

Corporate Radiation Protection Staff Functions

- Coordinate review of major design changes (and design of new facilities)
- Prepare long-term collective (person-rem) dose evaluations/projections to determine dose trends for ALARA planning and analyze the success of prior ALARA objectives.
- Review relevant experience at other nuclear power plants and apply learned improvements
- Appraise in-plant radiation and contamination control
- Conduct radiation protection inspections to evaluate the adequacy of the facility radiation protection program
- Review plant operating problems, including ALARA aspects
- Recommend generic design solutions to specific problems
- Provide basic guidelines for implementation of ALARA concepts in all aspects and phases of facility construction and operation to implement corporate policy
- Coordinate such activities as personnel dosimetry, environmental monitoring, bioassay, etc., as appropriate
- Review evaluations of exposures or releases in excess of regulatory limits

4. Radiation Protection Training and Qualification

a. PLAN Content

This section should identify, describe, and discuss the facility radiation protection training, qualification, and retraining programs, and describe selection of personnel (where indicated) for the following:

- (1) General employee training for restricted area access
- (2) Radiation work training for access and work in radiation and/or high radiation areas, airborne radioactivity areas, and radioactive surface contamination areas
- (3) Respiratory protection training
- (4) Radiation Protection Technician training
- (5) Radiation Protection Supervisor/Foreman training
- (6) Radiation Protection Manager training
- (7) Emergency Plan training

b. Acceptance Criteria

For the training categories listed an acceptable PLAN should include the following:

- (1) General employee training for restricted area access should be conducted annually for all facility personnel, visitor/transients, and subcontractors in accordance with:
 - (a) Regulatory Guide 8.____, "Radiation Protection Training for Light-Water-Cooled Nuclear Power Plant Personnel" (OH 717-4, August 1979)
 - (b) Regulatory Guide 8.____, "Instruction Concerning Risk from Occupational Radiation Exposure" (OH 902-1, May 1980)
- (2) Radiation work training should be conducted for all facility personnel, visitors/transients, and subcontractors who routinely have access to or work in radiation and/or high radiation areas, airborne radioactivity areas, and controlled surface contamination areas as follows:
 - (a) The licensee should implement a basic radiation work practices training and qualification program consistent with that outlined in Appendix A.
 - (b) A system for prompt instruction in changes in requirements, procedures, and equipment should be established to keep each worker's training current.

- (c) Separate and detailed instruction in advanced radiation work practices, consistent with Appendix A, should be provided for those workers involved in maintenance or operations which require work in contamination containment devices or areas; grinding, cutting, welding, or similar operations involving highly radioactive systems, components, or piping; and special complex radiation work which involves skills and training beyond that outlined for basic radiation work training.
 - (d) To be considered acceptable, training conducted at other facilities should meet the criteria outlined in this report and should be so verified through certification records or formal reciprocal agreements. In such cases, only specific facility-oriented training as established by the Radiation Protection Manager would be necessary for previously trained individuals, provided all other timing and verification criteria are met.
 - (e) Training personnel should evaluate the test results of personnel who fail exams to determine if additional training is needed, if limited duty assignment is appropriate, or if disqualification is necessary. A formalized upgrading/retraining program should be established.
- (3) Respiratory protection training should be conducted in accordance with:
- (a) The requirements of 10 CFR 20.103(c)
 - (b) Regulatory Guide 8.15, "Acceptable Programs for Respiratory Protection"
 - (c) NUREG-0041, "Manual of Respiratory Protection Against Airborne Radioactive Materials"

This should include formal, documented training, with provisions for periodic requalification or reevaluation of training where proficiency (e.g., monthly use of respiratory equipment) is maintained.

- (4) (a) Radiation Protection Technician training, qualification, and retraining should contain the elements of the program outlined in Appendices D and E, and should encompass both facility and subcontractor personnel assigned as Radiation Protection Technicians at the facility. Personnel performing limited aspects of Radiation Protection Technician Work, such as a Control Point Monitor, should not be considered Radiation Protection Technicians, and may receive specific, task-related training in a specialty program detailed and documented in accordance with advanced radiation work training of Appendix A. Similarly, contractor personnel other than Radiation Protection Technicians should receive training appropriate to their responsibilities in accordance with Appendix A. Training conducted at other facilities may be considered acceptable if it was conducted and documented in accordance with the provisions of this report (or a similar report developed by industry and approved by the NRC) and is acceptable to the Radiation Protection Manager.

- (b) Specialized training should also be conducted for the following radiation protection specialists/special skill categories:
 - i. Dosimetry Technicians
 - ii. Respiratory Protection Specialists
 - iii. Bioassay Technicians
 - iv. Counting Room Technician
 - v. Use of dose rate meters and swipes by Non-Radiation Protection Technicians
 - vi. Instrument Calibration Technician
 - vii. Environmental Monitoring Technician
- (c) A separate qualification folder, requiring signature verification of training by higher level management, to include:
 - i. Emergency Response duties
 - ii. Interactions with operators and other site personnel (e.g., chemistry, engineering) during normal operations, outages, unplanned radiological events, and emergency conditions
- (5) Radiation Protection Supervisor/Foreman training should specify the training and qualification criteria for such first-line supervisors to include:
 - (a) Initial qualification as a Radiation Protection Technician
 - (b) Biennial requalification and reexamination (practical, oral, and written) on selected aspects of the Radiation Protection Technician training and additional training approved by the Radiation Protection Manager
 - (c) Training in the supervisory and technical aspects of radiation protection engineering, monitoring, training, and dosimetry
- (6) Radiation Protection Manager training and qualification should include:
 - (a) Verification of prior education and experience as required by Regulatory Guide 1.8
 - (b) An orientation on the specific design and systems of the facility and management organization and functions at the facility
 - (c) Specific facility-oriented radiological controls training

- (d) Training in specific emergency plan responsibilities as outlined in NUREG-0654, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants"
 - (e) Periodic professional radiation protection training in the form of refresher courses, retraining, or continuing education which enable the Radiation Protection Manager to keep abreast of current developments in this field.
- (7) Emergency Response Plan Training should be integrated with all radiation protection training and for all facility personnel in accordance with NUREG-0654, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants."

All training-related records should be formally documented and made easily traceable to enhance the usability of training and minimize redundant training.

c. Procedural Details

For each of the training categories listed, implementing procedures should describe the standards for qualification and the training program content. The description should contain elements as detailed in the Appendices listed below (or their equivalents):

- Appendix A - Example Qualification Standards for Radiation Work Training
- Appendix B - Example Training Program Content for a Basic Radiation Work Training Program
- Appendix C - Example Responsibilities of All Workers
- Appendix D - Example Qualification Standards for Radiation Protection Technician Training
- Appendix E - Example Content for a Basic Radiation Protection Technician Training Program

5. Dose Control

a. PLAN Content

This section of the PLAN should describe a dose control system for evaluating, controlling, monitoring, and recording doses. The PLAN should contain the information necessary to assure that occupational doses are within regulatory limits and that individual and collective occupational doses are ALARA. Elements of this system to be included in the PLAN are:

- (1) ALARA Coordination (see b. (1) below)
- (2) Radiation Protection Evaluations of facilities, design, equipment, and procedures for ALARA applications
- (3) Administrative Dose Control
- (4) Dose Tracking by Job
- (5) Radiation Work Permits
- (6) Collective Dose Goal Approvals for Tasks
- (7) Monitoring for Gamma Dose
- (8) Monitoring for Neutron Dose
- (9) Monitoring for Beta Skin Dose
- (10) Monitoring Surface Contamination Areas
- (11) Controls for and Monitoring for Intake of Radioactivity into the Body
- (12) Quality Control for Dosimetry
- (13) Area Posting
- (14) Radiation Work Practices, Engineering Controls, and Procedures Related to Dose Control (see Section 12.)
- (15) Use of Current Survey Information for Dose Control

b. Acceptance Criteria

For this section of the PLAN to be acceptable, the following criteria should be met:

(1) ALARA Coordination

A qualified professional individual (or committee) should be assigned the responsibility and authority to coordinate ALARA development and implementation, including risk benefit coordination of tasks (See Regulatory Guide 8.8, Section B). The actual implementation of specific ALARA actions

should be via each individual line manager. ALARA considerations should, where appropriate, be incorporated into all aspects of daily work (See Section C.1.b of Regulatory Guide 8.8).

(2) Radiation Protection Evaluations of Facilities, Design, Equipment, and Procedures for ALARA Applications

All aspects of station operations should be reviewed to determine methods to keep exposure ALARA. These ALARA elements should be considered by appropriate line management in the planning of tasks. Radiation Protection controls should be integrated into procedures where practical. Within the PLAN for a station, considerations applied in Radiation Protection ALARA reviews should include implementation of appropriate sections of Regulatory Guide 8.8 (see Section 5.C.(1) of this report).

(3) Administrative Dose Control

There should be an administrative dose control system, requiring approval by line management, which controls both planned and actual doses to individuals as they progressively (incrementally) approach limits of 10 CFR 20.101 or administrative limits established for the facility. It is considered good practice and recommended by the staff that doses to personnel be maintained to the NCRP/ICRP/EPA recommendation of 5 rems/yr. Consideration should be given by licensees to voluntarily controlling individual doses to 5 rems/yr. Such a practice is to be used to reduce the risk to those small number of people who may exceed this criteria while providing a tool to reduce collective dose to the plant workers. The RPM should require review of all individual doses that exceed or are expected to exceed a specified investigation level, which should normally be 1.5 rems annual whole-body dose. These approvals should be based on a determination that the dose to be received by the individual is ALARA. Individual operations and support group managers, supervisors, and foreman should all strive actively to keep individual and group exposures at a minimum and to keep the number of workers exposed at a minimum. Guidelines and policies governing emergency exposures and overexposures should be outlined. This dose control system should be implemented via the Radiation Work Permit (RWP) system.

(4) Dose Tracking By Job

An accountability system that records doses for each individual, by major or repetitive operations performed and system or component serviced, should be described. This system should allow dose trend analysis and should provide workers with their current dose status frequently. For example, during outages this system should provide daily updates of worker doses. Computerized systems are an effective means of providing such information. This dose tracking should be implemented via the RWP system.

(5) Radiation Work Permits

Radiation Work Permit (RWP) criteria should be specified. The RWP should summarize the radiation protection controls established as part of job

planning and which have been incorporated into procedures; RWPs should not substitute for procedures or for incorporating radiation protection controls into procedures. For every task involving radiation work, sufficient radiation protection controls should be specified to meet all Federal and licensee requirements. Acceptable radiation work practices should also be described and sufficient Radiation Protection Technician coverage assigned to assure worker protection and ensure ALARA worker exposure. To the maximum extent possible, work procedures or engineering work tasks which fully incorporate radiation protection controls should be developed and should specifically identify work steps which require Radiation Protection Technician coverage. Section C.3.a(8) of Regulatory Guide 8.8 outlines information that should be included on an RWP. RWPs should show or reference dose rate and contamination level maps so that workers can spend minimum time in the highest dose rate locations. Dose rate maps should identify localized high dose rate areas (hot spots).

(6) Collective Dose Goal Approvals for Tasks

Tasks that involve significant total exposure (see Appendix F for an example) should be reviewed by higher level management. Criteria for RPM or other management approvals for tasks involving specified collective doses should be established. These reviews and approvals should establish collective (person-rem) dose goals for such tasks. Appendix F contains acceptable criteria for such reviews.

(7) Monitoring for Gamma Dose

Film badges and/or TLDs should be used to meet the personnel monitoring requirements of 10 CFR Part 20 for gamma exposure to radiations ranging from the 80 keV gammas from Xe-133 decay to the 6 MeV gammas from N-16 decay. Situations where direct-reading pocket chambers should be worn in addition to TLDs or film badges to provide workers with dose tracking capability should be described. Pocket chambers should be selected in accordance with Regulatory Guide 8.4, "Direct Reading and Indirect Reading Pocket Dosimeters." Criteria for the use of multiple whole-body dosimetry should be described. Appropriate monitoring devices should be attached to extremities when extremity doses meet the criteria of 10 CFR 20.202, and procedures for the evaluation and use of extremity dosimetry should be described. Otherwise, whole-body personnel monitoring results should be used as the limiting dose.

(8) Monitoring for Neutron Dose

Monitoring for neutron dose should be in accordance with Regulatory Guide 8.14, "Personnel Neutron Dosimeters," Revision 2, or an equivalent alternative should be described.

(9) Monitoring for Beta Skin Dose

Film badges and/or TLDs should be used to monitor the dose to the skin of a person's body. The dose due to skin contamination should be calculated in accordance with methods in LA-4558-MS, "Surface Contamination: Decision Levels" (especially Section III.A) or Medical Internal Radiation Dose (MIRD)

Pamphlet No. 11 published by the Medical Internal Radiation Dose Committee of the Society of Nuclear Medicine or an equivalent alternative should be specified. The dose recorded should be the highest dose received by any one square centimeter of skin.* Special procedures and guidelines for precluding beta exposure to the eyes and skin should be described.

(10) Monitoring Surface Contamination Areas

The program to control and contain the spread of contamination should include use of engineering controls to limit airborne radioactivity and prevent the spread of radioactive materials to and buildup in uncontrolled areas. The PLAN should specify contamination limits for demarcation of "Controlled Surface Contamination Areas" (acceptable limits are listed in Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors," or equivalent alternatives may be detailed), where a Controlled Surface Contamination Area is an area of loose radioactive surface contamination where acceptable limits are exceeded. Methods of posting and control, such as use of barriers and tape boundaries, where contamination levels exceed 1000 dpm/100 cm² beta/gamma should be described. Levels selected should be at or near background levels, detectable with available instrumentation, low enough to preclude buildup in the environment, and low enough to preclude an airborne radioactivity problem. The PLAN should also specify that protective clothing will be used in Controlled Surface Contamination Areas.

(11) Controls For and Monitoring For Intake of Radioactivity into the Body

The air sampling program should provide measurements of concentration of radionuclides representative of workers' breathing zones in order to determine and control workers' intakes in accordance with 10 CFR 20.103. The control of workers' intakes should be implemented by the RWP system. The bioassay program should include baseline information for the internal monitoring program and should be in accordance with Regulatory Guide 8.21, "Application of Bioassay of Fission and Activation Products," and Regulatory Guide 8.9, "Acceptable Concepts, Models, Equations and Assumptions for a Bioassay Program," or should be based on equivalent alternatives. A quality control program for the bioassay program should be established. Requirements for engineering controls which minimize potential intake should be described.

(12) Quality Control for Dosimetry Badges

The quality control program for TLDs should contain the same elements as ANSI N545-1975 or an equivalent alternative. The quality control program for film badges should meet the performance criteria of ANSI N13.11, "Criteria for Listing Personnel Dosimetry Performance," or an equivalent alternative should be detailed.

*See NBS Handbook 59, "Permissible Dose from External Sources of Ionizing Radiation," Sections 4.2 and 4.6 and ICRP publication 9, "Recommendations of the International Commission on Radiological Protection, Paragraph 28.

(13) Area Posting

Areas, access to which is controlled because of radiation protection considerations, should be clearly posted and/or locked in accordance with 10 CFR Part 20.203, technical specifications, or procedural requirements.

(14) Radiation Work Practices

Standardized procedures, engineering controls, and practices which are frequently used to effect dose control measures should be established to provide consistent and effective field implementation of these measures. Example of topics typically considered for work practices are provided in Section 11.

(15) Use of Current Survey Information for Dose Control

The Plan should describe how current surveillance information is used to establish dose control for work and how this is documented (e.g. RWPs). Requirements for special surveillance prior to, during, and after task should be established.

c. Procedural Details

The following guidance is provided for implementing the acceptance criteria into specific procedures for dose control:

(1) ALARA

The ALARA program should include the elements of Regulatory Guide 8.8 listed below:

- (a) Use of temporary or permanent shielding (see R.G. 8.8, Section C.2.b.(1), (2), (4), (5), (6), and (10).)
- (b) Use of special tools, features that permit prompt accessibility, remote monitors, or equipment (see R.G. 8.8, Sections C.2.a.(3), C.2.b(2), (7), and (9); C.3.a(4); and C.3.c(1) and (2).
- (c) Preoperational and postoperational briefings of personnel (see R.G. 8.8, section C.3.a(6); C.3.c(1).
- (d) "Dry runs" on mockup equipment and involvement of workers in planning (see R.G. 8.8, Section C.3.a(12)).
- (e) Use of portable temporary ventilation systems and contamination enclosures (see R.G. 8.8, Sections C.2.d(1), (2), (3), (4), and (6), and C.3.a(11) and (14)).
- (f) Use of auxiliary lighting and a working environment with comfortable temperature, humidity, and adequate space (see R.G. 8.8, Section C.3.a(13)
- (g) Use of communication systems (see R.G. 8.8, Section C.3.b(3)).

- (h) Assignment of radiation protection personnel job coverage (see R.G. 8.8, Section C.3.b(1)).
- (i) Scheduling activities such as maintenance and inspections following significant decay of short-lived isotopes or after flushing or decontamination (see R.G. 8.8, Section C.3.a(16) and C.2.f(1), (2) and (3)).
- (j) Controlling access to higher dose rate areas and routing traffic through lower dose rate areas (see R.G. 8.8, Section C.2.a).
- (k) Establishing person-rem goals.
- (l) Preplanning work (see Appendix F).

(2) Radiation Protection for Tasks

Radiation protection considerations for tasks should be incorporated into operational procedures or work packages to the maximum extent possible. Individual steps which require Radiation Protection Technician coverage should be clearly identified. RWPs should be used to supplement work documents or address changing conditions, but should not be the prime method of providing radiological work direction or controls. "Standing RWPs" should be limited only to conduct of radiation protection surveys and routine tours of areas where radiological conditions are stable. These should be approved by the Radiation Protection Manager.

(3) Monitoring for Gamma Dose

a. Primary Dosimetry

Personnel exposure records and reports made pursuant to 10 CFR Part 20 should normally be based on TLD or film badge results; however, the use of pocket chamber results or results calculated from exposure rates and stay times may be appropriate whenever TLD or film badge results are questionable. The TLD or film badge should be worn on that portion of the whole body which is expected to receive the highest dose. The whole body should include the gonads and lens of the eye. Where doses may vary greatly within small work areas such as inside a steam generator, several dosimeters should be worn (e.g., on the head, chest, and adjacent to the gonadal area) to assure that the maximum whole-body exposure is measured.

b. Use of Pocket Dosimeters

Pocket dosimeters should be read prior to their use and periodically thereafter by the wearer. Dosimeters should be recharged and doses recorded whenever indicated doses exceed three-fourths full scale. When a pocket dosimeter reading is off-scale or a dosimeter is lost under conditions such that a high dose is possible, the person's TLD or film badge should be processed as soon as possible and the person removed from radiation areas until the dose has been determined.

c. Stay Time

Where work area radiation levels are so high that a worker can rapidly receive his allowable radiation dose, the worker's occupancy in the work area should be limited on the basis of stay time and predetermined readings on direct-reading pocket dosimeters, or alarming dosimeters set to alarm at a predetermined dose. Pocket dosimeters covering both the expected exposure range and higher ranges should be used. The worker should promptly leave the work area whenever either the stay time or allotted pocket dosimeter reading is reached, whichever occurs first. If upon exit, the pocket dosimeter reading is below the allowable dose, reevaluation of both pocket dosimeter reading and stay time based on remaining allowable exposure should be performed, and stay time and allowed exposure should be readjusted with each subsequent work area entry.

d. Comparing Pocket Dosimeter and TLD or Film Badge Results

Pocket dosimeter results should be compared routinely with TLD or film badge results and each discrepancy greater than 25% for exposures over 100 mr should be thoroughly evaluated. The evaluation should include consideration of factors such as: energy dependence of devices used, survey results, exposure times, doses of others performing similar work, location of devices worn on body, etc.

e. Special Processing of Dosimetry Devices

To reduce the probability of exceeding dose limits, TLD or film badges should be processed frequently as limits are approached.

(4) Monitoring for Beta Skin Dose

Examples of areas of work where the skin may be a critical organ for radiation exposure are work inside steam generators, work under a reactor vessel head, or work in decayed noble gas environments. Measurement of beta dose rates should be made prior to start of the work. Beta monitoring should be accomplished by placing a TLD or film badge in contact with that portion of the body expected to receive the highest dose.

(5) Area Posting

Controlled surface contamination areas, radioactive materials storage areas, radiation areas, high radiation areas, exclusion areas (or very high radiation areas), hot spots, wait areas, airborne radioactivity areas, and restricted areas should be posted in such a manner that workers are aware of the approximate boundaries of the areas. For example, posting an entire building as a radiation area would be inappropriate if the areas meeting criteria for posting were limited to individual rooms or discrete areas within the building.

Methods for clearly distinguishing radioactively contaminated systems should be explained, along with special precautions required for maintenance for such systems.

Controls for potentially lethal radiation fields such as might occur during spent fuel transfer should be described in accordance with the Branch Position in Table 5-1.

(6) Bioassays

Procedures implementing the bioassay (in vivo counting, urinalysis, etc.) program should specify the people who will be in the program, the types of bioassay given them, frequencies, action levels, and actions to be taken.

(7) Use of Protective Clothing

Procedures for standardizing types of protective clothing in use at the facility and the preferred techniques for donning and removal should be described. Situations requiring protective clothing should be defined, including levels requiring double clothing or gloves and use within the Controlled Area.

Table 5-1

Control of Access to Spent Fuel
Transfer Tube Areas

All accessible portions of the spent fuel transfer tube and or canal must be shielded during fuel transfer. Use of removable shielding for this purpose is acceptable. This shielding shall be such that the resultant contact radiation levels shall be no greater than 100 rads per hour. All accessible portions of the spent fuel transfer tube shall be clearly marked with a sign stating that potentially lethal radiation fields are possible during fuel transfer. If removable shielding is used for the fuel transfer tubes, it must also be explicitly marked as above. If other than permanent shielding is used, local audible and visible alarming radiation monitors must be installed to alert personnel if temporary fuel transfer tube shielding is removed during fuel transfer operations.

6. Radioactive Materials (RAM) Control

a. PLAN Content

- (1) The Plan should describe the system for and the responsibilities for identification, accountability, control, movement, storage, and inventory of radioactive materials outside of controlled areas; for receipt and shipment of radioactive materials and criteria for the release and unrestricted use in uncontrolled areas of materials from controlled areas.

b. Acceptance Criteria

- (1) Procedures should specify controls and group and individual (by position) responsibilities for a radioactive materials control program which assures firm and positive control over RAM so that unnecessary or inadvertent exposures do not occur and RAM is not released into uncontrolled areas (e.g., offsite or to dumps) where individuals not monitored for occupational radiation exposure could receive exposure. The procedures should include:
 - (a) For controlled areas, at least provisions for:
 - i. identification of RAM
 - ii. positive control of RAM,
 - iii. movement and storage of RAM
 - (b) For uncontrolled areas, provisions for:
 - i. identification of RAM
 - ii. control of RAM
 - iii. accountability of RAM
 - iv. movement of RAM
 - v. storage of RAM
 - vi. inventory of RAM
- (2) Procedures for radioactive materials storage and laydown areas should include:
 - (a) criteria for posting and isolating
 - (b) survey requirements
 - (c) access requirements
- (3) Radioactive material transfer and receipt to/from other facilities should ensure that DOT requirements are met, and local criteria should be established for:
 - (a) radiation level and contamination surveys
 - i. when required
 - ii. types of surveys (e.g., α , β , β - γ)
 - iii. extent of surveys/documentation
 - iv. identifying and reporting (or preventing) DOT violations

- (b) packaging
 - (c) labelling
- (4) Procedures should describe local implementation of DOT requirements, criteria for release of materials from controlled areas (e.g., CSCAs), and include a program which verifies the absence of RAM from uncontrolled areas or outside of designated storage areas. Criteria should be that in Regulatory Guide 1.86. Area, equipment, and material decontamination criteria and procedures should be provided.

c. Procedural Details

The following guidance is provided for implementing the acceptance criteria into specific procedures for radioactive material control:

- (a) facility definition of radioactive materials
- (b) proper marking and identification
 - i. radiation levels
 - ii. contamination levels
- (c) systems and procedures for RAM:
 - i. initial generation
 - ii. movement and transfer within the controlled area and the restricted area
 - iii. shipment from facility, including application of basic DOT criteria
 - iv. receipt from off-facility
 - v. long-term storage
 - vi. liquid samples
- (d) storage and periodic inventory
- (e) loss of radioactive materials
- (f) survey and packaging procedures, to include:
 - i. thumb rules and estimates for determining handling requirements
 - ii. use of identifying features and markings, such as yellow plastic bags and sheets/tagging with yellow and magenta tags
 - iii. identification of uncontaminated materials (e.g., surveyed and released)
- (g) personnel authorized to handle radioactive materials
- (h) segregation and reduction of radioactive waste:
 - i. survey and release criteria
 - ii. low-level waste
 - iii. high-level waste

- (i) special controls (e.g., inventory, encumbrance, storage) for:
 - i. standard and check sources
 - ii. special nuclear materials
 - iii. fissile materials
 - iv. source materials
 - v. radiography sources
 - vi. highly radioactive materials of small size (e.g., pocketable with dose rates greater than 100 mrem/hr)
- (j) lifting and rigging of radioactive materials
- (k) marking and storage of contaminated portable tools
- (l) ALARA guidelines for radioactive material control
- (m) radioactive material control program responsibilities

7. Surveillance

a. PLAN Content

This section of the PLAN should describe the radiation protection surveillance program which will be conducted. The PLAN should specify that the frequencies of surveys for radiation, radioactive contamination, airborne radioactivity, and radioactive materials will be established in procedures; describe the situations where these surveys are required; describe the nature and extent of these surveys; describe the equipment used in the surveys; describe how these surveys verify the radiological status of all facility areas, and describe the uses of survey data in work planning, procedures, radiation work permits, and similar functions.

b. Acceptance Criteria

(1) Routine Surveys - General

- (a) Radiation protection surveys as required by 10 CFR Part 20, Section 20.201 should include not only physical measurements and monitoring but also investigation and correction of abnormal radiological conditions which may be discovered.
- (b) Frequencies of surveys and monitoring should be established based on the potential hazard, probability of change in radiological conditions, and occupancy factors. Surveys should be performed in both restricted and unrestricted areas to provide positive verification that radioactive materials are being adequately controlled and are not spreading to, or building up, in uncontrolled areas.
- (c) A mechanism should be established to assure that survey data are available and used for informing personnel of hazards, job evaluation, trend analysis, and ALARA pre-planning.

(2) Dose Rate Surveys

- (a) Dose rate surveys should be performed with instruments calibrated for the type and range of radiation being monitored, e.g., beta survey instruments should be calibrated for beta radiation.
- (b) Surveillance performed within large areas posted as high radiation areas where whole-body dose rates vary significantly should include the posting of "hot" spots and identifying low dose rate areas. Typical "hot" spot signs may designate 1/2, 1, 2, etc., rem/hr areas.

(3) Contamination Surveys

- (a) Areas to be surveyed and frequencies of surveys should be established based on the potential radiological hazard,

probability of change in conditions, and area occupancy factors.

(4) Airborne Radionuclide Surveys

- (a) Criteria for areas to be surveyed and monitored should be identified in the PLAN, and frequencies of surveys and monitoring should be established in procedures based on the potential radiological hazard, probability of change in conditions, and area occupancy factors.
- (b) Capabilities and procedures should be developed for prompt detection of radioiodine in the presence of noble gases.

c. Procedural Details

The following guidance is provided for criteria that should be incorporated into specific implementing procedures.

(1) Surveys - General

- (a) Frequency of Surveys: Active work areas where radiological conditions may change as a result of the work being performed should be surveyed for radiation and contamination at least once per shift, or more frequently if radiological conditions could change (e.g., upon opening a radioactive system).

Exit points from contamination controlled areas should be surveyed for contamination following use at least daily, and shiftly during frequent use, such as during outages.

Eating areas used by individuals who have worked in controlled surface contamination areas should be surveyed for contamination at least weekly during routine operations and at least daily during major outages; potable water supplies should be sampled at least weekly.

Storage areas for solid radioactive waste and irradiated/contaminated components and equipment should be surveyed at least weekly when materials are moved into or out of the area during the week. Pathways within the storage areas should be surveyed for radiation and contamination; external perimeters should be surveyed for radiation.

- (b) Survey results should normally be posted on status sheets or the signs at entrances to controlled areas. The results should also be available for use in developing controls for procedures and RWPs. Results may be specified as ranges.
- (c) Survey requirements for recurring, nonroutine jobs should be established by procedures. For example, specific concerns and the type of data needed should be specified for jobs such as PWR steam generator work, in-service inspections of in-vessel components at BWRs, and work on in-core detector systems.

- (d) Criteria and action levels/responses should be established for abnormally high or unusual survey results.
- (e) Radiation Work Permits or other work documents incorporating radiological control requirements should specify when surveys or coverage by a Radiation Protection Technician is required.
- (f) Surveys should be filed and maintained so that previous radiological conditions can be readily reconstructed and background data for engineering evaluations is readily available. The use of computers for storing and retrieval of survey/job experience data is helpful in that they allow prompt review of history for preplanning new activities.

(2) Dose Rate Surveys

- (a) In addition to physical dose rate surveys, restricted areas which are frequently occupied should also be monitored by recording area monitors or fixed dosimetry badges which are replaced and processed on a periodic basis.
- (b) Dose rate surveys should be performed on laundered/decontaminated personnel protective equipment prior to reuse. Acceptable limit for respiratory protective gear is given in NUREG-0041. Limits for clean protective clothing should not exceed 0.1 mrem/hr for routinely used clothing. For clothing to be used as the outside protective clothing in highly contaminated areas for short periods, higher dose rates from clean clothing is acceptable. General limits or single-use limits should balance radioactive waste reduction and water processing waste generation with exposure reduction.

(3) Contamination Surveys

- (a) Monitoring procedures (frisking, etc.) should be established to check for personnel contamination and to control the release of potentially contaminated or activated materials for unrestricted use.
- (b) Contamination surveys should include clean waste dumps and landfills, salvage areas, plant warehouses, tool storage areas, the gate house, and contractor buildings.
- (c) Any personnel contamination detected on hair or skin should be promptly removed, using licensee-approved procedures, under the supervision of trained radiation protection personnel, to the extent practicable. If initial washings with soap and water are not effective, radiation protection supervisory personnel should be notified and further attempts to decontaminate should be by procedures approved by medical personnel knowledgeable in radiological matters.
- (d) Records of personnel contamination and decontamination results should be maintained to assist in dose evaluations and as indications of potential problem areas. As a minimum, these records

should include names of individuals involved, survey results (including nasal swabs), decontamination methods, results of decontamination, areas worked, RWP numbers, investigation findings, and corrective actions.

- (e) Calibrated personnel "friskers" should be provided at or near the exits to controlled surface contamination areas and personnel should be monitored or required to monitor themselves upon leaving the controlled area. Personnel "friskers" should be capable of detecting total contamination levels of at least 5000 dpm/100 cm² (330 dpm per 15 cm² probe area) and preferably as low as 3,000 dpm/100 cm² (200 dpm per 15 cm² probe area) β - γ contamination. To achieve this detection range, low background monitoring areas are required. If low background areas cannot be achieved through shielding or other actions, frisking to detect gross contamination levels may be performed initially, but final frisker locations may have to be shielded or moved to remote areas and additional controls implemented to control passage to the remote frisking location.
- (f) Personnel frisking procedures should be established which specify the portions of the body that must be monitored (generally the entire body), the distance between the body and the detector (within about 1/2 inch for β γ), and the speed with which the detector is moved (maximum of about 2 inches per second for β γ). Frisking rate should be reduced where background levels are not minimal or alpha contamination is possible or very sensitive whole-body monitors should be used.
- (g) Portal monitors and hand and foot monitors are useful instruments and may provide supplementary monitoring for personnel contamination but may not be acceptable for use as the primary means of monitoring for personnel contamination.
- (h) Everything within a controlled surface contamination area should be considered and treated as contaminated. All items removed from the area should be surveyed for contamination, bagged and labelled if contaminated.

(4) Airborne Radioactivity Surveys

- (a) When continuous air monitoring is performed, periodic high volume grab samples or breathing zone air samples should be taken to verify that air monitoring is representative of the actual work area.
- (b) Capabilities should be provided for exhausting grab samples back to their source when extremely high levels of activities are expected.
- (c) A minimum detectable activity for the equipment in use should be established.
- (d) Collection efficiencies for particulate and iodine sampling media should be established.

- (e) Periodic tests should be conducted to assure pressure gradients and air flows are from areas of low potential airborne contamination to areas of higher potential contamination.

8. Instrumentation

a. PLAN Content

This section of the PLAN should describe the types, numbers, purpose, capabilities, and characteristics of the portable and non-portable survey instruments and laboratory counting equipment used for performing radiation and radioactive contamination surveys.

b. Acceptance Criteria

A radiation protection PLAN should describe the radiation survey instrumentation that detects and measures all types of radiation over a wide range of dose rates, doses and energy for the various types of radiation encountered. For this section of the PLAN to be acceptable, the following features should be described:

(1) Inventory

- (a) Instrumentation should include: pocket dosimeters, dosimeter readers, portable survey meters, low level contamination/dose rate meters, remote area monitors (fixed and portable), continuous air monitors (fixed and mobile), air samplers, personnel friskers, portal monitors, hand and foot monitors, laboratory counting instruments, whole body counters, flow rate measuring devices, and supporting calibration equipment and spare parts. The inventory description should include the requirements for selected ranges, sensitivities, types of radiation to be monitored, accuracy required, remote readout, alarm setpoints and conditions, and types of surveying or monitoring to be performed.
- (b) For counting facilities, backup counting facilities should be available, if the primary system is lost. For systems utilizing computer calculations, a manual backup capability should be provided.

(2) Calibration

- (a) Calibration of portable (hand carried) and non-portable radiation protection survey instrumentation should be performed in accordance with Regulatory Guide 8.25, ANSI N323-1978 or equivalent alternatives. Unless there is reason to suggest that more frequent primary calibrations are required, the ANSI standard recommendations for annual primary calibrations are acceptable. However, secondary calibrations should be performed quarterly. Secondary calibrations may be defined as a procedure which follows directly after a primary calibration and periodically (e.g., quarterly) thereafter to ensure that the instrument response remains accurate within prescribed limits. When performing the secondary calibration, the calibration source strength should be sufficient to encompass those dose rate ranges of the instrument to be calibrated that are normally used during normal plant operations. Calibration of at least one point per decade of this range shall be included.

- (b) A quality assurance program should be established as an integral part of the calibration procedures, using criteria contained in Regulatory Guide 1.144, Revision 1, "Auditing of Quality Assurance Programs at Nuclear Power Plants."

(3) Operational (functional) Checks

- (a) Operational (functional or response) checks should be developed for each type of instrumentation. Procedures for these checks should be incorporated into the station implementing procedures.
- (b) Operational (functional) checks of continuously operating instruments should be made daily; for other instrumentation, checks should be made prior to use.
- (c) Emergency and special use instruments should be response checked regularly.

c. Procedural Details

The following guidance is provided for criteria that should be incorporated into specific implementing and training procedures.

(1) Inventory

- (a) There should be a sufficient number of instruments available in operating condition to accommodate the need to monitor the number of operations that may be required in radiation areas and high radiation areas throughout the plant, particularly during major maintenance and refueling outages and/or accidents. In arriving at a total number, consideration should also be given to the number of survey instruments that may be out of service for calibration or maintenance, or inoperative during the outage or accident. A minimum inventory level should be established at which operations are limited due to inadequate surveying capability.
- (b) Instrumentation dedicated to specific uses should be identified. The location and dedicated use should be specified, e.g., emergency kits, beta dose rate measurements, alpha or neutron measurements, etc. A mechanism for assessing operability of such instrumentation should be described in procedures.
- (c) Implementing procedures should establish the criteria for frequencies of calibration. At least annually, a review of the maintenance and calibration history for each type of instrument should be performed to determine instrument performance, and the frequency of calibration modified, if appropriate.
- (d) Gamma high dose rate instruments with long or extendable probes should be maintained for routine use.

- (e) Whole-body counters or partial-body monitoring devices (body scanners) should be maintained onsite and be capable of promptly identifying approximately 10 percent body burdens from a 40-MPC-hour intake of common corrosion products and approximately 10 percent thyroid burden for radioiodine.
- (f) Means should be established to readily identify special use or dedicated instruments which are capable of being used for other purposes.

(2) Calibration

- (a) Portable (hand-carried) dose rate instruments should be calibrated at least quarterly unless there is evidence or experience to warrant more frequent calibrations.
- (b) Continuous air sampling/monitoring devices and air sampling lines should be tested on a periodic basis to determine that samples are representative.
- (c) Continuous air monitoring devices should be capable of detecting 1-MPC-hour in one hour.
- (d) Air flow measuring devices including those installed on radiation detection instrumentation should be calibrated against a standard reference instrument at least semiannually.

(3) Operational (functional) Checks

- (a) Operational (functional) checks which are performed using a radioactive source should check instrument response near the control level or within the range normally used.
- (b) Daily operational checks following the guidance of ANSI N 323-1978 (Section 4.6, "Periodic Performance Test") should be performed on portable (hand-carried) dose rate instruments, except for the high-range scale of high-range instruments.

9. Review and Audit

a. PLAN Content

This section of the PLAN should describe the types and frequencies of reviews and audits established for the radiation protection program including:

- (1) Radiation protection supervisory reviews,
- (2) Quality assurance audits,
- (3) Corporate or contract audits,
- (4) Radiation protection deficiency identification.

b. Acceptance Criteria

Reviews and audits should incorporate the following features:

(1) Radiation protection supervisory reviews

Onsite radiation protection supervision and radiation protection engineering should frequently perform in-plant reviews of radiation protection staff effectiveness in such areas as radiological work practices, work monitoring, procedural compliance, and survey adequacy.

(2) Quality assurance audits

Quality assurance audits should be performed by the onsite auditing group by personnel with radiation protection training or experience to assure that radiation protection functions are being performed as required. The quality assurance program audits should meet the requirements of Appendix B of 10 CFR Part 50.

(3) Corporate or contract audits

Offsite (corporate or contract) audits and evaluations should be performed to assure the compliance of the radiation protection program with regulations and requirements, and to assure that station-wide objectives are being met.

(4) Radiation protection deficiency identification

A reporting system should be established to identify and correct deficiencies in radiation work practices, training, maintenance, systems operations, and materials. It should include a tracking and analysis feature that can identify trends in exposure control, contamination control and airborne radioactivity control, so as to provide the capability to improve the radiation protection program.

(5) Audits and reviews should function to:

- (a) identify non-compliance with Federal and licensee radiation protection requirements,

- (b) identify work practices which could be improved, particularly those which result in unnecessary exposure,
- (c) evaluate radiation protection training effectiveness,
- (d) identify radiation control problems and determine the root causes of radiation protection incidents.

c. Procedural Details

- (1) The following guidance is provided for criteria that should be incorporated into specific implementing procedures.
 - (a) Specific senior management positions should be designated as responsible for assuring that deficiency reports and audit findings are addressed in a timely manner and that corrective actions are completed.
 - (b) Offsite audits of technical adequacy and safety objectives should be conducted at least annually.
 - (c) Observation and review of radiation protection practices should be conducted by the radiation protection staff to assure station-wide compliance with radiation protection procedures. Administration and documentation should be practical and functional to promote in-situ fixes of deficiencies and track and correct adverse trends or wide-spread deficiencies.
 - (d) Quality assurance audits should be performed for the following areas of radiation protection:

Radiation Monitoring (Fixed and Portable)

Radioactivity Monitoring (Fixed and Portable)

Radioactivity Sampling (Air, Surfaces, Liquids)

Radioactive Contamination Measurement and Analysis

Personnel Monitoring, Internal (e.g., whole-body counter) and external (e.g., TLD system)

Instrument Storage, Calibration and Maintenance

Decontamination (Facilities, Personnel, and Equipment)

Respiratory Protection, including testing

Contamination Control

Radiation Shielding

10. Radiation Protection Incident Analysis

a. PLAN Content

The PLAN should describe a system and criteria for identifying radiation protection incidents*, evaluating the circumstances and causes of these events, and developing short- and long-term corrective actions which preclude recurrence of such incidents.

b. Acceptance Criteria

The system should integrate lessons learned from incidents, licensee experience, the experience of others, and trend analysis, and apply this to radiation protection program improvement. Incident evaluations should be conducted by line supervisors and managers with the technical assistance of radiation protection personnel.

c. Procedural Details

*The following are typical situations which might be considered incidents for applying corrective actions and determining if undesirable trends exist at a facility:

- radiation exposure which exceeds licensee's control levels
- any body burdens received in excess of the licensee's control levels, including any measureable but unexpected depositions below those control levels
- all personnel contamination instances
- instances of actual or potential exposure to airborne radioactivity above licensee's control levels
- spills or spread of radioactive materials which affect operations, cause increased risk of exposure to personnel, or which degrade facility radiation protection conditions significantly
- radioactive materials which may be lost, or those which are found in unauthorized areas
- improper wearing or use of dosimetry equipment, including unmonitored exposures
- improper control or access for posted areas, particularly High Radiation Areas

11. Radiation Work Practices

a. PLAN Content

The PLAN should describe a system for providing standardized radiation work practices procedures and engineering controls. These procedures and controls might be included in procedures related to a particular PLAN area (such as temporary shielding is related to dose control) or as separate procedures and controls related to several PLAN areas (such as radioactive vacuum cleaner control is related to dose control, contamination control, airborne radioactivity control and radioactive material control).

b. Acceptance Criteria

An acceptable PLAN should include a description of the radiation work practices essential to operations and how they are utilized with work documents such as RWPs. Some typical work procedures are:

- (1) Radiation maintenance exposure reduction methods,
- (2) Radiation work performance methods, including preparation of work areas, grinding, welding, cutting of systems and components; venting and draining methods, component maintenance methods, and component removal methods,
- (3) Use of temporary shielding,
- (4) Contamination control equipment,
- (5) Work area ventilation,
- (6) Decontamination processes,
- (7) Liquid and solid waste processing,
- (8) Control system for contaminated tools,
- (9) Methods of radiation protection area posting,
- (10) Use of respiratory protection in accordance with Regulatory Guide 8.15 and NUREG-0041,
- (11) Description and functions of protective clothing.

REFERENCES

General

- | | |
|-----------------------|--|
| Regulatory Guide 8.8 | Information Relevant to Ensuring That Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable ¹ |
| Regulatory Guide 8.10 | Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable ¹ |

SECTION 3 Radiation Protection Organization and Function

- | | |
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| Regulatory Guide 1.8 | Personnel Selection and Training ¹ |
| NUREG-0731 | Guidelines for Utility Management Structure and Technical Resources (Draft) ² |
| Regulatory Guide 8.8 | Information Relevant to Ensuring That Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable ¹ |
| NUREG-0654 | Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants ⁹ |

SECTION 4 Radiation Protection Training and Qualification

- | | |
|---------------------------|---|
| Regulatory Guide 1.8 | Personnel Selection and Training ¹ |
| Regulatory Guide 8. _____ | Radiation Protection Training at Nuclear Power Plants, OH 717-4, August 1979 ² |
| Regulatory Guide 8.13 | Instruction Concerning Prenatal Radiation Exposure ¹ |
| Regulatory Guide 8. _____ | Instruction Concerning Risk From Occupational Radiation Exposure, OH 902-1, May 1980 ² |

SECTION 5 Dose Control

- | | |
|----------------------|---|
| Regulatory Guide 8.2 | Guide for Administrative Practices in Radiation Monitoring ¹ |
| Regulatory Guide 8.4 | Direct-Reading and Indirect-Reading Pocket Dosimeters ¹ |
| Regulatory Guide 8.7 | Occupational Radiation Exposure Records Systems ¹ |

Regulatory Guide 8.14	Personnel Neutron Dosimeters ¹
Regulatory Guide 8.9	Acceptable Concepts, Models, Equations and Assumptions for a Bioassay Program ¹
Regulatory Guide 8.15	Acceptable Programs for Respiratory Protection ¹
Regulatory Guide 8.20	Applications of Bioassay for I-125 and I-131 ¹
Regulatory Guide 8.26	Applications of Bioassay for Fission and Activation Products ¹
Regulatory Guide 1.86	Termination of Operation Licenses for Nuclear Reactors ¹
ANSI N13.11	"Criteria for Testing Personnel Dosimetry Performance" ³
ANSI N13.6-1966 (R1972)	"Practice for Occupational Radiation Exposure Records Systems" ³
ANSI N343-1978	"Internal Dosimetry for Mixed Fission and Activation Products" ³
ICRP 9	"Recommendations of the International Commission on Radiological Protection." ⁴
NBS Handbooks 9	"Permissible Dose from External Sources of Ionizing Radiation" ⁵
MIRD Pamphlet No. 11	'S', Absorbed Dose per Unit Cumulated Activity for Selected Radionuclides and Organs" ⁷
LA-4558-MS	"Surface Contamination: Decision Levels" ⁵

SECTION 6 Radioactive Materials Control

Regulatory Guide _____	Measurement of Radiation Levels on Surfaces of Packages Containing Radioactive Materials, TP 914-4, December 1979 ²
International Atomic Energy Agency (IAEA) Technical Report Series No. 120, "Monitoring of Radioactive Contamination on Surfaces," 1970. ⁶	
IAEA Safety Series No. 38, "Radiation Protection Procedures," 1973. ⁶	
IAEA Safety Series No. 1, "Safe Handling of Radionuclides," 1973 Edition, Code of Practice Sponsored by the International Atomic Energy Agency (IAEA) and the World Health Organization (WHO), 1973. ⁶	
NCRP Report No. 57, "Instrumentation and Monitoring Methods for Radiation Protection," ⁸	

1978 ANSI N13.1-1969, "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities."³

NCRP Report No. 58, "A Handbook of Radioactivity Measurement Procedures," 1978.⁸

C.B. Meinhold, "Facility Monitoring Programs Techniques, and Problem Solving," Health Physics Operational Monitoring, Vol. 1, C.A. Willis and J. A. Handloser, Eds., Gordon and Breach, New York, 1972, p. 363.⁵

C.A. Willis, "Safe Specific Activity," A Useful Concept in Monitoring Areas Containing Activated Materials," Health Physics Operational Monitoring, Vol. 1, C.A. Willis and J. A. Handloser, Eds., Gordon and Breach, New York, 1972, p. 373.⁵

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P.G. Voilleque, "Calculation of Expected Urinary and Fecal Excretion Patterns Using the ICRP Task Force Group Report on Human Respiratory Tract," Health Physics Operational Monitoring, Vol. 1, C.A. Willis and J.A. Handloser, Eds., Gordon and Breach, New York, 1972, p. 773.⁵

SECTION 7 Surveillance

USAS N13.2-1969	Guide for Administrative Practices in Radiation Monitoring ³
ANSI N13.6-1966 (R-1972)	Practices for Occupational Radiation Exposure Records Systems ³
Regulatory Guide 8.2	Guide for Administrative Practice in Radiation Monitoring ¹
Regulatory Guide 8.7	Occupational Exposure Records System ¹

SECTION 8 Instrumentation

Regulatory Guide 8.25	Calibration and Error Limits of Air Sampling Instruments for Total Volume of Air Sampled ¹
Regulatory Guide 8._____	Audible Alarm Dosimeters (OH804-4) ²
Regulatory Guide 8._____	Radiation Protection Instrumentation Test and Calibration ²
IAEA Technical Report Series No. 133, "Handbook on Calibration of Radiation Protection Monitoring Instruments," 1971. ⁶	

R.L. Kathren, "Instruments in the Field Use, Abuse, and Misuse," Health Physics Operational Monitoring, Vol. 2, C.A. Willis and J.A. Handloser, Eds., Gordon and Breach, New York, 1972, p. 811.⁵

W.P. Howell and R.L. Kathern, "Calibration and Field Use of Ionization Chamber Survey Instruments," Health Physics Operational Monitoring, Vol. 2, C.A. Willis, and J.A. Handloser, Eds., New York, 1972, p. 925.⁵

SECTION 9 Review and Audit

Regulatory Guide 1.33

Quality Assurance Program Requirements (Operation)¹

ANSI N18.7-1976

Administrative Controls and Quality Assurance For the Operational Phase of Nuclear Power Plants³

SECTION 11 Radiation Work Practices

Regulatory Guide 8.15

Acceptable Programs for Respiratory Protection¹

NUREG-0041

Manual of Respiratory Protection Against Radioactive Materials⁹

¹Copies are available from NRC/GPO Sales Program, U.S. Nuclear Regulatory Commission, Washington, D. C. 20555, Attn: Regulatory Guide Accounts.

²Draft Report - Single copies are available from the USNRC Division of Technical Information and Document Control, Washington, D.C. 20555.

³Available from American National Standards Institute, 1430 Broadway, New York, NY 10018, Copyrighted.

⁴Available from Pergaman Press, Marwell House, Fairview Park, Elmsford, NY 10523, Copyrighted.

⁵Available in Public Technical Libraries.

⁶Available from UNIPUB, 34 Park Avenue South, New York, NY 10010

⁷Available from MIRD Committee, 404 Church Avenue, Suite 15, Maryville, TN 37801

⁸NCRP Publications P.O. Box 30175, Washington, D.C. 20014

⁹Available for purchase from National Technical Information Service, Springfield, Virginia 22161, and/or the NRC/GPO Sales Program, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

Appendix A

Example Qualification Standard For Radiation Work Training

A. Levels of Training

1. Basic Radiation Work Training - for individuals who require routine or frequent access to radiation areas, high radiation areas, airborne activity areas, or radioactive surface contamination areas, for such purposes as routine systems operations, inspections, administrative or safety functions, or routine maintenance.
2. Advanced Radiation Work Training - for individuals who require additional training to enable them to use special skills or work training where high levels of radiation, radioactive surface contamination, airborne radioactivity, or other unusual and challenging radiation work conditions exist. Such additional training should include radiation controls integrated with the following operations:
 - a. Contamination containment device operations,
 - (1) Construction, verification of integrity
 - (2) Work practices (e.g., grinding, vacuum operations)
 - (3) Emergency procedures (e.g., punctures, flooding)
 - (4) Decontamination and disassembly
 - b. Radiation Controls for Sampling
 - c. Radiation Controls for movement of low-level activity (e.g., < 1000 dpm) samples
 - d. Specialized training for personnel listed under Section 4.b(2), (4) who are not previously trained as Radiation Protection Technicians

B. Elements of Training

1. Written examination covering essential information from each of the main functional elements of the training program, with a minimum passing grade of 70% for essay-type exams. Exams should minimize the use of True-False type questions. A key should be prepared for each exam. Procedures to control exams and keys should be implemented to assure accurate testing and valid evaluation of training.
2. Practical examination of asterisked items in Appendix B
3. Formal documentation of training and examination results, with qualification and requalification verified by a designated representative of the Radiation Protection Manager.

Appendix A (Continued)

4. Trained instructors, meeting qualification standards approved by the Radiation Protection Manager, utilizing formal lesson plans, prepared visual aides and training aides, a prepared training facility for practical demonstrations and examinations, and utilizing a sufficient variety of approved written exams such that examination effectiveness will not be reduced by repeated use of the same exam.
5. A periodic re-audit (written and/or practical) program administered annually (on the average) for each individual on an unannounced basis to determine proficiency and identify weaknesses in radiation controls work practices and knowledge.
6. Requalification of previously qualified individuals, at two year intervals following qualification, to the same extent as initial qualification. Successful performance of practical abilities may be performed on-the-job if observed and formally documented for requalification by persons designated by the Radiation Protection Manager (e.g., Radiation Protection Supervisors, Radiation protection training personnel), if performed within six months of requalification.
7. A topical outline for training which encompasses the topics listed in Appendix B, "Example Content for a Radiation Work Training Program."

Appendix B

Example Content For a Basic Radiation Work Training Program

*Asterisked topics are those for which personnel should demonstrate a practical ability to accomplish.

1. RADIATION FUNDAMENTALS

- a. Definition of Radioactivity
- b. Sources of Radioactivity
 - (1) Natural Background Sources
 - (2) Man-made Sources
- c. Types of Radiation and Their Characteristics
- d. Differentiation of Radiation and Radioactive Contamination

2. RADIATION EXPOSURE LIMITS AND CONTROLS/EXTERNAL EXPOSURE CONTROL

- a. Definition of radiation and rem as a unit of biological dose from radiation
- b. Basic limits for radiation exposure
- c. Explanation of dose and dose rate
- d. Explanation of "stay time" and application
- e. Procedures and methods for minimizing exposure
 - (1) Distance between people and radiation source
 - (2) Exposure time limitation
 - (3) Shielding effects and use for individual exposure reduction
- f. Potential radiation sources associated with an individual's work functions
- g. Seriousness and consequences and possible penalties for
 - (1) violating radiation warning sign instructions
 - (2) unauthorized passage through barriers
- h. Types and functions of dosimetry equipment
- i. Instructions on the use, care, and proper wearing (on the body) of dosimetry equipment
- *j. Individual should demonstrate the ability to read all types of dosimeters to be used

*To be demonstrated as a practical ability in addition to knowledge requirements.

Appendix B (Continued)

- k. Tracking exposure and minimizing exposure as an individual's responsibility
 - l. Meaning of radiation protection posting - restricted areas, radiation areas/ high radiation areas, exclusion areas, controlled surface contamination areas, airborne radioactivity areas, radioactive material storage areas, other posted/labelled areas
 - m. Radiation measurement and survey instruments' purposes
3. RADIOACTIVE CONTAMINATION LIMITS AND CONTROLS/INTERNAL EXPOSURE CONTROL
- a. Definition of contamination and differentiation between "loose surface" contamination and "fixed" contamination.
 - b. Surface contamination limits for beta-gamma, beta, and alpha contamination, and the meaning of the units
 - c. Contamination control during radioactive work (e.g., containment in plastic bags and use of Contamination Containment Areas). Procedures for preventing contamination of personnel and how contamination is detected on personnel
 - d. How contamination is removed from contaminated objects and personnel
 - e. Potential sources of contamination associated with work performed by individuals
 - *f. Each individual should demonstrate proper procedures for donning and removing a full set of anticontamination clothing
 - *g. Each individual should demonstrate proper procedures for entering and leaving a contaminated area, including proper procedures for self-monitoring
 - *h. For personnel required to work in containment areas (e.g., glove bags or tents), each individual should demonstrate proper procedures for working in these areas. (This ability could be demonstrated on a mock-up)
 - i. Respiratory protective devices and their use. Situations which require wearing masks, air-supplied respirators, or air-supplied hoods
 - *j. For personnel who are likely to encounter airborne radioactivity, each individual should demonstrate the proper procedure for donning and removing the type of respiratory equipment the individual will be required to wear. For personnel who are required to wear respiratory

*To be demonstrated as a practical ability in addition to knowledge requirements.

Appendix B (Continued)

equipment with anticontamination clothing, this demonstration should be performed when donning and removing anticontamination clothing and should include any leak checks required to be made to test for proper operation of respiratory equipment. Separate training in accordance with Regulatory Guide 8.15 may meet this requirement (Section 4.b(3)).

- k. Posting of controlled surface contamination areas, contamination zone barriers, signs, labels, and meanings
- l. Contamination measurement and survey instruments
- 4. RADIOACTIVE MATERIALS CONTROL
 - a. Definition of radioactive materials (RAM)-origins, types and forms
 - b. Physical identification and systems of control of radioactive materials; storage, transfer, use
 - c. Personnel responsible for RAM control and accountability
- 5. WASTE ASSOCIATED WITH RADIOLOGICAL WORK
 - a. Methods for identification and proper control of radioactive solid and liquid waste
 - b. Methods by which individual workers can reduce the amount of radioactive waste generated
- 6. PREPARATIONS FOR EMERGENCIES - WORKER-RELATED INFORMATION AND ACTIONS
 - a. Plant Safety and Accident Control Features
 - b. Signals and Alarms
 - c. Evacuation Routes and Procedures
 - d. Assembly Points
 - e. Communications
 - f. Guidance and Directions
 - g. Emergency Equipment
 - h. First Aid and Contaminated Wounds
 - i. Radiation Incidents

Appendix B (continued)

- (1) Need for consulting radiation protection control personnel when questions arise or incidents occur
- (2) Procedures to be followed after a spill of material (liquid or solid) which is or might be radioactive
- (3) Procedures to be followed when notified that airborne radioactivity is above the limit
- *(4) Individual should demonstrate the actions to be taken in event of a spill of radioactive liquid. (This ability should be demonstrated during a drill)
- (5) Actions to be taken when an individual discovers his dosimeter is off-scale, or has lost or damaged dosimetry

7. BIOLOGICAL EFFECTS OF RADIATION

- a. Carcinogenesis
- b. Genetic Effects
- c. Acute Effects
- d. Latent Effects
- e. Collective Dose Concept
 - (1) Group Total Man-Rem Risk
 - (2) Individual Dose Risk
- f. Dose-Effect Relationship
 - (1) External Radiation
 - (2) Internal Radiation
- g. Biological risks of radiation exposure to the unborn child (Regulatory Guide 8.13)

8. RADIATION PROTECTION PROGRAM

- a. ALARA Program - Guidelines to keep personnel radiation exposure As Low As Reasonably Achievable (Regulatory Guide 8.8)
- b. (1) Management commitment to program

*To be demonstrated as a practical ability in addition to knowledge requirements.

Appendix B (Continued)

- (2) Provisions for dose management in facilities design and equipment selection
- (3) References/organizations which provide the radiation protection program, plans, and procedures
- (4) Supporting equipment, instrumentations and facilities with ALARA applications
- (5) Methods for keeping individual exposure ALARA
 - (a) Planning
 - (b) Work Procedures
 - (c) Shielding
 - (d) Work Coordination
 - (e) Rehearsing and Briefing Workers
 - (f) Work Performance
- b. Physical/Medical qualifications for workers (if required by licensee)
- c. Location and availability of personal exposure records
- d. Bioassay Techniques
 - (1) Whole-Body Counting
 - (2) Urinalysis
 - (3) Fecal Analysis
 - (4) Avoiding Sample Contamination
- e. Investigation and Reporting of Abnormal Exposures
- f. Air and Area Monitoring
- g. Radiation Surveys -- Purpose and Methods
- h. Rules and Procedures, including Radiation Work Permits
- i. Pertinent NRC Regulations
 - (1) Dose Limits
 - (2) Concentration Values

Appendix B (Continued)

(3) Reporting Requirements (10 CFR Part 20)

(4) Reporting Responsibility (section 19.12 of 10 CFR Part 19)

- j. Professional Guidance and Assistance
- k. Radiation protection organization and functions
- l. Responsibility of the individual to inform his employer of previous or concurrent occupational radiation exposure received
- m. Responsibility of the individual to adhere to training and follow instructions (see Appendix C).

Appendix C

Example Responsibilities Of All Workers

1. Obey promptly "stop work" and "evacuate" instruction of radiation protection personnel.
2. Follow all procedures.
3. Wear TLD/film badge and pocket dosimeter where required by procedures, signs or by radiation protection personnel.
4. Keep track of your own radiation dose status and avoid exceeding dose limits.
5. Remain in as low radiation areas as practicable to accomplish work.
6. Do not loiter in radiation areas or airborne radioactivity areas, use "wait areas" when designated.
7. Do not smoke, eat, drink, or chew in controlled surface contamination areas.
8. Wear anticontamination clothing and respirators properly and wherever required by signs, RWPs, radiation protection personnel, and procedures.
9. Remove anticontamination clothing and respirators properly to minimize spread of contamination.
10. Frisk yourself or be frisked for contamination as directed when leaving a controlled surface contamination area.
11. For a known or possible radioactive spill, minimize its spread and notify radiation protection personnel promptly.
12. Do not unnecessarily touch a contaminated surface or allow your clothing, tools, or other equipment to do so.
13. Place contaminated tools, equipment, and solid waste on disposable surfaces (for example, sheet plastic) when not in use and inside plastic bags when work is finished.
14. Limit the amount of material that has to be decontaminated or disposed of as radioactive waste.
15. Report the presence of treated or open wounds to radiation protection personnel prior to work in areas where radioactive contamination exists and immediately exit if a wound occurs while in such an area.
16. Promptly report unsafe or noncompliance situations to plant management.
17. Report prior or concurrent occupational radiation exposure to the employer.

Appendix D

Example Qualification Standards For Radiation Protection Technician Training

A. Levels of Qualification

1. Senior radiation protection technician - individuals who have satisfactorily completed a radiation protection technician training program as outlined in this guide, and who have experience and/or education in accordance with the criteria for radiation protection technicians in Regulatory Guide 1.8.
2. Junior radiation protection technician - individuals who have satisfactorily completed a radiation protection technician training program as outlined in this guide, but do not meet the experience criteria referenced in Regulatory Guide 1.8.
3. Radiation protection technician in qualification - individuals in the process of completing a radiation protection technician training program as outlined in this guide.

B. Elements of Training

1. A qualification folder outlining each of the elements of training contained in Appendix D of this guide and serving as a record of signature verification for accomplishing this training.
2. Discussion and checkout of knowledge and ability level for qualification training program items which are verified by a variety of qualified senior radiation protection technicians, foremen, supervisors, or instructors.
3. Reading assignments (e.g., local procedures, Regulatory Guides, ANSI, 10 CFR, etc.), programmed instruction guides, computer-aided instruction (CAI), or other supplemental techniques for learning.
4. Classroom lessons, seminars, demonstrations and problem-solving sessions using prepared lesson plans and qualified instructors.
5. Supervised on-the-job experience and performance evaluation.
6. Periodic written and oral examinations, including final comprehensive written and oral examinations, with oral examinations stressing abnormal, emergency, and incident situations. A sufficient variety of exams and keys should be prepared and controlled so that valid results for testing and training evaluations are achieved. A minimum passing grade should be assigned which reflects the qualification level of the personnel being examined (e.g., 70% for Junior Technician, 75% for Senior Technicians, etc.), or exams of graded difficulty with the same passing score should be developed.

Appendix D (Continued)

7. Designation by the Radiation Protection Manager of personnel authorized to verify and conduct qualification training for each level of training (e.g., Jr., Sr., Supervisor).
 8. Demonstration of a practical ability to satisfactorily perform actions, operate equipment, and establish monitoring conditions as outlined in the attached Content of Training, Appendix E. These practical performances (practical factors) would involve actual performance (e.g., control point set-up and operation) or realistic training scenarios (e.g., contaminated, injured man drill) which would be evaluated by senior, highly qualified health physics personnel.
 9. Requalification every 2 years, using a structured program approved by the Radiation Protection Manager, with a final written and oral examination, and demonstration of required practical abilities performed within 6 months of requalification. Practical abilities may be accomplished on-the-job, if satisfactorily completed during actual operations, and observed and verified by an authorized individual.
 10. Regular, scheduled training cycles equivalent to 5% of technician time (i.e., equivalent to or averaging 2 hours/40-hour week, 8 hours/month, etc.).
 11. The criteria for satisfactory knowledge and skill levels for signature verification should entail relative proficiency, competence, consistency, and a high knowledge level.
- C. Qualification and Requalification Records - For Each Individual
1. Final written examination grade.
 2. Final oral examination summary and grade, with areas covered and signatures of examiners.
 3. Qualifications verification, by signature of trainers, of program training items, specifically including the individual's satisfactory demonstration of practical skills for each specific identified functional qualification element.*

*Individuals in qualification may perform work under the following conditions:

- a. the work is performed under the direct supervision of a fully qualified RPT who is responsible for and signs for the work accomplished, or
- b. the individual has satisfactorily performed the work and has been verified as proficient in a specific functional (qualification) element (e.g., signature verification of knowledge level and practical abilities), and the work is reviewed and countersigned by a qualified foreman/supervisor. For example, an individual may be qualified as a control point monitor without completion of the entire technical qualification program.

Appendix D (Continued)

4. Certification of radiation protection technician training, to include the Radiation Protection Manager's concurrence and signature verifying that the individual has completed all the requirements and has passed the written and oral examinations as required.

Appendix E

Example Content for a Basic Radiation Protection Technician Training Program

A. Radiological Fundamentals

1. Radiation and Radioactivity

- a. Natural background radiation
- b. Types of radiation
 - (1) charge and mass
 - (2) penetration power
 - (3) sources
 - (4) attenuation
 - (5) methods of interaction
- c. Ionization and the rem
 - (1) Ionization
 - (2) Rad, roentgen, quality factors (coulomb per kilogram)
 - (3) Rem - definition and units
- d. Curie
 - (1) Definition, units
 - (2) Sub-units conversions
 - (3) Curie/dose rate relationships
- e. Dose, dose rate, mixed radiation field dose calculations
- f. Radioactive Decay
 - (1) Decay constants and half-life
 - (2) Calculations/determinations
 - (3) Biological and effective half-life
 - (4) Airborne radioactivity equilibrium calculations

2. Biological Effects of Ionizing Radiation

- a. Effect of radiation on human tissue
- b. Effect of acute and chronic doses on man
- c. Biological and genetic effects of small doses on population
- d. Whole body limits for penetrating radiation
- e. Relative risk of radiation exposure and other environmental hazards
- f. Internal exposure
 - (1) Sources
 - (a) Inhalation
 - (b) Ingestion
 - (c) Imbedding
 - (d) Adsorption

Appendix E (Continued)

- (2) Critical organs
 - (3) Body burden and body burden limits
 - (4) Radionuclides of concern
 - (5) Derivation of limits
 - (6) Doses from internal radioactivity
 - (a) calculations of dose
 - (b) biological effects
 - (7) MPC hours - derivation and use
- g. Biological risks of radiation exposure to unborn child.
- 3. Radiation and Shielding
 - a. Effect of shielding (e.g., tenth value or half-value thickness)
 - b. Shielding attenuation values for different types of radiation (α , β , γ , η) and energies
 - (1) Lead
 - (2) Steel
 - (3) Water
 - (4) Polyethylene
 - (5) Concretes
- 4. Radiation Sources
 - a. Reactor and reactor system sources (fission and activation)
 - (1) Operations - isotopes, dose rates
 - (2) Maintenance - isotopes, dose rates
 - b. Corrosion products
 - (1) Crud traps
 - (2) Hot spots
 - (3) Beta dose during maintenance
 - c. Concept of buildup factors
 - d. Dose rate calculation involving time, distance, and shielding for:
 - (1) Point sources
 - (2) Line sources
 - (3) Cylindrical sources - thumb rules
 - (4) Plane sources - thumb rules
 - e. Shielding designs and materials in use at facility
 - f. Function and use of temporary shielding to reduce exposure during maintenance and operations

Appendix E (Continued)

- g. Airborne gaseous and particulate
 - (1) Radionuclides
 - (2) Limits
 - (3) Detection and identification
- 5. Radiation Detection
 - a. General principles of operation
 - (1) Scintillation detectors
 - (2) Dosimetry equipment
 - (3) Neutron detection instruments
 - (4) Gas ionization detectors
 - (a) Ionization chambers
 - (b) Proportional counters
 - (c) Geiger-Muller counters
 - (5) Solid state applications
 - b. For each type of portable radiation and radioactivity survey instrument, and semi-portable and fixed instruments (including Constant Air Monitors, Area Radiation Monitors, and effluent and process monitors), in use at the facility:
 - (1) Type of detection
 - (2) Conversion of meter readings to appropriate units
 - (3) Application of appropriate "thumb rules"
 - (4) Minimum sensitivity/lower limit of sensitivity
 - (5) Range, scale and limits of use
 - (6) Effects of other types of radiation on indication
 - *(7) Proper field use (e.g., directional, head phones, beta shields)
 - (8) Calibration and repair requirements
 - *(9) Method of source checking and response checking
 - *(10) Physical checks prior to use
 - (11) Additional functions (e.g., beta factor, directional meter)
 - (12) Normal background
- 6. Counting Statistics
 - a. Basic principles
 - b. Basic counting formula
 - c. Minimum detectable activity
 - d. Background-effects on results
 - e. Description, setup, use of equipment, and application of statistics for counting equipment in use at facility

*To be demonstrated as a practical factor by trainee in addition to knowledge requirements.

Appendix E (Continued)

B. Functional Knowledge and Abilities

1. Surveys - radiation, contamination, airborne radioactivity
 - a. Reasons for surveys and their applications
 - b. Frequency of required surveys (alpha, beta, gamma, and neutron)
 - c. Procedures for surveys
 - d. Survey techniques
 - e. Proper logging and documentation of results
 - f. Review and interpretation of results
 - (1) Normal levels/Abnormal levels
 - (2) Expected results
 - (3) Trends and trend analysis
 - (4) Actions if limits are approached or exceeded
 - *g. Routine surveys of representative areas of the facility and proper logging of results
 - h. Determination of radionuclide type and estimates of activity levels which can result from various incidents (e.g., spills, venting, discharge)
2. Facility Design, Systems, and Components
 - a. Radioactive systems (e.g., charging/discharge)
 - b. Auxiliary systems (e.g., ventilation, radioactive waste processing, radiation monitors)
 - c. System interfaces
 - d. Integrated plant operations (e.g., discharge, venting)
 - e. Plant emergency shutdown systems (e.g., ventilating, RHR, ECCS, Radioactive waste, containment isolation)
3. Contamination Control and Decontamination
 - a. Definition of contamination
 - (1) Loose contamination
 - (2) Fixed contamination
 - (3) Limits for loose and fixed alpha, beta, and beta-gamma
 - (4) Sources of contamination
 - b. Controlled surface contamination areas
 - * (1) Work area preparation, isolation, and posting
 - * (2) Set-up and operation of an access control point
 - * (3) Requirements for area entry
 - (4) Radiation Work Practices

*To be demonstrated as a practical factor by trainee in addition to knowledge requirements.

Appendix E (Continued)

- (a) Prevention of equipment contamination
- (b) Transfer of items to clean area
- (c) Area work habits
- * (5) Controls and monitoring required for contaminated filter removal from radioactive liquid systems, ventilation systems, and vacuum cleaners
- * (6) Personnel surveys (frisking)
 - (7) Requirements for entry into high radiation areas/controlled surface contamination areas
 - (8) Procedures and reasons for each step and technique in the above items
 - (9) Methods of controlling internal contamination
- c. Contamination/airborne radioactivity survey technique
 - * (1) Swipes/air samples
 - (a) Calculation of results for fixed area (e.g., 100 cm², 1m²) or volume (e.g., portable air samples of 3m³, 1m³)
 - (b) Calculation of results for large-area swipes or high-volume air samples
 - (c) Techniques
 - (d) Conversion factors and activity calculations
 - (e) Thumb rules for swipes and air samples
 - (2) Thumb rules for contamination level/dose rate conversions for meters in use.
 - (3) Personnel survey techniques
 - (a) Detection of internal radioactivity
 - (b) Detection of external radioactivity (alpha, beta, gamma)
- d. Anticontamination clothing
 - * (1) Proper procedures for donning and removing a complete set
 - * (2) Proper wearing and removing dosimetry equipment with anti-C clothing
 - (3) Conditions and requirements for wearing anti-C clothing
 - (4) Used anti-C control

*To be demonstrated as a practical factor by trainee in addition to knowledge requirements.

Appendix E (Continued)

e. Respiratory protection

- (1) Proper procedures for putting on, using, and removing respiratory protection equipment
- (2) Conditions and requirements for donning respiratory protection equipment; protection factors
- (3) Control of work to eliminate the need for respiratory equipment
- (4) Regulatory Guide 8.15/NUREG-0041 requirements and compliance
- * (5) Respirator maintenance
- * (6) Use of test booth/field checks
- (7) Use of MPC-hours

f. Contamination containment areas

- * (1) Construction and use of containment areas, disposable glove boxes, tents, etc.
- * (2) Verification of proper construction and set up, testing, and removal of containment areas
- (3) Corrective actions for leaks, tears, flooding

g. Routine systems operations

- (1) Valve disassembly
- (2) Venting and draining radioactive systems
- (3) Welding, grinding, and cutting radioactive pipe
- (4) Proper use of portable HEPA ventilation systems

h. Decontamination

- (1) Techniques for decon and waste handling
- (2) Standards applicable to reactor systems components
- (3) Techniques and procedures for limiting contamination spread and reducing exposure
- (4) Personnel decontamination
 - * (a) basic skin decontamination techniques (simulated)
 - (b) evaluation of effectiveness/documentation of results

4. Radioactive Material Control

a. Procedures and records for radioactive material control

- * (1) Control and tracking
- * (2) Shipment and receipt (facility procedures and DOT requirements)
- (3) Storage - environmental and fire protection, dose reduction

*To be demonstrated as a practical factor by trainee in addition to knowledge requirements.

Appendix E (Continued)

b. Identification of radioactive materials

- (1) Definitions - Federal/licensee
- (2) Surveys and estimates of radioactivity and contamination levels (e.g., valves, liquid sample, drums)
- (3) Physical identification
- (4) Criteria for liquids, solids with trace levels of radioactivity
- (5) Facility and DOT standards

c. Control of standard radioactive sources (e.g., instrument sources, check sources)

d. Control of source material, fissile, and special nuclear materials

e. Procedures in event of loss of radioactive materials

*f. Solid waste compactor controls

5. Dose Limits and Controls

a. Federal limits and licensee control levels

- (1) Whole-body penetrating radiation
- (2) Skin, forearms, extremities
- (3) Internal organs

b. Use and reasons for limits

c. Effects and exposures resulting from types of radiation

d. Emergency exposure guidelines

*e. Stay time calculations involving extremity and whole-body dose rate

f. Definitions, controls, and requirements for access for

- (1) Restricted Areas
- (2) Radiation Area
- (3) High Radiation Area
- (4) Exclusion Area
- (5) Hot Spots
- (6) Wait Area

g. Controls for preventing personnel from exceeding licensee control levels and dose limits

h. Actions for individual dose exceeding internal, external, or skin contamination limits

i. Practical dose control

- (1) For work in moderate general area dose rates (e.g., 100-200 mrem/hr)
- (2) For high radiation area work in the vicinity of hot spots

*To be demonstrated as a practical factor by trainee in addition to knowledge requirements.

Appendix E (Continued)

- j. ALARA applications for dose reduction (Regulatory Guides 8.8, 8.10)
- k. Field dose control actions for
 - (1) Individual with lost or off-scale pocket dosimeter
 - (2) Lost or damaged personnel monitoring device
- l. Limits for release of radioactive or contaminated material from controlled surface contamination or restricted areas
- 6. Radioactive Waste Control
 - a. Classifications
 - (1) High/low levels
 - (2) Baleable and non-baleable
 - (3) Liquid/solid/gas
 - b. Proper waste disposal
 - (1) Segregation of waste
 - (2) Survey and release of materials
 - c. Techniques for waste control and volume reduction
 - d. Waste sampling
 - (1) Normal levels
 - (2) Limits for discharge (e.g., processed liquids and gases)
 - (3) Calculations
 - * (4) Sampling procedures
 - e. Potential effects of uncontrolled discharges
 - *f. Controls for replacement of radioactive filters or resins
 - g. Radwaste systems operations
- 7. Environmental Monitoring
 - a. Reasons for environmental monitoring
 - b. Results of program
 - c. General techniques (e.g., for Emergency Monitoring)
- 8. Counting Systems
 - a. Type of samples counted
 - b. Preparation for counting/equipment setups
 - c. Sample counting procedures

*To be demonstrated as a practical factor by trainee in addition to knowledge requirements.

Appendix E (Continued)

- d. Documentation and reporting of results
- e. Actions for high or unusual results

9. Incident and Unusual Event Control

a. General incident analysis techniques

- (1) Evaluation of initial symptoms
- (2) Immediate actions
- (3) Supplemental actions
- (4) Analysis/problem identification

b. Symptoms of postulated accidents

- (1) Major reactor accidents
- (2) Primary to atmosphere leaks
- (3) Primary to secondary system (e.g., PWR steam generator) leaks

c. Control and corrective actions for major and minor categories of:

- *(1) Radioactive spill (liquid or dry)
- *(2) High airborne radioactivity (particulate and gaseous)
- *(3) Contaminated, injured person
- *(4) High radiation levels

d. Relative to above events

- (1) Reasons for actions taken
- (2) Radiological problems resulting
 - (a) dose
 - (b) dose rates
 - (c) activity concentrations
 - (d) radionuclides of concern
- (3) Possible causes
- (4) Consequences of improper actions

e. Radiation incident knowledge

- (1) Recent local events
- (2) Generic power reactor experiences

*f. Emergency Response Plan - Training and Drills

*To be demonstrated as a practical factor by trainee in addition to knowledge requirements.

Appendix E (Continued)

- (1) Technician assignments and responsibilities
 - (2) Walk-through training
 - (3) Drills
 - g. Post-Accident sampling and analysis
 - (1) Access/Work control
 - (2) Exposure reduction
 - (3) Sources of radiation/exposure
 - (a) Gaseous radioactivity
 - (b) Particulate radioactivity
 - (c) Source terms (e.g., RHR system, ventilation filters, LPCI, etc.)
 - (4) Radioiodine
 - (5) Emergency sampling and analysis procedures
10. Facility Radiation Protection Program
- a. ALARA programs guidelines and procedures
 - b. Facility radiation protection program procedures
 - c. Federal requirements, regulations, and guidelines (e.g., Regulatory Guides, 10 CFR 19, 20, ANSI)
 - d. Radiation protection organization and reporting
 - e. Bioassay program
 - f. Radiation Protection deficiency reporting, follow-up and analysis system
 - g. Work functions of radiation protection technicians (e.g., Jr., Sr., In Qualification)
 - (1) Operations support functions/facility interfaces
 - (2) Quality control functions
 - (3) Interface with individuals and the public

*To be demonstrated as a practical factor by trainee in addition to knowledge requirements.

Appendix F

A Sample Method of Pre-Planning Radiation Work to Maintain Occupational Radiation Exposures ALARA

Procedures developed for radiation exposure-related activities such as normal operations, maintenance, inservice inspection, radwaste handling, and refueling should be followed by workers to assure that work will be performed in a manner that will provide ALARA exposures. To accomplish this, all radiation work should be pre-planned in the following manner:

- A. Any task* that may cause an expected collective dose-equivalent exposure of 1 man-rem may not require special formal ALARA documentation other than instructions specified in the Radiation Work Permit (RWP) or radiological work package which is normally required for all radiation work. For relatively minor exposure tasks, an RWP need only address general radiation protection (e.g., clothing requirements, stay time) and obvious instructions for minimizing exposures, e.g., documentation of high radiation sources (hot spots) in the work area, provided that workers have received formal training in routine ALARA practices as outlined in Appendix B.
- B. Any task that may cause an expected collective dose equivalent exposure of greater than 1 man-rem should specifically address ALARA concepts such as training, temporary shielding, use of special tools, and any other techniques that would be used to minimize exposures. The individual preparing the task should state in the RWP (or other radiological work document) what techniques should be followed to keep exposures ALARA. This RWP should be approved by the RPM or equivalent.
- C. Any task that may cause an expected collective dose equivalent exposure of greater than 10 man-rem should (in addition to item B. above) address (a) historical data, if any, and the effectiveness of any previous ALARA techniques used in similar type operations, e.g., temporary shielding, decontamination and (b) alternative actions that could be taken, but were not taken, to reduce exposures, and specifically document why these actions were not taken, from an ALARA basis.
- D. Any task that may cause an expected collective dose equivalent exposure of greater than 50 man-rem should (in addition to item C. above) be reviewed by the Facility Review Group. Upon completion of the task, a written postoperation evaluation should be performed to document the degree of success (or failure) of ALARA techniques used.
- E. Any task that may cause an expected collective dose equivalent exposure of greater than 100 person-rem should (in addition to item D. above) be reviewed by the Corporate Health Physicist (or Group) and the ALARA Committee.

*A task is defined as an identifiable work package for which a specific, general procedure or set of related procedures is prepared. For example, a task would be the inspection and repair of a steam generator, inspection or repair of BWR reactor vessel nozzles, reactor head removal.

Appendix G

The following list defines usage particular to the RADIATION PROTECTION PLAN:

1. Restricted Area - As defined in 10 CFR 20.3(a)(14).
In common usage, this typically includes all areas within the facility fence where personnel are required to wear personnel monitoring dosimetry.
2. Radiation Area - As defined in 10 CFR 20.202(b)(2).
3. High Radiation Area - As defined in 10 CFR 20.202(b)(3).
4. Radiologically Posted Area - Any area posted with a yellow and magenta sign with a three-bladed radiation warning symbol for the purpose of controlling or restricting access to that area for radiation protection purposes.
5. Exclusion Area - Any area where the exposure limits of 10 CFR 20.101 could be exceeded in a very short time. Such areas must be controlled to prevent personnel access and posted clearly "Exclusion Area - Personnel Access Prohibited." If operational conditions permit radiation conditions acceptable for essential temporary access then:
 - (a) the acceptable radiation level condition must be stable for the duration of access (e.g., no reactor startup).
 - (b) a radiation survey must be performed to verify acceptable radiation levels.
 - (c) the area must be deposited as an exclusion area and reposted appropriately (e.g., as a high radiation area or radiation area).
6. Hot Spot - A locally intense source of radiation which exceeds general area radiation levels by about a factor of four. Hot Spot postings are typically used to clearly mark the highest sources of radiation in a radiation or high radiation area to help keep worker exposure at a minimum.
7. Wait Area - An area designated for workers to wait in the course of performing work in a radiologically posted area. Areas with exposure rates at background level should primarily be selected as wait areas. In cases where passage from the work area to minimally low background areas would lengthen work time and increase overall job exposure, then minimum dose rate areas in radiation areas or high radiation areas should be designated as short-term wait areas.
8. Radioactive Materials Storage Area - Any area where materials determined to be radioactive and/or contaminated are stored. Boundaries and posting should be established to mark these areas. Additional/multiple posting in accordance with radiation levels, contamination levels and types, and airborne radioactivity may be simultaneously required.

Appendix G (Continued)

9. Controlled Surface Contamination Area - Any area where loose surface contamination levels exceed 1000 dpm per 100 cm². Boundaries and posting should be established to mark these areas and a contamination control/access control point and frisking station established to control personnel access and egress and prevent the spread of contamination. Posting should additionally specify the contamination levels and types of protective clothing necessary for access.
10. Radioactive Materials - In addition to the 10 CFR 20.3(a)(13) definition, radioactive materials (RAM) are considered to be any parts, tools, waste, or removed system components or piping which contain accessible or inaccessible areas of radioactive loose surface contamination, and/or activated portions, and which meet Federal and licensee criteria for such materials.
11. Controlled Area - Areas within restricted areas which feature positive control over access and egress. Access is limited in accordance with operational requirements and individual training (in radiation protection). Controlled areas may include radiation areas, high radiation areas, exclusion areas, controlled surface contamination areas, radioactive material storage areas, and airborne radioactivity areas.

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