ALARA Plans and Dose Modeling

Nuclear Secured / Radiation Safety

NS-RS-PR-506, 0

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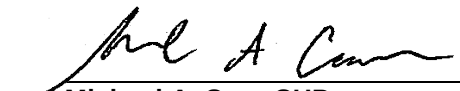
History and Approvals

History

Revision	Intent Y/N	Purpose description
0	Y	For Issue (Initial Issue)

Approvals

Preparer:  8/5/2019

Michael A. Carr, CHP Date
Radiation Safety Officer

Approver:  8/14/2019

Dutch Conrad Date
Senior Vice President Field Services

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Chapter Pages

1. Purpose and Scope

The basis for maintaining personnel exposure to radioactive materials as low as reasonably achievable (ALARA) is the linear no threshold hypothesis which assumes that any radiation exposure carries some risk and potential for adverse effects. As a result, all reasonable efforts (to the extent practical) shall be considered to minimize occupational and public exposure to radioactive materials.

1.1. Purpose

This procedure provides guidance to aid in the proper planning of radiological work where personnel exposures are of concern in order to maintain exposures ALARA. This includes ALARA job reviews, ALARA Plans, extablishing dose goals and performing dose modelling such that there is a full understanding of the dose profiles and working conditions when working around sources of radiation.

1.2. Scope

This Program is for the exclusive use of Nuclear Secured (NS) and subcontractor personnel at temporary job sites where the NS Radiation Protection Program (RPP) is implemented and/or NS has the primary role in controlling exposures to on-site personnel.

2. References

2.1. NS-RS-PG-001, *Radiation Protection Program*

2.2. NS-RS-PG-003, *ALARA Program*

2.3. NS-RS-PR-100, *Radiation Safety Committee*

2.4. NS-RS-PR-201, *Radiation Work Permits*

2.5. NS-RS-PR-300, *Performance of Radiological Surveys*

2.6. NS-RS-PR-500, *Personnel Monitoring*

3. General

3.1. Definitions

3.1.1. *Administrative Limit* - A radiation dose limit established by Nuclear Secured for the purpose of maintaining radiation dose below regulatory limits and maintaining personnel dose ALARA.

3.1.2. *ALARA (As Low As Reasonably Achievable)* – Making every reasonable effort to maintain exposures to radiation as far below the dose limits as is practical consistent with the purpose for which licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to the state of technology, the economics of improvements in relation to benefits to public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest.

3.1.3. *Dose* – Generic term that means adsorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, or total effective dose equivalent.

3.2. Responsibilities

Depending on personnel qualifications and the size of the project, project personnel may be assigned multiple roles and/or responsibilities.

3.2.1. NS Radiation Safety Officer

The NS Radiation Safety Officer (RSO) maintains and oversees the implementation of the NS RPP. The RSO shall ensure that radiation safety, radioactive materials management, and radiological operations procedures and programs are kept up to date such that they comply with current regulations and incorporate current and relevant industry practices and regulatory guidance.

3.2.2. Project Manager

The Project Manager (PM) is responsible for ensuring that the proper program procedures and programs are implemented on the project site as required by customer agreements and contracts. The PM is responsible for ensuring that these programs and procedures are properly incorporated into project specific plans and procedures. The PM is responsible for ensuring that the NS RPP and client programs and procedures, as applicable, are available for use by project personnel.

3.2.3. Project Health Physicist

The Project Health Physicist (PHP) is responsible for assisting the RSO in providing health physics support to the PM and Radiation Protection Supervisor (RPS). This includes technical support to ensure procedural and regulatory compliance and to ensure that the project-specific Data Quality Objectives (DQOs) are met.

3.2.4. Radiation Protection Supervisor

The Radiation Protection Supervisor (RPS) is responsible for implementing the NS RPP at the project location. The RPS manages and oversees the project personnel in regards to radiation and respiratory protection and reports directly to both the PM and the RSO.

3.2.5. Radiation Safety Committee

The Radiation Safety Committee (RSC) has the responsibility of overseeing the NS RPP and the review and approval of any ALARA Plans in accordance with NS-RS-PR-100, *Radiation Safety Committee*.

3.2.6. Project Personnel

All project personnel are responsible for safety at the project site including radiation safety and have the responsibility for maintaining exposures to themselves and their peers to ALARA. Each individual has the ability and responsibility to follow the work plans and procedures, to stop work as necessary and to bring any safety issues including radiation safety to the attention of the RPS, the PM, and/or the RSO

3.3. Precautions and Limitations

3.3.1. Take precaution when interpreting dose modeling results. Dose modeling results are only as good as the modeling input and assumptions and are considered rough estimates for planning purposes.

3.3.2. Dose modeling should be followed up with actual dose measurements to verify and refine dose models.

3.3.3. Personnel dose should be tracked in order to ensure no administrative dose limits are exceeded without the proper approvals in accordance with NS-RS-PR-500, *Personnel Monitoring*.

4. Pre-Requisites / Requirements

4.1. Access to restricted areas shall be controlled by Radiation Work Permit in accordance with NS-RS-PR-201, *Radiation Work Permits* specifying the radiological controls and monitoring requirements.

4.2. Surveys shall be performed in accordance with the ALARA Plan and NS-RS-PR-300, *Performance of Radiological Surveys* in order to assess working conditions and to verify area radiological postings, radiological controls, monitoring requirements and the locations of established boundaries.

5. Procedure

5.1. ALARA Job Reviews

5.1.1. Complete the ALARA review checklist, Attachment 7.1 or equivalent, as required by the radiation work permit and the project work plans.

5.1.2. Perform surveys of the general work area in accordance with NS-RS-PR-300, *Performance of Radiological Surveys*.

5.1.3. Identify sources of radiation in the work area(s).

5.1.4. Identify areas of exposure concern and low dose waiting areas.

5.1.5. Assess the potential and levels of airborne radioactivity.

5.1.6. Review the planned work activities in order to identify any dose reduction practices or techniques that may be implemented to reduce occupational dose to project staff.

5.1.7. Detemine if sources of radiation may be removed or shielded to eliminate or reduce potential exposure.

5.1.8. Evaluate and implement administrative and engineering controls that my help reduce personnel exposure.

5.1.9. Ensure the proper tools and equipment are staged and that the necessary support staff is coordinated such that radiological work may be performed efficiently with minimum exposure.

5.2. ALARA Plans

5.2.1. Develop an ALARA Plan as required by NS-RS-PG-001, *Radiation Protection Program* and NS-RS-PG-003, *ALARA Program*. Attachment 7.3 provides an example outline of an ALARA Plan.

5.2.2. Identify the major job tasks or activities and evaluate each activity with the perspective to either eliminate or minimize personnel exposure (e.g. see Section 5.1, ALARA Job Reviews).

5.2.3. Determine the type and number of personnel and their required work locations.

5.2.4. Estimate each job task duration.

5.2.5. Identify sources of radiation and peform surveys of the general work areas in accordance with NS-RS-PR-300, *Performance of Radiological Surveys* or perform dose modeling in accordance with Section 5.4 as applicable.

5.2.6. Identify areas of exposure concern and low dose waiting areas.

5.2.7. Assess the potential and levels of airborne activity in DAC.

5.2.8. Review the planned work activities in order to identify any dose reduction practices or techniques that may be implemented to reduce occupational dose to project staff.

5.2.9. Detemine if sources of radiation may be removed or shielded to eliminate or reduce potential exposure.

5.2.10. Evaluate and implement administrative and engineering controls that my help reduce personnel exposure.

5.2.11. Complete the dose assessment worksheet, 7.2 or equivalent for each job activity.

5.2.12. Determine the estimated cumulative exposure and the exposure to the maximum exposed individual.

5.2.13. Develop dose estimates and dose goals in accordance with Section 5.3.

5.2.14. Obtain the proper ALARA Plan reviews and approvals in accordance with NS-RS-PG-003, *ALARA Program*.

5.3. Dose Estimates / Dose Goals

5.3.1. As required by NS-RS-PG-003, *ALARA Program* and the ALARA Plan, establish dose goals for the work activities and/or project.

5.3.2. Utilize the ALARA Plan and the Dose Estimate Worksheet, Attachment 7.1 or equivalent, to develop the dose goals based on the number of personnel required per job task, task duration, and potential exposure pathways (external and interal exposure).

5.3.3. Determine the estimated total accumulated dose and the dose to the maximum exposed individual.

5.3.4. Establish dose goals based on the estimates and obtain the applicable review and approval in accordance with NS-RS-PG-003, *ALARA Program*.

5.4. Dose Modeling

5.4.1. Use dose modeling as a tool to help plan work with high activity sources of radiation (e.g., high dose rates) to gain an understanding of the potential dose rates within the work area(s) and surrounding areas, to establishing control boundaries and postings, identify areas of concern, help design shielding, etc.

5.4.2. Use survey results for supplemental data or confirmation.

5.4.3. Perform dose modeling using MicroShield®, Monte Carlo or other recognized dose modeling software.

5.4.4. Determine the radionuclides of concern, activities, relative ratios and geometries. These may be based on activiation analyses, source certificate, as built drawings, designed packaging, etc.

5.4.5. Simplify the dose modeling scenario(s) as applicable to basic geometries as supported by the dose modeling software.

5.4.6. For complex scenarios, the sources of radiation may be broken into smaller units that can be more easily modeled and the dose contribution from each source summed to provide a dose estimate.

5.4.7. Identify dose points of interest including work locations where personnel will be located, etc and determine the distance from the radiation source(s).

5.4.8. Identify any shielding, materials and equipment between the radiation source(s) and dose points of interest and determine:

- Types of material
- Thickness or equivalent/effective thickness

5.4.9. Build the dose model to most accurately represent the source geometries, shielding, types of materials, thicknesses, distances, etc.

5.4.10. Run the dose model(s) and review the results.

5.4.11. Sum the dose contributions from each source of radation as applicable.

5.4.12. Document assumptions and methods utilized.

5.4.13. Document dose modeling results.

5.4.14. Obtain independent verification of assumptions, techniques and calculations.

5.4.15. Modify and refine dose models and rerun as applicable depending on changes in assumptions, actual survey results, etc.

6. Records

6.1. Dose modeling output/Reports

6.2. Dose estimate worksheets

6.3. Surveys

7. Appendices and Forms

7.1. ALARA Job Review Checklist (Example)

7.2. Dose Estimate Worksheet (Example)

7.3. ALARA Plan Outline (Example)

Attachment 7.1 **ALARA Job Review Checklist (Example)**

Planning Element	NA	Yes	No	Comments
Planning (Time / Distance / Shielding)				
Have unnecessary tasks been eliminated.				
Can tasks be performed outside radiation areas to reduce dose.				
Can task sequences be modified to reduce dose.				
Can the number of workers be reduced.				
Can mock-up training be used to reduce dose.				
Have low and high dose areas been identified.				
Are the proper supplies, tools and equipment readily available.				
Is there adequate access and egress to the work area(s).				
Is there adequate work space.				
Can remote handling tools be used to help minimize dose.				
Will respiratory protection reduce worker efficiency.				
Source Reduction / Contamination Control				
Can containments or engineering controls be used to minimize dose.				
Can radiation sources be removed from the work area(s).				
Can temporary or permanent shielding be added				
Can the general area(s) be decontaminated prior to work				
Can local ventilation be used to minimize airborne contamination.				

Attachment 7.2 **Dose Estimate Worksheet (Example)**

Job/Work Task	Workers	Duration	Gen Area Dose Rate	Direct Dose	DAC	PF	Internal Dose	Total Dose
Subtotal / Total								

Attachment 7.3 **ALARA Plan Outline (Example)**

1. Introduction
   a. Scope
   b. Purpose
2. Exposure Pathways and Sources
3. Monitoring
   a. Exposure Limts
   b. Personnel Monitoring Requirements
   c. Public Monitoring Requirements
4. Job Task(s)
   a. Description
   b. Personnel
   c. Location(s)
   d. Duration
5. Work Controls and Dose Reduction
   a. Restricted / Controlled Areas and Boundaries
   b. Postings
   c. Engineering Controls
   d. Administrative Controls
6. Dose Goals / Estimates
   a. Surveys
   b. Dose Modeling
   c. Exposure Studies
7. Stop Work Criteria

Attachments

Dose Estimate Worksheets

Dose Modeling Results