September 28, 2001

MEMORANDUM TO: John A. Zwolinski, Director
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

FROM: John T. Greeves, Director ***/RA***/
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

SUBJECT: DRAFT STAFF GUIDANCE FOR DOSE MODELING OF PROPOSED PARTIAL SITE RELEASES

I am responding to your October 17, 2000, technical assistance request regarding the impact of interactive dose effects on partial site releases. This information has been requested to support your current rulemaking package on partial site release at nuclear reactor facilities. We have previously responded to the technical assistance request, completing the first three tasks on April 28, 2001. This memorandum provides the information requested by Task 4, guidance for use with the Office of Nuclear Material Safety and Safeguards (NMSS) Decommissioning Standard Review Plan (NUREG-1727). Attached is the draft version of the staff guidance to be used with NUREG-1727 in reviewing proposed partial site releases. The draft guidance will be released to the public for comment after the proposed rule is published.

NMSS' approach focuses on the considerations licensees and reviewers would need to make in developing the appropriate, reasonable scenarios for the released property and reach finality for site release, in the vast amount of cases. The guidance document is divided into three sections: (1) the technical review guidance; (2) more detailed technical bases; and (3) a checklist and worksheet for staff to use to quickly limit the amount of information needed and the number of scenarios that may need more consideration. After first screening out the scenarios that are not appropriate for the situation, the licensee would need to decide, and justify, the scenarios where calculations will be performed. The primary considerations are:

- How could (or does) the remaining licensed property influence the dose on the partial release[1] (e.g., effluent releases, groundwater contamination, etc.)?

CONTACT: Christepher McKenney, NMSS/DWM
301-415-6663

[1]Partial release means the area to be released under this rulemaking.

- How could (or does) the partial release influence dose estimates for the remaining portion of the site (e.g., limiting the decommissioning of areas near the partial release to a fraction of the 10 CFR Part 20, Subpart E limit)? and

- How could (or does) a previously released portion of the site affect the dose to an individual using both the proposed partial release and the previously released area?

In summary, the key points of the guidance document are:

- The guidance works within the framework established by NUREG-1727;

- The guidance addresses issues raised by the Commission, such as groundwater concerns; and,

- The goals of the review process are finality in approving the partial site release and recognition and identification of issues that will need to be addressed during future decommissioning of the remainder of the site.

Attachment: Draft Staff Supplemental Guidance for NUREG-1727 Partial Site Release Requests: Additional Considerations for Dose Modeling

- How could (or does) the partial release influence dose estimates for the remaining portion of the site (e.g., limiting the decommissioning of areas near the partial release to a fraction of the 10 CFR Part 20, Subpart E limit)? and

- How could (or does) a previously released portion of the site affect the dose to an individual using both the proposed partial release and the previously released area?

In summary, the key points of the guidance document are:

- The guidance works within the framework established by NUREG-1727;

- The guidance addresses issues raised by the Commission, such as groundwater concerns; and,

- The goals of the review process are finality in approving the partial site release and recognition and identification of issues that will need to be addressed during future decommissioning of the remainder of the site.

Attachment: Draft Staff Supplemental Guidance for NUREG-1727 Partial Site Release Requests: Additional Considerations for Dose Modeling

DISTRIBUTION:

| | | | | |
|---|---|---|---|---|
| File Center | DWM r/f | CCraig | LCamper | MRipley |
| SKlementowicz | CWReamer | TMcCartin | BEid | SSchneider |
| JLieberman | EPAB r/f | | | |

DOCUMENT NAME: G:\EPAB\CAM\PartialSiteReleaseSupplementMemo.wpd
Ticket No. D2001-08
ADAMS ACCESSION NUMBER: ML012140043 Log No.:
* See previous concurrence

| OFC | EPAB* | EPAB* | EPAB* | DCB* | Technical Ed* |
|---|---|---|---|---|---|
| NAME | CMcKenney:rmc | SWastler | TEssig | LCamper | E.Kraus |
| DATE | 9/5/01 | 9/7/01 | 9/12/01 | 9/29/01 | 8/27/01 |

| OFC | DWM | | | | |
|---|---|---|---|---|---|
| NAME | JGreeves | | | | |
| DATE | 9/ 28 /01 | | | | |

**OFFICIAL RECORD COPY**

ACNW: YES ___ NO _X_ Delete file after distribution: Yes _X_ No __
1) This document should not be made available to the PUBLIC CAM 7/30/01
2) This document is not related to the HLW program.

# DRAFT STAFF SUPPLEMENTAL GUIDANCE FOR NUREG-1727
# PARTIAL SITE RELEASE REQUESTS:
# ADDITIONAL CONSIDERATIONS FOR DOSE MODELING

**This draft staff supplemental guidance is being issued to describe, and make available to the public, methods acceptable to the U.S. Nuclear Regulatory Commission staff in implementing specific parts of the Commission's regulations: to delineate techniques and criteria used by the staff in evaluating partial site release requests (and other similar situations); and to provide guidance to licensees or responsible parties (i.e., the person(s) responsible for decommissioning the site). This guidance is not a substitute for regulations, and compliance with the guidance is not required. Methods and solutions different from those set out in the NMSS Decommissioning Standard Review Plan (NUREG-1727), as supplemented by this guidance, will be acceptable, if they provide a basis for concluding that the partial site release request is in compliance with the Commission's regulations.**

## PURPOSE

The purpose of this supplemental guidance is to provide U.S. Nuclear Regulatory Commission (NRC) staff with guidance to evaluate the long-term potential doses associated with release of parts of an NRC-licensed facility before the license termination plan (LTP), or decommissioning plan has been approved. The general approach for such partial site releases is to parallel the considerations and process for license termination. This guidance is focused on the review of reactor licensees releasing portions of their sites, but the guidance, in general, can be used for any dose modeling situation involving partial release.

## BACKGROUND ON GUIDANCE DEVELOPMENT

NRC published staff guidance on the acceptance and review criteria to use for decommissioning plans for Office of Nuclear Material Safety and Safeguards licensees in NUREG-1727, Rev. 0, "NMSS Decommissioning Standard Review Plan" (NRC, 2000). The focus of the NUREG is on license termination of the facility or site. During development of NUREG-1727 (hereafter, "SRP"), NRC held multiple public workshops. Releasing areas of the site before terminating the license was one topic consistently raised by licensees but outside the scope of the original development plan.

Recently (66 *FR* 45703, August 29, 2001), NRC has provided a proposed rulemaking to allow release of parts of NRC-licensed reactor sites or facilities before

**Partial Site Release (or Partial Release), refers to the situation allowing a licensee of an operating facility, or a facility that has entered into decommissioning, to release parts of its reactor facility or site for unrestricted use before receiving NRC approval of its LTP**.

**Box 1. Definition of Partial Site Release**

license termination (hereafter, "partial release," see Box 1) provided the release complies with applicable NRC standards, including the unrestricted release requirements in 10 CFR Part 20, Subpart E (hereafter, "Subpart E"). The proposed rule suggests that the staff review the dose modeling performed by the licensee for impacted areas (see Box 2) by using current guidance (i.e., SRP 5.0, "Dose Modeling Evaluations," and SRP Appendix C, "Technical Basis for Dose Modeling Evaluations"), to independently confirm the analysis. Although the current guidance in both SRP 5 and SRP Appendix C could be used by the staff to complete the assessment, there is a need for additional guidance to clarify some specific issues related to partial release. In general, this guidance supplements the review criteria in SRP 5 and SRP Appendix C, with specific emphasis on scenarios, including pathway identification and critical group assumptions, and conceptual model development.

## HOW TO USE

This guidance follows the same approach explained in the SRP's "Introduction" (pages 0.4 and 0.5). The guidance has been developed to encompass the needs of the most complex situations, but the specific informational needs for a partial release request will be tailored to the complexity and safety significance of the proposed action.

The guidance is split into two sections. Each is analogous to the approach used in the SRP. The first section details review criteria to be used in assessing compliance with Subpart E, whereas the second section provides technical information to assist the staff in using the criteria.

**NOTE: This guidance does not replace the guidance in SRP 5 or SRP Appendix C but supplements it. This guidance, although it notes other areas of the SRP that likely need to be updated during the next revision, focuses solely on providing supplemental guidance for the Subpart E dose modeling aspects of the review. For information on all of the requirements associated with a partial site release, including non-Subpart E dose analyses, the staff should refer to the statements of consideration of the proposed "Partial Site Release" rule.**

## 1.0 PARTIAL RELEASE REVIEW PROCESS

The review process depends on the classification of the area. A successful demonstration, typically based on the Historical Site Assessment (HSA) -- that an area proposed for partial release is non-impacted -- is sufficient to demonstrate compliance with the unrestricted release criteria of Subpart E. However, a non-impacted area will still need to meet other safety reviews, as noted in the statements of consideration for the proposed rule (see Box 3 for examples).

An impacted area will need to demonstrate compliance with the requirements of 10 CFR 20.1402. Figure 1 details a modified Decommissioning Framework, which identifies steps a licensee may take in developing the Derived Concentration Guideline Limits (DCGLs). The modified Framework does not change the approach taken by the licensee or the staff (see "Introduction" to SRP 5.0 - page 5.1) but details additional considerations for partial releases. For example, the assimilation of existing data and information now includes three input areas: the proposed partial release, the currently licensed site (hereafter, "licensed site"), and prior partial releases. The division of the existing data and information into the three areas is

because different levels of detail are likely to be associated with these inputs. For example, more information is likely to be available for previous partial releases than for the licensed site. The staff review focuses on the licensee submittal and supporting information. Therefore, issues related to options analyses (i.e., the path starting with "Can Site Be Released?" and ending with "Dose Assessment," in Figure 1, associated with dose assessments that do not meet the Subpart E limits) are analyses and decisions made by the licensee and not necessarily reviewed by the staff responsible for dose modeling.

In a partial release, dose modeling is not necessarily limited to the dose caused by areas with residual radioactivity on the partial release, but, also, residual radioactivity outside of the partial release (hereafter, "offsite sources," see Box 4). In addition to compliance analyses for the partial release, there should be review of potential prospective analyses. These analyses evaluate how the partial release could impact the license termination of the licensed site, including any additional partial releases. For example, releasing an area of the site at higher DCGLs than is likely for the rest of the site could constrain the future decommissioning, forcing the licensee to calculate DCGLs for the rest of the site that are below what could have been achieved if the partial release never occurred.

**Compliance with Subpart E dose limits is not the only safety analysis associated with partial release. Other safety analyses are focused on the continued operations of the licensed site or facility, generally related to the change in the boundary. Examples include evaluating the boundary change on:**

- **Annual dose to individual members of the public (Part 20, Subpart D);**
- **Effectiveness of emergency planning or physical security;**
- **Effluent releases;**
- **Environmental monitoring program;**
- **Siting criteria of 10 CFR Part 100;**
- **Impacts for other licensed facilities, such as an Independent Spent Fuel Storage Installation; and**
- **Other applicable regulatory requirements.**

**<u>Compliance with other regulations may affect the maximum allowed dose for the Subpart E dose analyses.</u> For example, a partial release downwind of the operating facility may need to limit its Subpart E dose constraint [e.g., to 0.2 milliSievert (mSv) [20 millirem (mrem)] to account for the dose from effluents when showing compliance with 40 CFR Part 190 [0.25 mSv/yr (25 mrem/yr)] public dose limit from all parts of the fuel cycle, which would include effluent releases from a reactor as well as dose from residual radioactivity on a partial release]. Therefore, the staff needs to communicate with the other members of the review team, to make sure assumptions are appropriately consistent, throughout the various analyses.**

**Box 3. Examples of Other Safety Analyses**

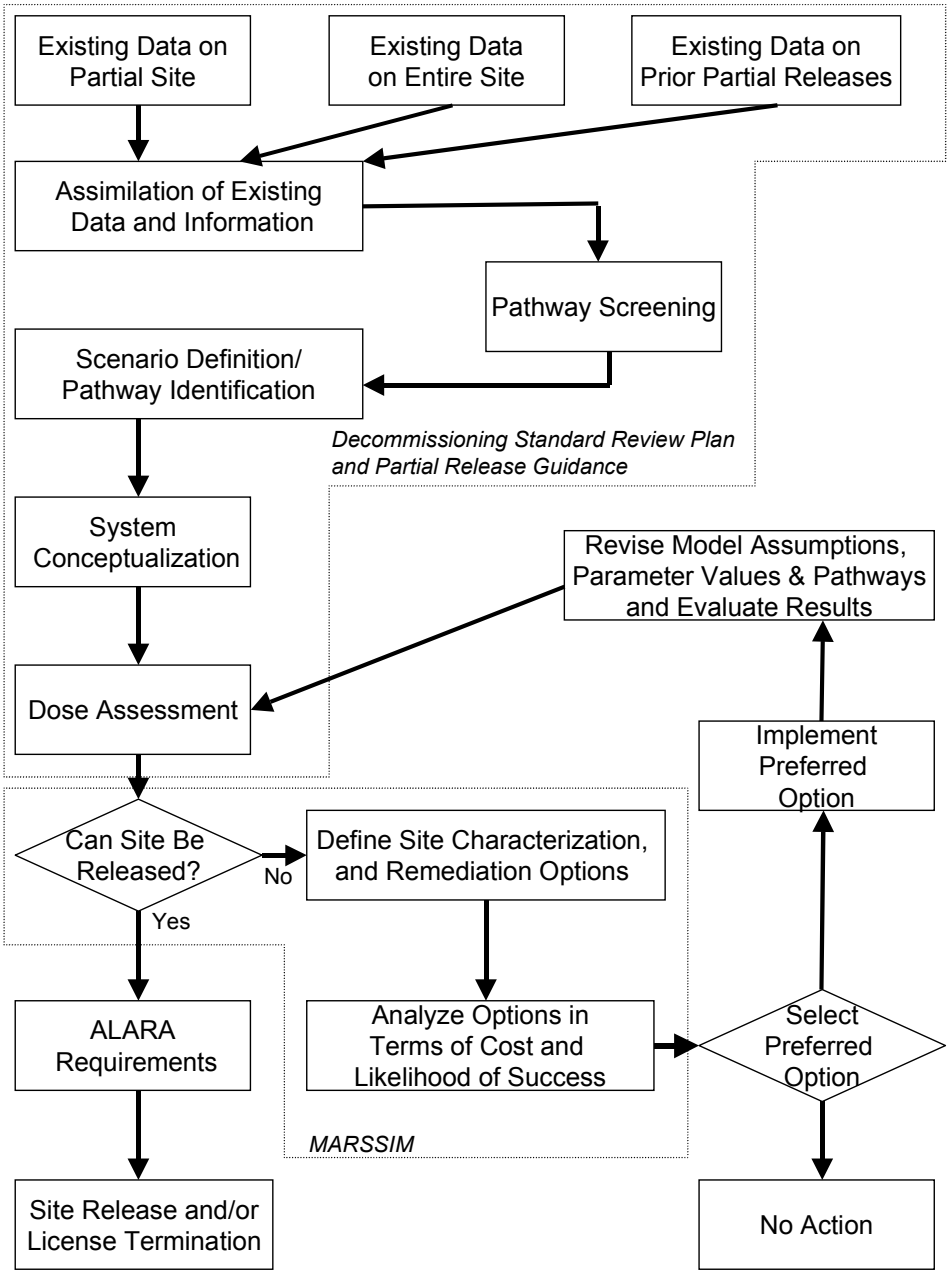


**Figure 1. Decommissioning Framework Involving Partial Site Release (adapted from NUREG-1549)**

The licensee still may use generic dose analyses such as the screening limits (Section 2.0 of SRP Appendix C) provided that the partial release meets the conditions described in SRP 5.0 and SRP 5.1, as well as those specified below.

If the licensee performs a site-specific analysis, the review is the same as detailed in SRP 5.2, except for the additional considerations for scenario and pathway identification detailed below.

**Offsite sources means, for the purposes of this guidance, potential sources of exposure that are not on the partial release, but still on impacted areas under (or previously under) the control of the licensee.**

**Box 4. Offsite Sources Definition**

## 1.1 CHANGES TO SRP REVIEW PROCESS

This supplemental guidance makes no substantial changes, in the" Areas of Review", "Review Procedures", or "Acceptance Criteria" from the appropriate portion of SRP 5. The only modification is that the staff should remain cognizant that the informational needs may extend beyond the partial release. For example, in SRP 5.2, under "Areas of Review," it states, "...the staff should ensure that, at a minimum, information on the source term, exposure scenario(s), conceptual model(s)...have been included." The tone of the discussion assumes that the source term will be on (or under) the site at the time of license termination. As is described below, one of the fundamental issues, for a partial site release, is whether offsite sources exist, that could contribute sufficient amounts of residual radioactive material, to the partial release which would contribute significantly to the dose estimates associated with its release.

For additional assistance in the acceptance review and discussions with the licensee on the amount of information needed, an addendum to the "Acceptance Review Checklist" (SRP Appendix A) is included as Appendix A of this guidance.

## 1.2 EVALUATION INFORMATION

As discussed in Section 2.0 of this document, the difference between dose assessment for license termination of the entire site license and one involved in partial release is that other sources under control of the licensee may affect the potential dose on the partial release. In license termination of the entire site, when the site is released for unrestricted use, there are no offsite sources remaining under the control of the licensee to affect the projected dose for residents or workers using the site. After a partial release, the licensed site may still be operating and thus have dose contributions from offsite sources under the licensee's control. As discussed in Box 3, such offsite sources could include continued effluents from the reactor. Other possible sources include direct gamma exposure from sources offsite, transportation of material from offsite, or reasonable future use of the licensed site (or previous partial releases). Additional discussion of these topics is included in Section 2.0 of this guidance.

Fundamentally, the evaluation criteria remain the same as currently described in SRP 5. The staff still evaluates the source term(s) on the partial release; appropriate scenario(s) [including critical group(s) and pathways]; conceptual model(s); input parameters; calculations; and uncertainty analysis. In addition, the staff may need to assess offsite sources that may influence the dose analysis, and the staff would evaluate these sources similar to a source on

the partial release. The development of the appropriate scenarios for compliance evaluation will identify which sources the staff should focus on.

The primary areas of additional consideration given to partial release cases in developing reasonable scenarios are how could or does:

- The licensed site or a previous partial release influence the dose on the partial release (e.g., effluent releases, groundwater plumes, future combined use, etc.)?
- The partial release influence dose estimates for the licensed site during its decommissioning? and
- The partial release influence previous partial releases (e.g., possible effects on the partial release's final DCGLs to limit the impacts on the previous partial release, so that the potential dose on the previous partial release does not exceed Subpart E)?

## 1.3 DEVELOPMENT/IDENTIFICATION OF PARTIAL RELEASE SCENARIOS

Based on the questions above, scenarios can be divided for purposes of analysis into two categories: compliance and prospective. Analysis of both of these categories of scenarios will assist in establishing the finality of the decision regarding the partial release.

Compliance scenarios involve assessing the compliance of the proposed partial release, or the continued compliance of a previous partial release affected by the proposed partial release, with the Subpart E dose limit. Compliance scenarios involve current or future exposure routes between the partial release and the previous partial release or the licensed site (e.g., Section 3.1's example's low-level waste (LLW) storage area). Compliance scenarios that calculate exposures in excess of the limit or self-imposed constraint (e.g., from a previous partial release's approval) will then entail remedial actions on the proposed partial release [not the previous partial release(s)] or more realistic dose assessments. Fuel cycle facilities (excluding waste disposal sites) will be limited to 0.25 mSv/yr (25 mrem/yr) from licensed activities, which includes doses from the partial release and any effluents, by 10 CFR Part 20 Subpart D. Non-fuel cycle facilities may require a license condition, to limit the allowable effluents, to maintain the partial release at or below the Subpart E dose limit.

Prospective scenarios involve assessing possible interactions between the partial release and any future decommissioning actions on the licensed site, including another partial release. The purpose of prospective analyses is to scope out the potential interactions in the future, and either address them by additional remediation of the partial release or by placing constraints on the future decommissioning of the other sources.

Section 3.1 and Section 3.2 provide illustrations of these two types of analyses.

### 1.3.1 SCREENING OF FEATURES, EVENTS, AND PROCESSES

The staff should use the worksheet in Appendix B of this guidance to guide reviews of potential sources of interaction between the partial release and offsite sources. The purpose of this screening is to answer the questions from Section 1.2 above, by identifying any potential interaction and evaluating the impact(s) on the dose calculations.

The worksheet is broken into three areas of questions: (1) "Screening Sources;" (2) "Screening Transport Processes;" and (3) "Screening Exposure Pathways." Answering "no" to any of the major questions (those using a solid bullet), in the checklist, generally results in that source, transport, or exposure pathway being eliminated from further consideration.

The licensee must have adequate justification for excluding each of the potential sources, transport processes, or exposure pathways not evaluated in the dose assessment analyses. Justification can be quantitive or qualitative. This approach is not different than that taken in justifying the removal of pathways from a normal decommissioning analyses (see SRP Appendix C, Section 4, for level of justification generally associated with pathway removal).

For processes or pathways that are not removed by the screening, the transport mechanisms can be evaluated for the apparent contribution to the dose evaluation. In other words, if a transport mechanism or a source is going to provide less than 5 percent of the dose limit, the licensee can eliminate it from explicit consideration, in most cases. The staff must evaluate the total amount of estimated dose eliminated by this method to make sure that the sum does not exceed 10% of the dose limit.

There are three acceptable methods of handling the offsite impact related to interactions that haven't been screened out: (1) incorporate the source, transport mechanisms, and pathways into the conceptual model and the dose analyses; (2) remediate those sources; or (3) apply constraints on the partial release's DCGLs, to accommodate potential exposures from offsite sources, or to previous partial releases.

Therefore, the staff should evaluate the information to verify that:

- The licensee screened potential interactions with the licensed site and previous partial releases;
- The screening arguments are justified; and
- The licensee properly addressed the remaining potential exposure pathways.

Section 3.1's example illustrates these considerations.

### 1.3.2 Screening the Use of the Partial Site and Other Areas by the Critical Group

A member of the critical group could be potentially exposed to higher doses than those resulting from the partial release alone. This would be through the use of other impacted areas, after they have been released (including previous partial releases), in addition to continuing the use of the partial release. More information on why use of multiple areas is important for a partial release case is provided in Section 2.6.3 of this guidance.

Three general situations can result in doses to individuals that are higher than that for the partial release alone:

- One of the land area's DCGLs took into account the small size of the area;
- Use of more than one exposure area would result in the dose receptor receiving exposure from radionuclides not present on the partial release; and
- Use of more than one exposure area would result in the dose receptor receiving exposure from new exposure pathways or would increase the degree of exposure to a current exposure pathway.

Section 3.2's example illustrates a hypothetical review of a situation involving multiple land use.

If the licensee has used the same DCGLs for a previous partial release, or commits to use the same DCGLs for areas surrounding the partial site, multiple use of the areas is not likely to result in a higher dose, as long as none of the above situations is present, and the scenarios and assumptions used in the calculations are appropriate for all areas.

If the licensee has: (1) used different DCGLs; (2) has at least one of the above situations present; (3) found that the scenarios and assumptions regarding the proposed partial release used for a previous partial release are no longer appropriate; or (4) has not committed to use the same analyses for surrounding areas (as long as it would be valid for the other areas, too), the staff should evaluate the licensee's analyses of potential multiple use scenarios. For example, for interactions with a previous partial release, the staff needs to look at: (1) any prospective analyses and associated constraints, if established, done for the previous partial release; (2) the estimated dose from the residual radioactivity on both the previous partial release and the proposed partial release; and (3) any new or updated analyses performed by the licensee.

## 1.4 EVALUATION CRITERIA

The staff will verify the following points regarding partial release considerations:

- For partial release and previous partial release interactions:
    - The scenarios used in the prospective analyses for the previous partial release, that analyzed the interactions, between the previous partial release and the area encompassed by the proposed partial release, continue to be appropriate, or have been updated appropriately;
    - The licensee did incorporate any constraints, imposed by the previous partial release, that remain appropriate in determining the DCGLs for the proposed partial release;
    - The licensee appropriately identified those sources, that may affect the dose to the average member of the critical group, on either the previous partial release or the proposed partial release;
    - The licensee provided adequate justification for each excluded potential source, transport mechanism, and pathway;
    - The licensee incorporated, or addressed by other appropriate means, any sources, transport mechanisms, or pathways that could not be screened out;

- The licensee evaluated (either quantitatively or qualitatively) reasonable scenarios to account for interactions between the previous partial release and proposed partial release. This includes the prospective analyses for the previous partial release, as well as any new scenarios that needed to be evaluated based on new information; and
- The DCGLs for the proposed partial release will not result in exposures exceeding the dose limit at either the previous partial release or the proposed partial release. The dose assessment for the proposed partial release must also include any appropriate contributions from the licensed site.

- For partial release and interactions with the licensed site, considering both current and future sources (e.g., effluents from the licensed site during operations or decommissioning activities, or potential future parallel use of impacted areas on the licensed site and the partial release):

  - The licensee appropriately identified those current and potential future offsite sources that may affect the dose calculated for the partial site;
  - The licensee provided adequate justification for each excluded potential source, transport mechanism, and exposure pathway;
  - The licensee incorporated, or addressed by other appropriate means, any sources, transport mechanisms, and exposure pathways that could not be screened out;
  - The licensee evaluated reasonable scenarios to account for interactions between the proposed partial release and the licensed site. This includes any prospective analyses that estimate exposures after the licensed site is decommissioned;
  - The DCGLs will not result in exposures exceeding the dose limit at the proposed partial release. The dose assessment for the proposed partial release must also include any appropriate contributions from previous partial releases; and
  - The licensee has clearly documented any constraints placed on current and potential future sources of exposure on the licensed site.

## 1.5 DOSE MODELING APPROACHES

Licensees proposing partial releases may still be able to use either dose modeling option: screening numbers or site-specific analyses.

- If a licensee proposes to use the screening criteria, the following have to be verified by the staff:

  - The partial release itself does not exhibit any of the problems listed on page 5.7 of SRP 5.0;
  - Interactions with the licensed site or previous partial releases have been appropriately evaluated;
  - Any sources of potential exposure from the licensed site have been either constrained or remediated;
  - Any sources of potential exposure increasing either the dose to residents or workers on the proposed partial release or a previous partial release have been either constrained or remediated;

- The screening criteria have been appropriately scaled by all the constraints associated with the partial release. For example, in Section 3.1's example, the licensee constrained the groundwater to 0.05 mSv (5 mrem). Therefore, the screening values for the partial release would need to be scaled to 80 percent [0.2 mSv (20 mrem)/0.25 mSv (25 mrem)] of the published values or those received by using the current version of the DandD computer code; and
- The partial release and its analysis meet the other requirements of SRP 5.1.1 and 5.1.2, as appropriate.

- If a licensee uses site-specific modeling, the following have to be verified by the staff:
  - All sources from the licensed site or previous partial releases have been incorporated, as necessary, into the analyses;
  - Any constraints used by the licensee have been properly reflected in calculating the DCGLs; and
  - The modeling meets all the other review criteria of SRP 5.2.

## 1.6 LICENSE TERMINATION: THE EFFECT OF PREVIOUS PARTIAL RELEASES

At the time of the review of the LTP, the staff must take into consideration any previous partial releases. The entire site (including the previous partial releases) must meet the Subpart E dose limit. When the SRP guidance is revised, it is suggested that SRP 2, "Facility Operating History," add a section similar to SRP 2.5, "Prior On-Site Burials," for the licensee to document any partial releases that have occurred under the license. Reviewing the impact on the license termination is exactly the same as that discussed under "For partial release and previous partial release interactions" of Section 1.4, above. In this case, it is necessary to consider the rest of the licensed site as the partial release.

## 1.7 USE OF PARTIAL RELEASE GUIDANCE AFTER SUBMITTAL OF THE LTP

Reviewers can use this guidance, when licensees request release of portions of their site(s), either as part of a LTP submittal, or after the LTP has been approved. Because of the definition of partial release, technically, the licensee is not performing a partial release, but a phased decommissioning. The guidance is still applicable to those situations, but some of the issues are not as relevant for the situation. If the licensee has prepared an LTP for the entire site, more information will be available about sources of radiation, critical group use, etc., than would likely be available at the time of a partial release. Importantly, the reviewer will be able to review the DCGLs for both the phased release and other areas of the site, and, also, any plans on continued remediation of other areas of the site. Since the phased release would occur while decommissioning activities may be underway on other portions of the site, the analyses should take any releases into account that could affect the dose to the critical group. Prospective analyses of critical group behavior after the entire site is released will still need to be completed, but these scenarios are likely to be easier to define and evaluate.

# 2.0 TECHNICAL BASIS DOCUMENTATION

## 2.1 CONSIDERATIONS FOR PARTIAL RELEASE DOSE ASSESSMENTS

Although the license termination requirements in Subpart E provide options of unrestricted and restricted release, partial releases can only be approved for unrestricted release. Partial release has many aspects in common with the existing approach for unrestricted release, and the available guidance is generally applicable. One key difference is that partial release does not occur concurrent with license termination. As a result, continuation of licensed activities outside of the partial release represents a potential source of exposure. In turn, the residual radioactivity on the partial release may impact dose analyses for other areas of the facility during subsequent partial release requests and/or eventual license termination.

Because existing SRP guidance requires that the dose assessment include all significant exposure pathways, the need to consider the potential for accumulation processes resulting in increased radionuclide concentrations over time is not a new concept for partial release. Nonetheless, the importance of accumulation is increased under partial release because the license will not be terminated. The existing site areas outside the partial release are not required to be remediated at the time of partial release. Therefore, the potential for accumulation, on the partial site, that could impact the dose assessment, is increased.

One of the most important concepts behind the guidance for partial release is the finality of the decision. The purpose of the guidance is to establish the scope of the review and focus staff attention and resources to early identification of aspects important to compliance. The primary objective of the partial release guidance is to ensure that any partial release meets Subpart E requirements, even if potentially impacted by later partial releases and/or license termination. The secondary objective of the partial release guidance is designed to ensure, at the time of license termination, that all prior released areas are considered and included, as necessary, in dose assessments to provide assurance that the entire site meets Subpart E requirements. To meet these two objectives, the licensee is requested to perform both compliance calculations for current conditions at the partial release (or the effect on a previous partial release) and prospective calculations to estimate the impact on other decommissioning activities by a licensee. This set of analyses will help ensure that the DCGLs chosen for the partial release will not result in the need for future remediation of the partial release or unduly constrain the decommissioning of the entire site.

The existence of a partial release may place constraints, on the future activities that occur nearby, to limit the potential for exposures, to the critical group residing or working on the partial release, exceeding the Subpart E limits or other public dose limits. Existing NRC effluent control and operational dose limits and their associated guidance will generally limit operational releases to acceptable levels. Adjustments may need to be made to effluent compliance calculations or environmental sampling areas to account for the removal of the partial release from licensee's control.

## 2.2 DESIGNATION OF AREAS IMPACTED OR NON-IMPACTED

An important initial consideration for partial release is whether the partial release has been impacted by past practices or potentially will be impacted by future actions by the licensee. Licensees are expected to conduct an HSA to determine whether an area is impacted or non-impacted. The HSA is an investigation to collect existing information describing a site's complete history from the start of site activities to the present time. This guidance includes reviews of potential, likely, or known sources of radioactive material and residual radioactivity (e.g., prior areas of material processing, storage, transport, and waste disposal) and the likelihood of residual radioactivity migration. The site (or areas within the site) is classified as impacted or non-impacted, based on whether the HSA finds any potential for an area to have residual radioactivity currently or in the future.

For non-impacted areas, the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) does not require surveys to demonstrate compliance beyond what may have been done for the HSA because such areas are considered to be free of residual radioactivity currently and in the future. Thus, for non-impacted areas, the staff technical review will normally be limited to the sufficiency of bases in the HSA. Partial release narrows the definition of non-impacted because of the possibility of future licensee actions resulting in impacting the partial release. For example, in some cases, close proximity to existing operations, contaminated areas, future remediation sites, or potential storage areas, may not allow a licensee to designate an area as non-impacted and release it without a dose assessment. The HSA should include areas of the site outside of the partial release to the extent necessary to provide assurance that residual radioactivity from the licensed site (or previous partial release) is unlikely to transport material, to the partial release, that would result in potential exposures, to users of the property (including subsurface and groundwater), in the future.

For impacted areas, partial release requests involve a more complicated compliance demonstration and review effort. First, impacted areas require the licensee to request a license amendment. The impacted status determination triggers the MARSSIM radiation surveys and site investigation (RSSI) process, with the exception that simple sites can undergo a more streamlined approach. RSSI includes scoping, characterization, remedial action (as needed), and final status surveys of impacted areas. The MARSSIM guidance is adequate for a partial release (for surface soil and buildings); however, the RSSI process requires DCGLs as inputs that could involve special considerations for a partial release. These considerations are the focus of this supplemental guidance (i.e., evaluating possible interactions between the partial release and the licensed site or previous partial releases that may impact the DCGLs).

## 2.3 USE OF CURRENT SRP GUIDANCE

Some of the clarifications required for applying the SRP to partial release reviews are common to many sections of the SRP. As a result, they are discussed generically as broad issues in the following paragraphs.

The SRP was written to address decommissioning of sites as part of the license termination process. As a result, termination of the license is often discussed as the end result of decommissioning. When applying the SRP to partial release, most of the references to license termination should be regarded to imply the completion of the partial site decommissioning

effort. Despite the frequent use of the term, "license termination," licensees should be aware that partial release will not result in license termination, as the entire licensed site, including any partial releases, must meet the Subpart E requirements at the time of license termination. Therefore, true license termination issues only need to be considered in partial release reviews when assessing prospective analyses that may raise issues that need to be considered or analyzed at the time of license termination (e.g., creation of new license conditions that identify pathways that should be included in DCGL calculations). Licensees should also be aware that the existence of a partial release adjacent to impacted areas could place constraints on future decommissioning methods and actions related to the license termination (e.g., to minimize the potential for decommissioning to re-contaminate previously partial releases).

The terms "site" and "facility" are used interchangeably in the SRP. Under partial site release, most of the references to site or facility will apply to the boundaries of the area proposed for partial release (i.e., the area to be decommissioned). Exceptions to this would be when the SRP discusses the need to collect site characterization information, in which case the terms "site" or "facility" can include areas beyond the boundary of the partial release and potentially encompass the entire site and any previous partial release(s), as necessary to establish contaminant source, transport, and exposure pathways for DCGL calculations. Staff is expected to use pre-submittal meetings with the licensee to develop the amount of information needed on the licensed site for specific areas of such safety concerns. The SRP's Appendix A checklist, as modified by Appendix A of this document, is a tool the staff can use in these pre-submittal meetings.

## 2.4 MARSSIM AND PARTIAL RELEASE

The SRP references the MARSSIM approach for planning and conducting surveys of buildings and surface soil that support demonstration of compliance with the license termination criteria in Subpart E. The limited scope of the approach (i.e., to surface soil and buildings), was necessary, in part, to avoid delays in the availability of guidance for surface soils and buildings while awaiting development of guidance for subsurface and groundwater surveys. Until such issues have been addressed in a future update of MARSSIM, the SRP has allowed the surface-based methods to be applied to subsurface and groundwater contamination (see SRP Appendix E, Section 11.1). Special considerations for subsurface contamination for partial release are discussed in Section 2.7 of this guidance document.

The MARSSIM approach involves demonstration of compliance on a survey unit by survey unit basis. Survey units are determined based on the expected level of residual radioactivity in areas across the site as well as spatial and topographical considerations. By allowing compliance demonstration by survey unit, the current approach is congruent with a partial release concept. As a result, in general, the MARSSIM approach can be directly applied to a partial release without significant problems.

To limit the potential for interactive dose effects, any impacted areas, identified to exist on the partial release, which continue across the proposed partial release boundary, should be fully included in the proposed partial release final surveys. If buildings are intended for partial release, the building should be included in the partial release unless a licensee can provide information to demonstrate a low potential for future exposure of individuals in the partial release portions of the building from other impacted areas of the building and that any

significant dose contributions from areas outside the partial release are included in determination of the DCGLs for the partial release.

## 2.5 DOSE MODELING SPECIFIC ISSUES

The compliance methodology in the SRP emphasizes dose modeling to derive DCGLs that will be used as input to the MARSSIM process. Simple sites that only involve surface contamination and low potential for migration of residual radioactivity will require straightforward dose calculations to derive DCGLs. Sites with subsurface and groundwater residual radioactivity or migration of radioactive material from one area to another will generally require more complex modeling and compliance demonstration methods.

Because areas of the site outside a partial release may not be remediated at the same time as the partial release, a primary concern with the calculation of DCGLs is that the dose calculation includes all applicable transport and exposure pathways. For partial release, special consideration needs to be given to any potential for significant transport of material into the partial release from outside the boundary, or from the partial release to other areas of the licensed site or a previous partial release. DCGLs need to account for movement of radioactive material under circumstances where accumulation processes could lead to media concentrations significantly increasing, if the transport were included, or would add new radionuclides or exposure pathways for the partial release dose assessment.

For example, an area designated for partial release may not have impacted groundwater, but an impacted area on the licensed site up-gradient has impacted groundwater that is expected to migrate into the partial release in the future. The future groundwater residual radioactivity must be included in the dose calculation for the partial release (unless its contribution would not be significant) or addressed by other methods. The surface DCGLs for the partial release may need to be constrained by the groundwater dose to ensure the total partial release complies with the 0.25 mSv/yr (25 mrem/yr) dose limit for the 1000-year compliance period. Similar situations could exist with up-gradient surface or subsurface contamination (e.g., leaching and transport from the sources to the partial release).

Similarly, residual radioactivity sources on the partial release must be evaluated for potential transport to the licensed site or other previous partial releases. Most licensees should be able to assess the potential for transport pathway communication between site areas using available HSA and site characterization information. Complex sites may require collection of additional site characterization information (inside and outside of the partial release) to support evaluation of transport pathways. The scope of site characterization work should be consistent with the expected level of residual radioactivity and potential dose consequences.

An additional consideration for partial releases is the potential for the partial release to impact the existing site or the eventual license termination for the site. Review of non-Subpart E impacts is discussed in the proposed rule.

Records of the partial release are needed to ensure the residual radioactivity at the partial release can be included in subsequent partial release analyses and in the overall site license termination process. Residual radioactivity at partial releases may be a concern for site license termination when the potential for migration and accumulation of radioactive materials to the

licensed site exists. This circumstance may only be significant when a number of partial releases exist, in close proximity, that share common transport pathways with the licensed site, such that accumulation of transported material is possible. Another situation is when the critical group may use multiple partial releases. In addition, the partial release's approval may have involved constraints on the dose contributions from decommissioning activities or residual radioactivity sources that may remain on the licensed site.

For each subsequent partial release request and at license termination, all prior partial releases need to be considered for potential contributions to dose that may need to be included in partial or site DCGLs that are calculated. For some sites, this could mean that prior partial releases could constrain the amount of residual radioactivity allowed in a partial release, or at the remainder of a site, at license termination. If the review of a partial release identifies important features, events, and/or processes (FEPs) that need to be considered at license termination, staff may develop a license condition to ensure the matter is addressed.

**Review of impacts on previous partial releases is very important because the previous partial release was approved based on the calculations and evaluations done to show compliance with the Subpart E limit. If, at a later date, another portion of the site is decommissioned and released, the possible impacts on the dose estimates at the previous partial release need to be reviewed. The first area to investigate is to review the previous approval and look at the prospective analyses done at that time. If they remain valid and bound any impacts that could be caused by the proposed partial release, then the impact of the proposed partial release can be considered acceptable. If the proposed partial release will result in impacts that may cause the previous partial release to exceed the Subpart E limit, the DCGLs for the proposed partial release should be constrained to limit the impact so that the dose on the previous partial release remains below the Subpart E limit.**

Scenario development, especially for prospective analyses, does involve some speculation. Staff should focus on reasonable scenarios to limit the degree of speculation. Both human behavior and FEPs should be based on present knowledge. Speculation of regarding activities that are not present in the region, not reasonably likely to occur, or would change the behavior of the FEPs, should be avoided. For example, a scenario that involves modifying the local topography so that surface water would then transport radioactive material from an impacted area to the partial release is too speculative and not a reasonable scenario.

Ultimately, all partial releases and, eventually, the entire site, will have to meet the Subpart E requirements. Each time a partial release is requested, the licensee will have to consider the potential impacts, if any, of all prior partial releases on the calculated DCGLs, and when the license is terminated, all prior partial releases will have to be reviewed to determine whether they will contribute significantly to the site DCGL calculations. In most cases, it is expected the review of prior partial releases will not be time-consuming, because of the use of prospective dose analyses as part of the previous partial release request.

An important part of the detailed technical review will be determining if a licensee has included all applicable exposure pathways in the DCGL calculations and provided sufficient bases for exclusion of exposure pathways. Applicable exposure pathways are determined by considering: (1) the means by which the critical group can be exposed to localized residual radioactivity; (2) the potential for sources and transport of radioactive materials (from the partial release, the licensed site, or previous partial releases) to the location of the applicable critical group; and (3) concurrent use, if appropriate, of the partial release and previous partial releases by the critical group. The SRP currently addresses exposure pathways for localized residual radioactivity, and the methods are straightforward. This guidance focuses on analyzing sources and transport pathways because the potential risk of additional sources of exposure impacting a partial release (or a previous partial release) is increased when the entire site is not decommissioned at the same time. Scenario definition and pathway identification (step 4 in the "Decommissioning Framework" shown in Figure 1) are therefore key aspects of DCGL dose modeling that are impacted by the unique circumstances possible under partial release.

### 2.6 FEPS

Applicable source, transport, and exposure pathways comprise the exposure scenario for DCGL calculations. DCGL calculations can be done using all-pathway models or pathways can be decoupled from the modeling and their results allocated to pathway-specific DCGLs that can be combined to generate a survey unit or partial release DCGL that equates to the Subpart E dose limit. A number of options for calculating DCGLs exists, and the specific option, chosen by the licensee, for a site, will be determined by the site conditions, complexity, and level of risk involved.

#### 2.6.1 Screening Methods

The purpose of screening various sources, transport mechanisms, and exposure pathways is to evaluate whether the partial release may have processes that could result in radioactive material being transferred between the partial release and either the licensed site or previous partial releases. The first goal of the screening criteria is to eliminate various FEPs from consideration, while minimizing the amount of information needed by the staff to make a decision. A second goal is for the screening criteria to factor in the availability/cost of information (i.e., the first criterion should not require the need to develop a complex site-specific three-dimensional groundwater model). The screening of these criteria should not only focus on the effect of the licensed site, or a previous partial release, on the partial release, but, also, the potential contribution of the partial release on the dose assessment for the entire site at the time of decommissioning, or the current compliance of a previous partial release with Subpart E. The general categories of screening criteria are:

- The presence of residual radioactivity in various media, including effluent releases from the operating site (e.g., soil, groundwater, air);
- The availability of mechanisms to either move material from one location to another, (e.g., groundwater movement) or project exposure from one area to another (e.g., direct radiation); and
- The availability of exposure pathways to cause dose in humans after it is moved or projected to the area.

After a medium, such as groundwater, is found to contain residual radioactivity, it may be screened out if it has minimal levels of residual radioactivity (compared with the residual radioactivity currently present in the media at the critical group location). If the source is not screened, then the transport mechanism(s) that may transport the radionuclides to the area of interest is (are) screened to evaluate the capability of the process to move material to the area of interest. This can then be compared to the residual radioactivity levels for each radionuclide currently present on the area of interest or other processes moving material. Finally, the potential exposure pathways can be screened to remove those pathways that would result in insignificant doses or are not present at the location where the material is being deposited.

In formulating a complete exposure scenario for a proposed partial release, initial consideration should be given to available information (from the partial release area, the site, or any prior partial release) that can rule out further consideration of specific sources or transport pathways. Although investigation of potential sources and transport pathways can become complicated and expensive, a number of potential sources and transport pathways can be ruled out with relatively simple and available information. Appendix B provides a worksheet of source, transport, and exposure pathways with questions that can be used for screening. Use of a "top-down" approach to screening can avoid unnecessary and costly investigation into details that will not have a significant impact on DCGL calculations. It is expected that once a potential release or transport pathway has been identified, licensees may provide simple, yet reasonably conservative, screening-type calculations to assess importance. Pathways may be excluded because of only a small dose contribution, if the pathway results in less than 5 percent of the dose limit, and the sum total of all pathway exclusions does not exceed 10 percent of the dose limit. The licensee should clearly identify all screened pathways, and should show sufficient bases for exclusion.

### 2.6.2 Example of Screening Process for FEPs

In Appendix B, a worksheet has been provided as one method of screening FEPs for partial release. The purpose of the worksheet is to provide some general topics that can, in most cases, be considered with generally available information, to minimize unnecessary site characterization, modeling, and review. The worksheet can be used to develop both compliance and prospective analyses. Ultimately, if radionuclides cannot be released or transported to the critical group location, there is no point for further consideration of the FEP(s) in the dose assessment.

Specific site conditions and available information may make it desirable for a licensee to initially focus on source, transport, or both, when trying to screen FEPs. In some cases, it may be necessary to conduct limited dose calculations to provide information to justify the exclusion of a source, transport mechanism, or exposure pathway. If a source cannot be screened out, then it should be considered for transport screening. If pathways cannot be excluded using this worksheet, they should be considered in initial dose calculations, by either inclusion in the analysis or in modifying the dose limit through the use of a constraint. Results of the initial dose calculations can provide additional insights to the significance of pathways with respect to dose and may provide additional means for further refinement of the calculations to address only the important features and processes. All source, transport, and exposure pathway exclusions from modeling must be identified and accompanied by an appropriate justification for exclusion.

The worksheet is split into three parts: (1) Sources; (2) Transport Processes; and (3) Exposure Pathways. The method is to start with the source questions and follow the directions under each item as necessary. The user should follow the path down until the item is screened out or needs to be considered in the analyses. After reaching the end of a path, the user should go back to where the branching occurred and continue with the questions, if applicable. For example, a site has some residual radioactivity in soil and the licensee reviews the questions under 2.2.2 ("Soil Transport: Leaching"). The questions lead the user on to 2.4 ("Groundwater,") and the user follows that path to its conclusion. The user then needs to go back and still evaluate 2.2.3-2.2.6 for that residual radioactivity in soil.

In general, for each "yes" the analysis continues to more detailed questions on that source and media type. Each "no" on a black bulleted question means no further evaluation of that area (and its related questions) is necessary for that specific source/media combination. For a black-bulleted question with a list of more detailed questions (i.e., with the empty bullets) to be excluded, all of the detailed questions need to be "no." Some instructions will provide exceptions to this general rule.

For example, the last question of 2.3.1 ("Deep Soil Transport: Leaching") includes three specific transport mechanisms from deep soil. If the answers to all three were "no," the leaching of the source would be screened out of the dose assessment. If the answer was "no" for surface water and other, but "yes" for groundwater, potential leaching of the deep soil source would need to be addressed unless the groundwater transport or related exposure pathways were subsequently screened out.

**2.6.3 Human-Induced Scenarios**

Another source of exposure that may lead to interactive dose effects between the partial release and another impacted area under (or previously under) control of the licensees is individuals using both the partial release and the impacted area(s) after the licensee no longer controls those areas. The concern is that a critical group could use the partial release, such that it still receives a large fraction of the Subpart E dose limit, and reasonably use another impacted area that would lead to the critical group receiving, in total, doses in excess of the Subpart E dose limit.

Obviously, most of the human-induced scenarios are prospective scenarios to evaluate the human-induced scenarios after the other impacted area is released for unrestricted use. In cases where the human-induced scenario involves a previous partial release, the analysis is one of compliance for the partial release, which will also verify that the human-induced scenario will not result in exposures to the previous partial release, above the limit. The licensee can use constraints to address the exposures from future use of areas that are on the licensed site (see Section 3.2's example).

Three situations can result in dose assessments higher than that for the partial release alone:

- One of the land areas' DCGLs took into account the small size of the area;
- Use of more than one impacted areas would result in the dose receptor receiving exposure from radionuclides not present on the partial release; and

- Use of more than one impacted areas would result in the dose receptor receiving exposure from new exposure pathways or would increase the degree of exposure to a current exposure pathway.

Taking an area's size into account when developing the DCGLs is a special case of the aforementioned third bullet. This is because usually size-related modifications for dose modeling result in reducing the number of pathways or amount of exposure, but these changes may not be obvious especially if the code itself (like RESRAD does) modifies the dose calculations.

## 2.7 SUBSURFACE RESIDUAL RADIOACTIVITY

Subsurface residual radioactivity can exist in soils and deeper geologic strata. Common sources of subsurface residual radioactivity include material leached from surface soils, buried waste, and impacted groundwater. Impacted areas can be either saturated with groundwater or unsaturated (where water may percolate through but does not fill all pore spaces). Guidance in the SRP related to subsurface residual radioactivity applies the MARSSIM (surface-based) methodology to subsurface, with a few modifications to address volume sources. Guidance is expected to be updated in the future to improve methods for subsurface residual radioactivity. This section discusses special considerations for addressing subsurface residual radioactivity under the partial release scenario(s), with an emphasis on pathway identification for DCGL calculations. Because addressing subsurface residual radioactivity is merely a component of the same dose modeling discussed in the previous sections, the same framework for DCGL calculations applies. For the purpose of discussion, surface water is included in some examples because of the interconnections between surface water and groundwater systems.

The SRP and MARSSIM recommend combined use of data from the HSA in assessing residual radioactivity. If a site is classified as impacted by the MARSSIM methodology, the SRP states that surface and groundwater surveys should be designed on a site-specific basis. If important information necessary to understand subsurface characteristics (including extent and amount/type of residual radioactivity) is not immediately available when partial release is requested, some characterization of surface water flow, sediment movement, and groundwater flow for both the partial release and adjacent areas, as necessary, on the licensed site may be needed to support the amendment request. The source locations in conjunction with the site complexity determine the surface and groundwater characterization needed at the time of partial release. The level of surveys for surface and groundwater residual radioactivity should factor in: (1) the extent of existing residual radioactivity of soil on the partial release; (2) the proximity of the partial release to existing and potential impacted areas on the licensed site; and (3) the complexity of the surface and groundwater hydrology.

As noted previously, dose modeling is required for a partial release that has been classified as impacted. Subsurface residual radioactivity, once identified, must be assessed for inclusion or exclusion in dose modeling to derive DCGLs. Residual subsurface radioactivity that contributes less than 5 percent of the dose limit does not need to be included in the DCGL calculations, as long as all exclusions do not consist of more than 10 percent of the dose limit, but its exclusion should be documented for future consideration at license termination.

Simple situations that need to include subsurface residual radioactivity in dose modeling may involve only radioactive material originating from the partial release or only one offsite source of impacted groundwater in a relatively simple hydrology system. More complex partial release can involve numerous additional sources of residual radioactivity migrating from areas outside the partial release or migrating off the partial release onto a previous partial release or the licensed site. An important aspect is the possibility of multiple sources coalescing in the surface or groundwater systems (i.e., the additive effect of multiple sources from the licensed site, the partial release, or other previous partial releases).

All potential processes for migration of material need to be considered; however, some pathways can be easily excluded with available information (see Appendix B). There is a large dilution effect when radionuclides migrate into bodies of water, such as streams, rivers, lakes, and ponds. Sediment movement and groundwater flow are commonly slow processes, relative to surface water flow. Reduction of residual concentrations in groundwater (caused by mechanical mixing and sorption) and radioactive decay effects are associated with the longer time factor in the transport legs for sediment movement and groundwater transport. A clear example of pathway exclusion would be a partial release in a watershed that is isolated from the licensed site operations and impacted areas, and the partial release is located upstream of all other offsite sources. It is reasonable in this case that the residual radioactivity at the partial release area can be neglected in dose modeling at the time of license termination if it can be demonstrated that there is no significant dose contribution to the site DCGLs. Another simple example is the exclusion of drinking water pathways, given the absence of a drinking water aquifer accessible to the critical group.

Types of surface and groundwater features that could lead to a focusing of residual radioactivity from multiple, spatially separated source areas can be separated into two categories -- common features and site-specific features. To determine if focusing occurs, site characterization data are needed to identify spatially convergent groundwater flow directions or convergent surface water flow and sediment movement. The level of site characterization needed should be determined by the potential for these features to occur at the particular site. Examples of each are described below.

The most common feature leading to convergent mass movement is a river, stream, or pond in a watershed. Multiple radionuclide sources at various locations around a watershed could all potentially migrate in the surface and subsurface towards the main stream channel or pond. All surface water in the watershed could be routed into the main channel or pond. Whereas most watersheds have an outlet, some lakes, ponds, or bogs may be the terminal point in a transport pathway where residual radioactivity may accumulate. Changing chemistry of the transport path (e.g., the reducing environment of a swamp) can also impact the deposition or dissolution/mobilization of specific contaminants.

In that same watershed, the uppermost aquifer may also focus groundwater flow into the stream since gradients in the unconfined aquifers typically follow the topography and commonly seep into stream and river channels. The exception is for uppermost aquifers with water tables that lie below the stream elevation; these aquifers would not, necessarily, seep into the stream channels or ponds and would not lead to a convergence of groundwater flow directions unless dictated by another feature.

Site-specific features, such as faults, karst terrains, and alluvial channel deposits, have the potential to focus water from diverse locations into single transport pathways. These features may lead to a channelization of flow in the subsurface. Licensees should first determine if such subsurface features exist at a site. If present, the candidates can then be analyzed for the potential to focus transport pathways from impacted areas of the licensed site or a previous partial release.

Facilities and partial releases with the potential for multiple sources of residual radioactivity that could migrate to surface or groundwater should use or obtain sufficient site characterization data to ascertain if there is a potential for convergent features to exist on the site. This site characterization data will have to be obtained at the time of a partial site release if they are not already available. The potential for overlapping transport pathways needs to be assessed from multiple source areas, where those sources could be on the partial release, the licensed site, or previous partial releases.

## 2.8 RECORDS AND DOCUMENTATION

Maintaining complete records of partial releases is important because the information will likely be needed for any subsequent partial releases and at the time of license termination. The existing SRP directs staff to consider all prior licensing actions in the reviews for a license termination, of which partial release is only one example. Similarly, the framework for partial release involves consideration of all prior partial releases and consideration of whether the residual radioactivity needs to be included in DCGL calculations for license termination. Because considerable time may elapse between a partial release and the eventual license termination, maintenance of complete records is an important aid to the licensee, as well as NRC staff. Incomplete records may result in the need for additional site characterization at the time of license termination. Records should include HSA documentation, identification of impacted areas, and information describing the MARSSIM RSSI methods used and results obtained, including all site characterization information, applicable to the partial release, that supports DCGL calculations. Any information supporting source, transport, or exposure pathway exclusions at the partial release, in common with the licensed site, is of particular importance, as are any assumed dose constraints used to simplify the previous dose assessments. This information will be used to support a determination of whether partial releases will have to be included in DCGL calculations at the time of license termination.

## 3.0 EXAMPLES

## 3.1 EXAMPLE 1

A licensee wishes to release a portion of the site, 10 years before the LTP is estimated to be provided to NRC. The partial release has surface soil residual radioactivity of Cobalt-60 (Co-60) and Cesium-137. Adjacent to the partial release, on the licensed site, is the low-level waste storage area, which is a potential source of gamma exposure to individuals on the partial release. The only other potential offsite source is a groundwater plume from the licensed site. The licensee evaluates the two offsite sources and eliminates all other offsite sources because of the absence of valid transport mechanisms to allow significant impact on dose analyses. The licensee then takes the following actions to address the remaining potential exposure sources:

1) A berm is going to be built between the low-level waste facility and the partial release, on the licensed site, to reduce the external gamma exposure. The berm is estimated to reduce the potential dose from 0.05 mSv (5 mrem) to less than 0.001 mSv (0.1 mrem). The contribution is now insignificant and the source can be eliminated from further consideration in estimating the dose for the compliance calculations for the partial release's DCGLs. The berm presence of the berm would then likely become a license condition. Removal of the berm in the future may require re-analysis of the total dose to the critical group, to verify that exposures on the partial release will not exceed the Subpart E limit; and

2) The groundwater plume is estimated to reach the partial release in approximately 15 years. The licensee has currently no final plans on the level of remediation that will be done to the plume. Current conservative dose modeling estimates the annual peak exposure to be approximately 0.1 mSv (10 mrem) from an all-pathway analysis, using the groundwater concentration at its current location. The licensee proposes partitioning the unrestricted dose limit for the partial release. The licensee will constrain the annual peak dose from the residual radioactivity to 0.2 mSv (20 mrem) and the groundwater dose to 0.05 mSv (5 mrem). To ensure the groundwater concentrations do not exceed specific concentrations associated with the
0.05-mSv (5-mrem) constraint, the licensee will install monitoring wells between the plume and the new licensed site boundary and develop a corrective action plan to use in case the concentrations raise above some specified fraction of the constraint concentrations.

In both cases, although the partial release will meet the Subpart E dose limits at the time of approval, these actions may result in further impact on the final decommissioning of the licensed site. For example, assume, at the time of license termination, residual amounts of Co-60 and Niobium-94 are in the surface soil around the low-level waste storage area, and a building code requires the berm to be removed. When the berm is removed, external exposure would result in 0.04 mSv/yr (4 mrem/yr) which, based on the final status survey of the partial release and the groundwater constraint, would result in a total

**Note that if a previous partial release is impacted by a proposed partial release, or the decommissioning of the site, such that doses on the previous partial release may exceed the Subpart E dose limit, constraints are to be placed on the current action(s) and do not require that the partial site release be remediated [except as noted by 10 CFR 20.1401(c)].**

dose estimate of 0.29 mSv/yr (29 mrem/yr), which does not meet the Subpart E dose limit for unrestricted release. The final DCGLs of the low-level waste storage area may be constrained because of the effect on the partial release. Other options available to the licensee would be to re-evaluate the partial release dose assessment to account for decay and new information on the dose from the groundwater plume or additional remediation of the groundwater plume.

### 3.2 EXAMPLE 2

A second licensee wishes to release an impacted portion of a licensed site. The area has residual radioactivity of uranium and thorium. The partial release is rocky, with poor soil, and the licensee can provide adequate justification that the critical group would not plant extensive gardens nor use the groundwater under the partial release. No offsite sources or transport mechanisms could affect the dose if the critical group used only the partial release.

The closest other radioactive source, under the control of the licensee, is some groundwater concentrations of Hydrogen-3 and Chlorine-36, present nearby, on the licensed site, from old tracer tests. The land over the groundwater residual radioactivity is suitable for extensive gardening, or farming and the aquifer is potable. As part of the dose assessment, the licensee evaluates a prospective scenario where the critical group may use both the partial release and portions of the licensed site after it is decommissioned. After review of the sources, impacted areas, and routes of exposure, it is decided that a reasonable scenario would involve the person living on the partial release, and using the offsite area and its impacted aquifer for drinking water and growing an extensive garden. The licensee, believing it will be easy to remediate the groundwater, addresses the offsite pathways in this scenario by placing an aggressive constraint (i.e., a small fraction of the current dose estimate) on the dose from the waterborne pathways (which are all from the offsite area). The licensee then, accounting for the dose constraint, calculates DCGLs for the partial release, using only the radioactivity on the partial release, does a final status survey, and gains NRC approval to release the partial release for unrestricted use.

At the time of site decommissioning, years later, the licensee, having better characterized the groundwater plume and having run some well pumping tests, finds that it will be difficult to meet the constraint it established on the groundwater dose, without extensive remediation of the groundwater. Therefore, from NRC's perspective, the licensee is effectively left, at license termination, with three options: 1) remediate the groundwater down to the constraint; 2) revise the constraint based on additional modeling (e.g., taking into account actual final status survey results for the partial release, decay of the sources, new information known about the groundwater system, and associated residual radioactivity, or more realistic models of groundwater dispersion and transport); or 3) a combination of the two options. NRC views remediating a previous partial release as the option of last resort, consistent with NRC's policy on intervention of terminated licenses. Obviously, if the licensee desires to remediate the previous partial release, NRC would not necessarily stop the licensee but the situation could involve a number of issues related to regulatory authority, not to mention the need for the current owner's approval.

**Note that if the groundwater with residual radioactivity had been under a previous partial release instead of the licensed site, the options would have been different. The options would be to remediate the uranium and thorium residual radioactivity on the proposed partial release, do more complex modeling or a combination of the two.**

## 4.0 REFERENCES

U.S. Nuclear Regulatory Commission, et al, NUREG–1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, Revision 1, Washington DC: U.S. Nuclear Regulatory Commission, 2000.

U.S. Nuclear Regulatory Commission, NUREG–1727, *NMSS Decommissioning Standard Review Plan*, Revision 0, Washington DC: U.S. Nuclear Regulatory Commission, 2000.

# APPENDIX A

## ADDENDUM TO THE ACCEPTANCE REVIEW CHECKLIST

To help the staff conduct complete acceptance reviews, NUREG-1727, the Office of Nuclear Material Safety and Safeguards Decommissioning Standard Review Plan (SRP), contains an acceptance review checklist in its Appendix A. The following is a list of items related to partial site release (hereafter, partial release) that should be considered when doing an acceptance review.

**EXECUTIVE SUMMARY**

— Description of any previous partial releases;

**FACILITY OPERATING HISTORY**

**LICENSE HISTORY**

— Include information on any previous partial releases;

**PREVIOUS DECOMMISSIONING ACTIVITIES**

— (Add to first item.) . . . including a list or summary of previous partial releases;

**PRIOR PARTIAL RELEASES** (New subsection)

— A summary of the areas at the site where licensed areas have been released for unrestricted use in the past;
— The types, forms, activities, and concentrations of the residual radioactivity on previous partial releases; and
— A scale drawing or map of the site, facilities, and environs, showing the locations of previous partial releases.

**RADIOLOGICAL STATUS OF THE FACILITY**

**CONTAMINATED STRUCTURES**

— Include information for any structures remaining on any previous partial releases;

**CONTAMINATED SYSTEMS AND EQUIPMENT**

— Include information for systems and equipment remaining on any previous partial releases;

**SURFACE SOIL CONTAMINATION**

— Include information for surface soils from any previous partial releases;

**SUBSURFACE SOIL CONTAMINATION**

— Include information on subsurface soils from any previous partial releases;

**SURFACE WATER**

— A summary of residual radioactivity present in lake and stream sediments;
— Include information on surface water from any previous partial releases;

**GROUNDWATER**

— A summary of the spatial distribution of residual radioactivity in the aquifer(s) at the site and in the vicinity;
— Include information on groundwater on any previous partial releases;

# APPENDIX B

## WORKSHEET FOR SCREENING PARTIAL RELEASE INTERACTIONS

This worksheet is provided to assist the staff and licensee in screening potential sources and transport pathways from consideration in dose modeling for Derived Concentration Guideline Levels for a partial site release (hereafter, partial release). It is intended that the results of this worksheet summarize the exclusion or inclusion of each item and the screening argument, as well as reference the more complete screening argument, if necessary. The questions must be considered for all sources of residual radioactivity and potential critical group locations. Although this worksheet has been designed for use in identifying features, events, or processes that could result in additional sources of exposure for the critical group on the partial release, it can also be used for general scenario and pathway development.

---

**NOTE: The worksheet focuses on physical features, events, and processes that may transport radioactive material to the partial site. Additionally, it covers *in vitro* situations, where offsite radioactive material may directly expose critical group members using the partial release. It does not explicitly address sources or routes of exposure that result from the critical group using more than the partial release (see Section 2.6.3 of the guidance).**

---

### INSTRUCTIONS

The worksheet is split into three parts: (1) "Screening Sources," (2) "Screening Transport Processes," and (3) "Exposure Pathways." The method is to start with the source questions and follow the directions under each item as necessary. The user should follow the path down until the item is screened out or needs to be considered in the analyses. After reaching the end of a path, the user should go back to where the branching occurred and continue with the questions, if applicable. For example, a site has some residual radioactivity in soil and the licensee reviews the questions under Subsection 2.2.2 ("Soil Transport: Leaching"). The questions lead the user on to Section 2.4 "Groundwater," and the user follows that path to its conclusion. The user then needs to go back and still evaluate Subsections 2.2.3-2.2.6 for that source of residual radioactivity in soil.

## 1.0 SCREENING SOURCES (YES/NO)

Do the following section that is appropriate for each possible source of residual radioactivity.

### 1.1 EXISTING/HISTORICAL RESIDUAL RADIOACTIVITY (YES/NO)

- Is there residual radioactivity presence in media? (yes/no)
  - Gaseous or Particulate Release?
  - Surface Soil [less than 30 centimeters (1 foot)]?
  - Deep Soil [greater than 30 cm (1 ft)]?
  - Groundwater?
  - Surface Water?
  - Structures?

- Other?

- Evaluate, for each media type: is there a sufficient amount of residual radioactivity to include in dose calculations? (yes/no)
  - Gaseous or Particulate Release? If "yes," go to Section 2.1 (hereafter, just the number of the section or subsection).
  - Surface Soil [less than 30 cm (1 ft)]? If "yes," go to 2.2.
  - Deep Soil [greater than 30 cm (1 ft)]? If "yes," go to 2.3.
  - Groundwater? If "yes," go to 2.4.
  - Surface Water? If "yes," go to 2.5.
  - Structures? If "yes," go to 2.6.
  - Other? If "yes," follow the process for the most similar media.

### 1.2 CURRENT OPERATIONAL RELEASES (YES/NO)

- Are there current effluents or 10 CFR 20.2002 ongoing disposals from the operating facility in the media? (yes/no)
  - Gaseous or Particulate Release? If "yes," got to 2.1.
  - Surface Soil [less than 30 cm (1 ft)]? If "yes," go to 2.2.
  - Deep Soil [greater than 30 cm (1 ft)]? If "yes," go to 2.3.
  - Groundwater? If "yes," go to 2.4.
  - Surface Water? If "yes," go to 2.5.
  - Other? If "yes," follow the process for the most similar media.

- Are there ongoing or planned decommissioning activities involved with media containing residual radioactivity? (yes/no)
  - Gaseous or Particulate Release? If "yes," got to 2.1
  - Surface Soil [less than 30 cm (1 ft)]? If "yes," go to 2.2.
  - Groundwater? If "yes," go to 2.4.
  - Surface Water? If "yes," go to 2.5.
  - Structures? If "yes," go to 2.6.
  - Other? If "yes," follow the process for the most similar media.

## 2.0 SCREENING TRANSPORT PROCESSES (YES/NO)

Do the following appropriate section(s) for the media type/source combination.

### 2.1 AIR TRANSPORT (YES/NO)

- Does the wind travel a significant portion of the year from the source to the critical group location? (yes/no)

- Is the source location near enough to the critical group location to avoid significant dilution of suspended or gaseous residual radioactivity? (yes/no)

- Do the structures, topography, and vegetation between the source and critical group locations provide only small amounts of dispersion? (yes/no)

If the answer to any one of the black bullets is "no," answer the following question. If all are "yes'," go to 3.1.

- Is there the potential for this source's air-transported residual radioactivity to accumulate with other source/air transport combinations that have been screened out, so that the combined effect of all sources would result in a significant source of exposure? (yes/no)

If the answer is "yes," air transport for this source and for any other sources identified by this question are not screened out. Go to 3.1. If "no," air transport for the source is screened out.

## 2.2 SURFACE SOIL TRANSPORT (YES/NO)

Each source should go through all subsections. Screening out one subsection does not mean all subsections are screened out, necessarily. To screen out the entire surface soil transport mechanism for a source, Subsections 2.2.1 - 2.2.5 all need to be screened out individually.

### 2.2.1 Erosion (yes/no)

- Is the residual radioactivity chemical/structural form erodible within analysis time frame? (yes/no)

- Is the rainfall, runoff, or wind speed sufficient to erode source contaminants? (yes/no)

- Is the proximity of the source location to the critical group location sufficient for erosion to transport contaminants to the critical group location? (yes/no)

- Do the structures, topography, and vegetation between the source location and the critical group favor transport of material to the critical group location? (yes/no)

If the answer to any one of the black bullets is "no," answer the following question. If all are "yes'," skip the next question, and then answer the last question of this subsection.

- Is there the potential for this source's eroded residual radioactivity to accumulate with other source/erosion transport combinations that have been screened out so that the combined effect of all sources would result in a significant source of exposure? (yes/no)

If the answer is "yes," the erosion subsection for this source and any other sources identified by this question are not screened out. Answer the following question. If "no," the erosion subsection is screened out. Go to 2.2.2.

- If erosion were to occur, where would the material end up so that it can be transported to the critical group location? (yes/no)
    - Direct overland flow? If "yes," go to 2.5 and answer surface water questions for potential overland flow.
    - Surface water body? If "yes," go to 2.5.
    - Other? - If "yes," go to the appropriate similar transport mechanism.

If the answer to any one of these is "yes," the erosion subsection for this source is not screened out. Proceed as directed by the specific question. When complete with that pathway, return, and proceed through 2.2.2. If "no," the erosion subsection is screened out. Go to 2.2.2.

**2.2.2 Leaching (yes/no)**

- Is the rainfall or infiltration amount sufficient for leaching of residual radioactivity to occur to a significant degree? (yes/no)

- Will the residual radioactivity leach within the analysis time frame? (yes/no)

- Does the geochemistry of the soil and radionuclides [e.g., distribution coefficients ($K_d$)] allow leached residual radioactivity to reach the ultimate transport mechanism within the analysis time frame (e.g., will the residual radioactivity be able to move through the unsaturated zone and enter into the groundwater aquifer)? (yes/no)

If the answer to any one of the black bullets is "no," answer the following question. If all are "yes'," skip the next question, and then answer the last question of this subsection.

- Is there the potential for this source's leached residual radioactivity to accumulate with other source/leach transport combinations that have been screened out so that the combined effect of all sources would result in a significant source of exposure? (yes/no)

If the answer is "yes," the leaching subsection for this source and for any other sources identified by this question are not screened out. Answer the following question. If "no," the leaching subsection is screened out. Go to 2.2.3.

- If leaching were to occur, where would the material end up so that it can be transported to the critical group location? (yes/no)
  - Groundwater aquifer? If "yes," go to 2.4.
  - Surface water body? If "yes," go to 2.5.
  - Other? - If "yes," go to the appropriate similar transport mechanism.

If the answer to any one of these is "yes," the leaching subsection for this source is not screened out. Proceed as directed by the specific question. When complete with that pathway, return, and proceed through 2.2.3. If the answers to all of these empty bullets are "no's," the leaching subsection is screened out. Go to 2.2.3.

**2.2.3 Resuspension (yes/no)**

- Does the wind travel a significant portion of the year from the source to the critical group location? (yes/no)
- Is the source location near enough to the critical group location to avoid significant dilution of suspended or gaseous residual radioactivity? (yes/no)

- Do the structures, topography, and vegetation between the source location and the critical group favor transport of material to the critical group location? (yes/no)

- Can enough of the residual radioactivity be resuspended to affect the dose to the critical group? (yes/no)

If the answer to any one of the black bullets is "no," answer the following question. If all are "yes'," skip the next question and go to 3.1. When complete with that pathway, return and proceed through 2.2.4.

- Is there the potential for this source's resuspended residual radioactivity to accumulate with other source/resuspension or air-transport combinations that have been screened out so that the combined effect of all sources would result in a significant source of exposure? (yes/no)

If the answer is "yes," the resuspension subsection for this source and for any other sources identified by this question are not screened out. Go to 3.1. When complete with that pathway, return, and proceed through 2.2.4. If "no," the resuspension subsection is screened out. Go to 2.2.4.

**2.2.4 Manual Redistribution (e.g., excavation and fill) (yes/no)**

- Do source area characteristics allow future excavation and reuse? (yes/no)

- Would reuse be reasonable for use on or near the partial site? (yes/no) A "no" on this question does not screen this subsection out.

- Would the source be able to become airborne as part of fugitive dust emissions? (yes/no) if "yes," go to 2.2.3. A "no" on this question does not screen this subsection out.

If the answer to the first bullet is "no," or bullets two and three are "no's," the manual redistribution subsection is screened out. Go to 2.2.5. If manual redistribution is not screened out, go to 3.2. When complete with that pathway, return, and proceed through 2.2.5.

**2.2.5 Direct Radiation (yes/no)**

- Are the radionuclides significant external hazards? (yes/no)

- Is the source location close enough to the critical group location to avoid significant reduction in dose rate? (yes/no)

- Do the structures, topography, and vegetation between the source and critical group locations provide inadequate shielding to minimize the external exposure? (yes/no)

If the answer to any one of the black bullets is "no," the direct radiation subsection is screened out. If all are "yes'," go to 3.2

**2.3 DEEP SOIL TRANSPORT (YES/NO)**

Each source should go through both subsections. Screening out one subsection does not mean both subsections are screened out, necessarily. To screen out the entire deep soil

transport mechanism for a source, Subsections 2.3.1 and 2.3.2 need to be each screened out individually.

### 2.3.1 Leaching (yes/no)

- Is the rainfall or infiltration amount sufficient for leaching of residual radioactivity to occur to a significant degree? (yes/no)

- Will the residual radioactivity leach within the analysis time frame? (yes/no)

- Does the geochemistry of the soil and radionuclides (e.g., $K_d$) allow leached residual radioactivity to reach the ultimate transport mechanism within the analysis time frame (e.g., will the residual radioactivity be able to move through the unsaturated zone and enter into the groundwater aquifer)? (yes/no)

If the answer to any one of the black bullets is "no," answer the following question. If all are "yes'," skip the next question, and then answer the last question of this subsection.

- Is there the potential for this source's leached residual radioactivity to accumulate with other source/leach transport combinations that have been screened out so that the combined effect of all sources would result in a significant source of exposure? (yes/no)

If the answer is "yes," the leaching subsection for this source and for any other sources identified by this question are not screened out. Answer the following question. If "no," the leaching subsection is screened out. Go to 2.3.2.

- If leaching were to occur, where would the material end up so that it can be transported to the critical group location? (yes/no)
  - Groundwater aquifer? If "yes," go to 2.4.
  - Surface water body? If "yes," go to 2.5.
  - Other? - If "yes," go to the appropriate similar transport mechanism.

If the answer to anyone of these is "yes," the leaching subsection for this source is not screened out. Proceed as directed by the specific question. When complete with that pathway, return, and proceed through 2.3.2. If the answers to all these empty bullets are "no's," the leaching subsection is screened out. Go to 2.3.2.

### 2.3.2 Manual Redistribution (yes/no) (e.g., excavation and fill)

- Do source area characteristics allow future excavation and reuse? (yes/no)
- Would reuse be reasonable for use on or near the partial site? (yes/no) A "no" on this question does not screen this subsection out.

- Would the source be able to become airborne as part of fugitive dust emissions? (yes/no) If "yes," go to 2.2.3. A "no" on this question does not screen this subsection out.

If the answer to the first bullet is "no," or all bullets are "no's," the manual redistribution subsection is screened out. If manual redistribution is not screened out, go to 3.2.

## 2.4 GROUNDWATER TRANSPORT (YES/NO)

- Does saturated groundwater exist that is in hydraulic connection with the radioactive source? (yes/no)

- Does the groundwater (including unconfined or confined aquifers, as necessary) flow from the source to the location of the critical group? (yes/no)

- Is the aquifer fit for use? (yes/no)
  - Potable? (yes/no)
  - Irrigation? (yes/no)

- Can the residual radioactivity enter the groundwater aquifer in significant amounts [e.g., is the aquifer not protected from all potential migrating contaminants by low-permeability geologic strata (e.g., clay layer)]? (yes/no)

- Is the yield rate of the aquifer sufficient? (yes/no)
  - Household and Drinking Water? (yes/no)
  - Irrigation? (yes/no)

- Is the distance traveled from source to the critical group location close enough to avoid significant dilution and sorption of migrating radionuclides? (yes/no)

If the answer to any one of the black bullets is "no," the groundwater transport mechanism is screened out. If all are "yes'," go to 3.3

## 2.5 SURFACE WATER TRANSPORT (YES/NO)

- Does surface water flow from the source of residual radioactivity (or from zones of mobilized radionuclides) to the critical group location? (yes/no)

- Does the volume of surface water allow transport of significant concentrations of either dissolved or suspended radioactive solids? (yes/no)
-

If the answer to either of the black bullets is "no," the surface water transport mechanism is screened out. If both are "yes'," answer the following question.

- Is significant sediment buildup possible at the critical group location? (yes/no)

If the answer is "yes," go to 3.5. When complete with that pathway, return and go to 3.4. If the answer is "no," go to 3.4.

## 2.6 STRUCTURES (YES/NO)

### 2.6.1 Direct Radiation (yes/no)

- Are the radionuclides significant external hazards? (yes/no)

- Is the source location close enough to the critical group location to avoid significant reduction in dose rate? (yes/no)

- Do the structures, topography, and vegetation between the source and critical group locations provide inadequate shielding to minimize the external exposure? (yes/no)

If the answer to any one of the black bullets is "no," the direct radiation subsection is screened out. Go to 2.6.2. If all are "yes'," go to 3.2. When complete with that pathway, return and proceed through 2.6.2.

**2.6.2 Leaching (yes/no)**

- Is the rainfall or infiltration amount sufficient for leaching of residual radioactivity to occur to a significant degree? (yes/no)

- Will the residual radioactivity leach from the structure within the analysis time frame? (yes/no)

- Does the geochemistry of the soil and radionuclides (e.g., $K_d$) allow leached residual radioactivity to reach the ultimate transport mechanism within the analysis time frame (e.g., will the residual radioactivity be able to move through the unsaturated zone and enter into the groundwater aquifer)? (yes/no)

If the answer to any one of the black bullets is "no," answer the following question. If all are "yes'," skip the next question, and then answer the last question of this subsection.

- Is there the potential for this source's leached residual radioactivity to accumulate with other source/leach transport combinations that have been screened out so that the combined effect of all sources would result in a significant source of exposure? (yes/no)

If the answer is "yes," the leaching subsection for this source and for any other sources identified by this question are not screened out. Answer the next question. If "no," the leaching subsection is screened out.

- If leaching were to occur, where would the material end up so that it can be transported to the critical group location? (yes/no)
  - Groundwater aquifer? If "yes," go to 2.4.
  - Surface water body? If "yes," go to 2.5.
  - Other? - If "yes," go to the appropriate similar transport mechanism.

If the answer to any one of these is "yes," the leaching subsection for this source is not screened out. Proceed as directed by the specific question. If the answers to all these empty bullets are "no's," the leaching subsection is screened out.

## 3.0 EXPOSURE PATHWAYS

"No's" on the black bullets will not eliminate the entire section.

### 3.1 AIR PATHWAYS (YES/NO)

- Based on the critical group habits and activities, are the following viable? (yes/no)
  - Inhalation? (yes/no)
  - Submersion External Dose? (yes/no)

- Is significant deposition viable? (yes/no) If "yes," go to 3.2 and consider the potential soil pathways at the deposition area.

### 3.2 SOIL PATHWAYS (YES/NO)

- Is external exposure viable? (yes/no)

- Is exposure through ingestion viable? (yes/no)
  - Direct Soil Ingestion? (yes/no)
  - Gardening/Crops? (yes/no)
    - Leafy Vegetables? (yes/no)
    - Non-Leafy Vegetables? (yes/no)
    - Fruits? (yes/no)
    - Grain? (yes/no)
  - Animal Husbandry? (yes/no)
    - Meat? (yes/no)
    - Milk? (yes/no)
    - Eggs? (yes/no)

- Is exposure through inhalation viable? (yes/no)
  - Indoors? (yes/no)
  - Outdoors? (yes/no)

### 3.3 GROUNDWATER PATHWAYS (YES/NO)

- Is exposure via drinking water viable? (yes/no)

- Is exposure via irrigation viable? (yes/no)
  - Crops/Garden? (yes/no)
  - Animal Husbandry? (yes/no)
  - Fish Farming? (yes/no)

  If irrigation is viable, go to 3.2. Consider the soil pathways appropriate for the soil impacted by the irrigation.

- Is water used for purposes other than household uses (including drinking water) or irrigation? Examples would include evaporative coolers, dust suppression, etc. (yes/no) If "yes," go to 3.2. Consider the soil pathways appropriate for the impacts of the activity.

### 3.4 SURFACE WATER PATHWAYS (YES/NO)

- Is internal exposure viable? (yes/no)
  - Fish? (yes/no)

- Drinking Water? (yes/no)
- Inadvertent Intakes? (yes/no)

- Is exposure via irrigation viable? (yes/no)
  - Crops/Garden? (yes/no)
  - Animal Husbandry? (yes/no)

  If irrigation is viable, go to 3.2. Consider the soil pathways appropriate for the soil impacted by the irrigation.

- Is water used for purposes other than household uses (including drinking water) or irrigation? Examples would include evaporative coolers, dust suppression, etc. (yes/no)
  If "yes," go to 3.2. Consider the soil pathways appropriate for the impacts of the activity.

- Are recreational activities viable? (yes/no)
  If recreational activities are viable, go to 3.2. Consider the exposure pathways appropriate for recreational activities in the water (e.g., incidental ingestion during swimming)

**3.5 SEDIMENTS (YES/NO)**

- Are recreational activities viable? (yes/no)
  If recreational activities are viable, go to 3.2. Consider the exposure pathways appropriate for recreational activities on the shore, or involving sediments (e.g., incidental ingestion from making sand castles).

- Is use of sediments for land-based activities viable (e.g., fill or crops, etc)?
  If use of sediments is viable, go to 3.2. Consider the soil pathways appropriate for the impacts of the activity.

## DOCUMENTATION

The information from the worksheet should be summarized in tables. The tables should summarize: (1) the source; (2) whether it is included or excluded; (3) the FEPs screened; (4) the screening argument; and (5) the reference for the screening argument. For example, one format is below, using the supplemental guidance's Section 3.1's example, as a basis. The level of detail is only needed for the question being used to screen out the source, transport mechanism, or pathway. Common pathways using the same or similar screening arguments can be grouped (e.g., fourth row of example table).

| Source | Status | Screening Pathway | Screening Argument | Reference |
|---|---|---|---|---|
| Groundwater (GW) Plume - Area 4-10 | Incl | GW (1.1) - GW (2.4) - GW (3.3) - Soil (3.2) | N/A | N/A |
| GW Plume - Area 4-12 | Excl | GW (1.1)- GW(2.4/YIELD) | Yield of Pico Aquifer <30 L/day | LTP Chapter 3.7.3 |
| Low-Level Waste (LLW) Storage Area | Incl | Other (1.2) - Soil (2.6) - Soil (3.2/direct) | N/A | N/A |
| | Excl | Other (1.2) - Soil (2.1-2.2) | No significant erosion or leaching of LLW Area within 1000 yr. | LTP Chapter 4.1.5 |
| .... | .... | .... | .... | .... |

**Example of Summary Format.**