



Appendix II-B

How Good the Impact Assessment Results Must Be

The requirements in this appendix call for the assessment to be performed according to the principles of fidelity, dominance, and management of uncertainty specified in the “Principles and General Requirements” section. As used here, fidelity carries the same meaning that it does in high fidelity sound reproduction. It expresses the faithfulness of reproduction of the actual performance without adding distorting noise or bias that may obscure the more delicate but crucial sounds. To be useful for addressing public and regulator concerns, the assessment results must have acceptable fidelity, in other words, an acceptably low level of error, distortion, and bias. Idealized Hanford impact simulations must be shown to capture the essential factors of the actual situation. Fidelity also must encompass the lowest impact levels of concern to stakeholders and regulators.

Applying the principle of dominance requires selecting the largest contributors to contaminant impact from among the demonstrably complete set of candidates specified in Appendix II-A. For example, all potentially harmful Hanford-derived materials and contaminants must be included as candidates. This appendix specifies that the most dominant must be selected as contaminants to be assessed.

Consistent treatment of uncertainty throughout the assessment is indispensable in controlling quality or how good the impact assessment must be. For example, inattention to uncertainty of some field data may relegate all the assessments data to unacceptably low levels. Fidelity of the assessment results could diminish because of uncertainties in one area, obscuring the impact to some receptors.

The following is an overview of the requirements in this appendix:

- (B0.0-1) Impact assessment fidelity shall be adequate for the assessment uses and users, either those directing the Hanford cleanup effort or those affected by its results. See "Uses and Users" in the “Principles and General Requirements” section.
- (B0.0-2) The impact assessment shall provide the range of impact values that bracket uncertain impact with high probability. For example, it may be decided that the results must be able to show that, with 95 percent certainty, a given impact is less than the assessed bound or within the range of assessed bounds.
- (B0.0-3) An explicit, documented definition and validation of model structure and parameters shall be established and maintained current with model and parameter revisions.
- (B0.0-4) Overall assessment uncertainty objectives shall be consistent with the applicable definition of the post-cleanup Hanford Site end state.
- (B0.0-5) Projected assessment quality shall be acceptable to the CRCIA Board. (See Appendix II-D.)



B.1 Fidelity of Detecting Harmful Effects

The requirements in this section call for the assessment calculations to accurately characterize the impacts of concern. Decisions on the acceptability of generalizations or approximations that deviate from reality shall be made with an understanding and a concern for the people potentially affected by Hanford-derived contaminants. Their cultural perspective and values are the only moral measures of the acceptable fidelity. Fidelity shall be treated as a serious factor that requires major investments of time to gather information about the ecosystems and population groups in the study area.

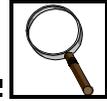
One fidelity concern is identifying the highest exposure periods, which correspond to the periods when peak contaminant concentrations reach the Columbia River. Evaluating the models' ability to predict peak exposure levels is particularly important. The time at which high exposures occur is less important than correctly representing the peak concentrations encountered, except to correctly represent simultaneously arriving contaminants that combine in their effects on receptors. The following is an overview of the requirements in this section:

- (B1.0-1) Assessment fidelity shall be sufficient to enable impact assessment at a level determined by the needs of affected ecosystems and cultural groups.
- (B1.0-3) Temporal peak width shall be accurate enough to support estimates of multi-generational exposure.
- (B1.0-4) The effect of uncertainty in the relative timing of peaks shall be considered in evaluating the uncertainty of combined (total) peak exposures. The timing of contaminant concentration peaks and their period (temporal width) shall be accurate enough in relation to each other that they adequately approximate total dose to an unspecified maximally exposed receptor generation, including the effect of individual contaminant peaks overlapping in time. (See Appendix II-C.2.)
- (B1.0-5) Uncertainty in peak exposure level shall be quantified and managed to allow the impact to be detected relative to the criteria developed in response to the requirements specified in CRCIA Standards in the "Principles and General Requirements" section.

B.1.1 Required Fidelity of Spatial Representation

The requirements in this section call for spatial representation that allows realistic representation of contact between receptors and contaminants. The requirements in this section are as follows:

- (B1.1-1) Discretization (lumping) of space and geographical features shall support realistic representation of contact between receptors and contaminants.



- (B1.1-2) Conditions at areas not adequately represented by data or models shall be identified as unknown and not assessed.
- (B1.1-3) Land description shall realistically represent dominant contaminated locations within the study region, particularly on and adjacent to the Hanford Site.
- (B1.1-4) River/land discretization (grid size or spatial resolution) shall adequately represent known local hazardous conditions at critical locations.
- (B1.1-5) Areas with unknown characteristics shall be evaluated and, if necessary, scheduled for R&D activities.
 - (a) Ensure that historical sampling and analysis done by the State of Oregon at sites along the Columbia River shall be evaluated.

B.2 Model Integration and Consistency

The requirements in this section call for the overall assessment to conform to established physical laws and sound practice. This will help maintain the required consistency among all the subtasks and models in the assessment, for example, across geographical subdivisions. The following is an overview of the requirements in this section:

- (B2.0-1) Consistency shall be maintained at the interfaces between all partitioned sub-region analyses, supporting valid and seamless integration into the overall assessment. For example, contaminants leaving one sub-region analysis shall be the same as those entering the adjoining sub-region, even if the analyses are done separately.
- (B2.0-2) Consistency shall be maintained at all interfaces between models used in the assessment. Before models are designed or selected, interfaces shall be defined in terms of the output data characteristics required from one model to enable the receiving model to function with consistency, for example, in uncertainty and fidelity.
- (B2.0-3) Mass and momentum conservation laws shall be satisfied across the study area. This includes, but is not limited to, calculations of partitioned geographical sub-regions of the Hanford Site and river corridor downstream.
- (B2.0-4) Integration of model equations for all exposure process and harmful effects steps shall be validated before committing resources to their use.
- (B2.0-5) The consistency and seamless integration requirements above also apply to data taken from other studies and analyses.



B.2.1 Integration of Isolation Forms and Surrounding Media

The requirements in this section call for consistency between transport of contaminants from isolation forms to the media surrounding them. The requirements in this section are as follows:

- (B2.1-1) All mass leaving isolation forms shall be accounted for entering the adjacent zone, for example, from the isolation form to the vadose zone.
- (B2.1-2) Coupling between contaminant migration rates out of any isolation form and the associated migration rates in the region adjacent to the isolation form shall be represented and consistent.

B.2.2 Integration of Vadose Zone Partitions

The requirement in this section calls for consistency for contaminants transported between one geographical region of the vadose zone and another. The requirement in this section is as follows:

- (B2.2-1) Mass and momentum shall be conserved across interfaces between any geographical partition of the vadose zone into sub-regions.

B.2.3 Integration of Groundwater Transport between the Vadose and Saturated Zones

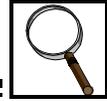
The requirement in this section calls for consistency for contaminants and groundwater transported between the vadose and saturated zones. The requirement in this section is as follows:

- (B2.3-1) Mass and momentum shall be conserved at the interface between groundwater in the vadose zone and the saturated zone.

B.3 Selecting Factors for Assessment: The Study Set

The requirements in this section parallel the sections in Appendix II-A. The purpose of Appendix II-A is to ensure that no relevant factor is overlooked. This appendix requires that for any level of CRCIA effort, the assessment always considers the most important factors. These requirements call for the narrowing of the candidate sets of factors specified in Appendix II-A to study sets composed of the entities that dominate potential impact to the receptors, that is, from demonstrably complete candidate sets to dominant study sets. The study sets for individual entity classes are collected to form the Assessment Study Set. The following is an overview of the requirements in this section:

- (B3.0-1) Individual entities included in all the study sets specified below shall be consistent with the threats to humans, cultures, and the Columbia River ecosystem in the selected impact set.
- (B3.0-2) The dominant sources of harmful effects, both existing and projected, shall be evaluated.



- (B3.0-3) The assessment shall provide estimates of peak concentrations and the duration of contaminant pulses at all Columbia River locations of importance to the Hanford ecosystem and human users.



B.3.1 Hanford Materials and Contaminants

The requirements in this section ensure that all Hanford radioactive materials and chemicals that effectively account for any unacceptable impact are assessed. The candidate contaminant and inventory sets identified in Appendix II-A are reduced to study sets in this section. This reduction results in explicit treatment of only part of the contaminants and inventories identified in Appendix II-A. It results in the need for contaminant and spatial lumping of the elements in the candidate sets. A suggested way to do this is to estimate the likely impact of contaminants and inventories with successive, iteratively refined models of the contaminant-transport-exposure-impact process. The reduced study sets must be validated using the final, most refined model.

At different times and locations, different isotopes are dominant contributors to impacts, depending on their migration and radioactive decay rates. The study sets shall cover the important contaminants during any part of the time period and region being analyzed. An overview of the requirements in this section is as follows:

- (B3.1-1) The impacts of all contaminants in the Contaminants Study Set from all the discrete inventories in the Inventories Study Set shall be explicitly assessed and reported.
- (B3.1-2) Uncertainties in the contaminant inventories shall be assessed.

B.3.1.1 Required Contaminants Study Set

The requirements in this section call for a Contaminants Study Set that identifies the materials and contaminants whose contributions to harmful effects are to be explicitly assessed. All other contaminants' contributions to harmful effects are to be assessed in lumped groups. The requirements in this section are as follows:

- (B3.1.1-1) The Contaminants Study Set shall be formed by eliminating, over one or more screening iterations, contaminants from the Candidate Contaminants Set defined in Appendix II-A.
- (B3.1.1-2) Criteria for retaining, at each iteration, contaminants in the Contaminants Study Set, the associated screening models for that iteration, as well as the number of iterations, shall be established in consultation with the CRCIA Board and shall be subject to its approval.



- (B3.1.1-3) The screening criteria shall be set at levels that are inclusive (prudent and conservative) considering the stage of screening or uncertain nature of the screening models used.
- (B3.1.1-4) The selection criteria shall ensure that all contaminants retained at any location and during any part of the time period being assessed
- materially contribute to harm along the Columbia River corridor
 - contribute more to an assessed impact than the least significant contaminant included because of its significance for that impact, as determined by the assessment calculations in their final level of refinement
 - contribute more to additive or synergistic effects in impacts, dose, or transport geochemistry than the least significant contaminant included for that purpose, as determined by the assessment calculations in their final level of refinement
 - have the likelihood of exceeding current regulatory limits or accepted health physics “good practice”
- (B3.1.1-5) One or more “other” contaminant categories shall be identified to approximately represent the lumped effects of all the contaminants not explicitly included in the Contaminants Study Set.
- (B3.1.1-6) Impact errors resulting from lumping contaminants shall be evaluated or bounded and shown to meet the criteria established in requirement B3.1.1-2 above.
- (B3.1.1-7) The derivation of the Contaminants Study Set shall be documented. The process used and the analysis for eliminating each contaminant from explicit inclusion in the Contaminants Study Set shall be documented.

B.3.1.2 Required Inventories Study Set

The requirements in this section call for approximating the inventories of radionuclides and chemicals in the Candidate Inventories Set. Representation of the overall effects of the inventories taken together may be simplified by grouping separate inventories into lumped masses. Waste form performance, addressed in Section II-B.3.2, shall also be considered when forming inventory groupings. Quantification of inventory uncertainties is essential as a part of uncertainty management, described in Section II-C.2 and II-C.3. The requirements in this section are as follows:

- (B3.1.2-1) The Inventories Study Set shall include all mass in the Candidate Inventories Set defined in Appendix II-A.
- (B3.1.2-2) Individual inventories in the Inventories Study Set shall be composed of spatially lumped groups of inventories from the Candidate Inventories Set.



- (B3.1.2-3) Criteria for impact representation accuracy after spatial lumping of the inventories in the Inventories Study Set shall be established in consultation with the CRCIA Board and shall be subject to its approval.
- (B3.1.2-4) The criteria for constructing the Inventories Study Set shall be coordinated with sequential (iteration) criteria used for constructing the Contaminants Study Set.
- (B3.1.2-5) Waste Form performance, addressed in this appendix, Section II-B.3.2, shall be considered in constructing the Inventories Study Set.
- (B3.1.2-6) Inventory uncertainties in the Candidate Inventories Set shall be evaluated and considered in constructing the Inventories Study Set.
- (B3.1.2-7) Impact errors resulting from spatial inventory lumping shall be evaluated or bounded and shown to meet the criteria established in requirement B3.1.2-3 above.
- (B3.1.2-8) The derivation of the Inventories Study Set shall be documented. The process used and the analysis for grouping inventories and deriving group spatial distribution in the Inventories Study Set shall be documented.



B.3.2 Containment Failure and Release

The requirements in this section call for selecting the dominant containment failure scenarios from among the candidates defined in Section II-A.2. Radioactive materials and hazardous chemicals are expected to be contained after disposal following cleanup operations. They also are expected to slowly leak into the surrounding ground, water, and air when the containments eventually fail. Containment failure scenarios will be selected based on credible probability of occurrence and the extent of resulting impact. To preserve CRCIA relevancy to cleanup decisions, containment performance information shall come from DOE's approved disposal engineering plans. Alternate sources of information will be used only if no such documentation exists. This could include DOE performance requirements, or generally accepted performance estimates for the selected disposal method. The following is an overview of the requirements in this section:

- (B3.2-1) Waste form performance—time to containment failure and rate of release after failure—corresponding to each inventory in the Inventories Study Set defined in Section II-B.3.1, shall be assessed.
- (B3.2-2) Uncertainties in waste form performance shall be assessed.



B.3.2.1 Required Containment Failure Scenarios Study Set

The requirements in this section call for a Containment Failure Scenarios Study Set that identifies the scenarios which make the largest contribution to contaminant release into the adjacent environment. The requirements in this section are as follows:

- (B3.2.1-1) The Containment Failure Scenarios Study Set shall be formed by eliminating, over one or more screening iterations, individual containment failure scenarios from the Candidate Containment Failure Scenarios Set defined in Appendix II-A.
- (B3.2.1-2) Criteria for retaining, at each iteration, containment failure scenarios in the Containment Failure Scenarios Study Set shall be established in consultation with the CRCIA Board and shall be subject to its approval.
- (B3.2.1-3) The probability of failure scenarios occurring shall be assessed.
- (B3.2.1-4) The containment performance description shall represent the failure scenarios in the Containment Failure Scenarios Study Set.
- (B3.2.1-5) In following the approved disposal plan (see requirements A2.2-1, A2.2-2, and A2.2-4 in Appendix II-A), assessment of containment failure shall include evaluating final disposition designs without replacement. For example, the CRCIA Board shall accept a proposed cover over a waste site as it is designed. The assessment shall also, however, evaluate engineered barrier performance without relying on periodic refurbishing into the indefinite future. Final disposition designs that reflect undefined or unlimited energy inputs into maintenance shall be reviewed by the CRCIA Board for realism.



B.3.3 Transport Mechanisms and Paths to the Columbia River

The requirements in this section call for selecting the transport mechanisms and paths to the Columbia River from among the candidates defined in Section II-A.3. Physical transport mechanisms are involved in moving contaminants from an inventory in a contaminated region or breached containment to the Columbia River. Selecting the level of detail in modeling or in choosing from among alternative mechanisms and paths shall be done using the principles of dominance, fidelity, and management of uncertainty. Valid receptor dose assessment depends on valid assessment of contaminant migration to the zone where introduction into the river takes place. Paths accounting for 95 percent of the receptors dose are to be included for each of the river scenarios in Section II-A.10. Uncertainties may be large. If so, the cost effectiveness of research efforts to reduce uncertainty to a level comparable with other calculations and modeling in the assessment could be determined. The following is an overview of the requirements in this section:



- (B3.3-1) Paths accounting for 95 percent of the receptors' dose shall be included for each river scenario in Section II-A.10.
- (B3.3-2) Uncertainties in contaminant migration, including travel time to the Columbia River, shall be assessed.
- (B3.3-3) Stochastic behavior of groundwater infiltration and recharge shall be represented. Sources of variability from future climate changes and weather, as well as future land uses, shall be considered. Short-term and seasonal variability shall be considered.
- (B3.3-4) Uncertainties in hydrogeologic information shall be evaluated, based on needed estimates of contaminant concentration at the Columbia River.
- (B3.3-5) Assessments of airborne contaminant transport shall consider stochastic atmospheric behavior. Such assessments shall be supported by representation and documentation of uncertain wind patterns; for example, assuming only SW wind (SW to NE) is unacceptable.

B.3.3.1 Required Transport Paths Study Set

The requirements in this section call for a Transport Paths Study Set that identifies the paths and the associated geologic features which make the largest contribution to contaminant migration to the Columbia River. The requirements in this section are as follows:

- (B3.3.1-1) The Transport Paths Study Set shall be formed by eliminating, over one or more screening iterations, transport paths from the Candidate Transport Paths Set defined in Appendix II-A.
- (B3.3.1-2) Criteria for retaining, at each iteration, transport paths in the Transport Paths Study Set shall be based on contribution to assessment fidelity and shall be established in consultation with the CRCIA Board and subject to its approval.



B.3.4 Contaminant Entry into the Columbia River

The requirements in this section call for field data and the selection of the interface models that describe the manner and locations where contaminants enter the Columbia River. Candidates were identified in Section II-A.4. While groundwater may be perceived to be the most probable path and entry mechanism, some scenarios may suggest other paths to be more dominant and will require attention to other entry mechanisms and locations. Applying the principles of dominance and fidelity to this selection process may depend on considerations such as habitat and drinking water uptake locations. The following is an overview of the requirements in this section:

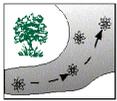


- (B3.4-1) Criteria for the required resolution of the concentration gradient near the point of introduction to the river shall be established in consultation with the CRCIA Board and shall be subject to its approval.
- (B3.4-2) Uncertainty in peak contaminant concentration near the point of introduction to the river shall be assessed.

B.3.4.1 Required River Entry Location Study Set

The requirements in this section call for a River Entry Location Study Set that identifies river entry regions which are the largest sources of harmful contaminants in the river. The requirements in this section are as follows:

- (B3.4.1-1) The River Entry Location Study Set shall be formed by eliminating, over one or more screening iterations, entry locations from the Candidate River Entry Location Set defined in Appendix II-A.
- (B3.4.1-2) Criteria for retaining, at each iteration, entry locations in the River Entry Location Study Set shall be established in consultation with the CRCIA Board and shall be subject to its approval.



B.3.5 Fate and Transport of Columbia River-Borne Contaminants

The requirements in this section call for selecting the dominant, most credible mechanisms of contaminant concentration upon initial entry into the Columbia River. The requirements also address the rate and pattern of mixing with bulk river water, reconcentration of diluted contaminants, and redistribution of contaminated sediments. Candidate mechanisms were developed in response to the requirements in Appendix II-A.5. Examples of situations these requirements examine include reconcentration of contaminants in soils through years of using weakly contaminated irrigation water, reconcentration of contaminants on hydroelectric equipment that is exposed for years to large volumes of water, and the redistribution of contaminated sediment by dredging or the eventual removal of dams. Rates and patterns of mixing with bulk river water also require insightful selection from among candidate scenarios such as patterns of dam operations and cyclical river flow rates. The following is an overview of the requirements in this section:

- (B3.5-1) Criteria governing the resolution required for the contaminant concentration distribution in the river shall be established in consultation with the CRCIA Board and shall be subject to its approval.
- (B3.5-2) Representation quality for contaminant concentrations at critical locations shall be traded off against exposure modeling requirements.



- (B3.5-3) Prudent estimates shall be provided of contaminant concentrations encountered at critical locations by the most exposed individuals in any population identified in the CRCIA.
- (B3.5-4) Uncertainties associated with river-borne contaminant fate and transport assessment shall be assessed.

B.3.5.1 Required River Holdup Location Study Set

The requirements in this section call for a River Holdup Location Study Set that identifies holdup regions which make the largest contribution to contaminant sources in the river. The requirements in this section are as follows:

- (B3.5.1-1) The River Holdup Location Study Set shall be formed by eliminating, over one or more screening iterations, holdup locations from the Candidate River Holdup Location Set defined in Appendix II-A.
- (B3.5.1-2) Criteria for retaining, at each iteration, holdup locations in the River Holdup Location Study Set shall be established in consultation with the CRCIA Board and shall be subject to its approval.



B.3.6 Critical Habitat and Uptake Locations

The requirements in this section call for selecting dominant uptake mechanisms and locations that result in the largest contributions to receptor dose. Candidate ecosystem habitat locations and requirements to identify candidate critical uptake locations such as drinking water uptake were addressed in Section II-A.6. The selections specified in this section define the interface between distributed contaminants and the biotic exposure webs, such as food chains. Matching locations of concentrated contaminants with critical uptake is key to the assessment. The following is an overview of the requirements in this section:

- (B3.6-1) Dominant uptake locations shall be identified.
- (B3.6-2) Critical habitat locations shall be identified.
- (B3.6-3) Uncertainties in critical habitat and uptake locations shall be represented.
- (B3.6-4) The adequacy of contaminant concentration characterization at critical locations shall be evaluated in consultation with the CRCIA Board and shall be subject to its approval.



B.3.6.1 Required Critical Habitat and Uptake Location Set

The requirements in this section call for a Critical Habitat and Uptake Location Set that identifies habitat and uptake regions which make the largest contribution to dose in biota and humans. The requirements in this section are as follows:

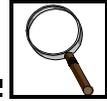
- (B3.6.1-1) The Critical Habitat and Uptake Location Set shall be selected from the intersection of the Candidate Habitat Location Set and River Holdup Location Study Set defined in Section II-B.3.5.
- (B3.6.1-2) Criteria for retaining, at each iteration, locations in the Critical Habitat and Uptake Location Set shall be established in consultation with the CRCIA Board and shall be subject to its approval.



B.3.7 Receptors and Exposure Pathways

The requirements in this section call for a Selected Receptors Set chosen from among the candidates identified in Section II-A.7. Selections will also be made from among the candidate exposure pathways such that the chosen exposure models (the pathway study set), regardless of depth of detail, always represent the most important pathways to the potentially most impacted receptors. In addition to the candidate receptors required to be considered for selection in Section II-A.7, this section also requires selecting candidate receptors if they occupy crucial positions in food chains, cultural webs, economic networks, or any other receptor dependency web. If resource allocations to CRCIA are highly constrained, tradeoffs may have to be made between assessing more receptors or a broader spectrum of contaminants, for example. In any case, the most highly impacted receptors and the most dominant exposure pathways must be selected—a balance achievable only through iterative executions of rough order-of-magnitude calculations before significant resources are committed. The following is an overview of the requirements in this section:

- (B3.7-1) The receptors to be chosen for the impact assessment shall include those included as subjects for the impacts to be assessed, those needed for the validity of impact estimates for other receptors, and those of particular concern to stakeholders.
- (B3.7-2) Exposure mechanisms not explicitly evaluated shall be evaluated in a lumped “other” exposure mechanism.
- (B3.7-3) Uncertainties in exposure mechanisms and pathways shall be assessed .



B.3.7.1 Required Selected Receptors Set

The requirements in this section call for a Selected Receptors Set that identifies the receptors which are the subjects of the impact assessment. The requirements in this section are as follows:

- (B3.7.1-1) The Selected Receptors Set shall be formed by eliminating, over one or more screening iterations, species from the Candidate Receptors Set defined in Appendix II-A.
- (B3.7.1-2) Criteria for retaining species in the Selected Receptors Set, at each iteration, shall be established in consultation with the CRCIA Board and shall be subject to its approval.
- (B3.7.1-3) Species of importance in sustaining the existing trophic structure shall be retained in the Selected Receptors Set.
- (B3.7.1-4) Species that compete with species chosen for impact assessment or that have the potential to alter the trophic structure by eliminating the chosen species shall be retained in the Selected Receptors Set.
- (B3.7.1-5) Edible plants, or classes of edible plants, chosen for the Selected Receptors Set shall account for the fraction of dose to humans and biota required by the exposure representation criteria established.
- (B3.7.1-6) Biota and socio-economic entities included in the Receptors of Concern Set required in Section II-A.7.5 shall be included in the Selected Receptors Set.

B.3.7.2 Required Exposure Mechanisms Study Set

The requirements in this section call for an Exposure Mechanisms Study Set that identifies the exposure mechanisms to be evaluated, resulting in contact and uptake of harmful contaminants by receptors. The requirements in this section are as follows:

- (B3.7.2-1) The Exposure Mechanisms Study Set shall be formed by eliminating, over one or more screening iterations, mechanisms from the Candidate Exposure Mechanisms Set.
- (B3.7.2-2) Criteria for retaining, at each iteration, mechanisms in the Exposure Mechanisms Study Set shall be established in consultation with the CRCIA Board and shall be subject to its approval. Criteria shall include completeness of explicit dose contributions and exposure mechanism coverage for each species in the Selected Receptors Set.
- (B3.7.2-3) Any exposure mechanism that makes a larger contribution to the dose to a receptor than any exposure in the Exposure Mechanisms Study Set for that receptor shall also be included in the Exposure Mechanisms Study Set.



B.3.7.3 Required Pathways Study Set

The requirements in this section call for a Pathways Study Set that identifies the networks of biological interactions which result in transfer of harmful contaminants between receptors. The requirements in this section are as follows:

- (B3.7.3-1) The Pathways Study Set shall be formed by eliminating, over one or more screening iterations, pathways from the Candidate Pathways Set defined in Appendix II-A.
- (B3.7.3-2) Criteria for retaining, at each iteration, pathways in the Pathways Study Set shall be established in consultation with the CRCIA Board and shall be subject to its approval.

B.3.7.4 Required Cultural Dependency Webs Study Set

The requirements in this section call for a Cultural Dependency Webs Study Set that identifies the networks of dependencies which result in damage to cultural practices and institutions. The requirements in this section are as follows:

- (B3.7.4-1) The Cultural Dependency Webs Study Set shall be formed by eliminating, over one or more screening iterations, dependency webs from the Candidate Cultural Dependency Webs defined in Appendix II-A.
- (B3.7.4-2) Criteria for retaining, at each iteration, cultural dependency webs in the Cultural Dependency Webs Study Set shall be established in consultation with the CRCIA Board and shall be subject to its approval.



B.3.8 Dose Assessment

The requirements in this section address how well the dose characterization and quantification requirements in Section II-A.8 will be implemented. Dose assessment provides the basis for assessing the impact because doses are measurements of contaminant uptake by receptors that correlate with impact. Dose characterization approximates and simplifies dose. The dose as characterized must represent the actual or impending dose to an acceptable degree of approximation. For example, dose is characterized in part by the selected contaminants of concern. Dominant contaminants are selected on the basis of their contributions to dose. Simplifying approximations must be applied similarly to other factors determining dose. Dose characterization must be statistical. Dose distribution across population groups must be assessed. Because of their disproportionate contribution to impact, the dose to the most highly exposed segments of the general population is important. The tails on the high side of the dose distributions, for example, the group of individuals in and above the 95th dose percentile, are of particular importance. They may have the primary impact on values, for example, environmental justice.



Dose calculations shall be made for each of the receptors in the Selected Receptors Set defined in Section II-B.3.7.1. After the Selected Receptors Set is established, changes will probably seldom be needed. However, dose calculations may be constrained in some fiscal years to only a portion of the selected receptors by CRCIA resource limitations. If dose calculations cannot be made for all receptors of concern, a subset shall be defined using the requirements of dominance (see “Principles and General Requirements.”) The following is an overview of the requirements in this section:

- (B3.8-1) Radiation and chemical doses shall be calculated for each of the receptors included in the Selected Receptor Set defined in Section II-B.3.7.1, for any combination of the contaminants included in the Contaminant Study Set defined in Section II-B.3.1.1.
- (B3.8-2) Dose measures and attributes needed to quantify the impacts to be assessed shall be established in consultation with the CRCIA Board and shall be subject to its approval.
- (B3.8-3) Dose to most highly exposed, as well as the most highly sensitive, population groups shall be characterized.
- (B3.8-4) Dose to biological receptors receiving short-term acute exposures, long-term chronic exposures, and multi-generational exposures to hazardous contaminants shall be quantified.
- (B3.8-5) Uncertainties in dose estimates shall be assessed.
- (B3.8-6) Dose distributions to human socio-cultural population groups shall be assessed, particularly including individuals within the groups to at least the 95th percentile in dose level.

B.3.8.1 Required Dose Measures Study Set

The requirements in this section call for a Dose Measures Study Set that identifies the dose measures which provide an adequate basis for impact quantification. The requirements in this section are as follows:

- (B3.8.1-1) The Dose Measures Study Set shall be formed by eliminating, over one or more screening iterations, dose measures from the Candidate Dose Measures Set defined in Appendix II-A.
- (B3.8.1-2) Criteria for retaining, at each iteration, dose measures in the Dose Measures Study Set shall be established in consultation with the CRCIA Board and shall be subject to its approval.
- (B3.8.1-3) Dose measures applicable to each receptor shall be specified in the Dose Measures Study Set. An example is association of contaminant accumulations with predatory river fish.

B.3.8.2 Required Dose Attributes Study Set

The requirements in this section call for a Dose Attributes Study Set that identifies the dose attributes which provide an adequate basis for impact quantification. The requirements in this section are as follows:



- (B3.8.2-1) The Dose Attributes Study Set shall be formed by eliminating, over one or more screening iterations, dose attributes from the Candidate Dose Attributes Set defined in Appendix II-A.
- (B3.8.2-2) Criteria for retaining, at each iteration, dose attributes in the Dose Attributes Study Set shall be established in consultation with the CRCIA Board and shall be subject to its approval.



B.3.9 Receptor Impact and Tolerance Assessment

The requirements in this section call for selecting the adverse effects of greatest concern to stakeholders from among the candidates required to be considered in Section II-A.9. This section also requires the adverse effects selected for evaluation (the study set) to be assessed with sufficient fidelity to reveal actual conditions. Project scope limitations will constrain these choices. Unexpected potential adverse effects discovered during the assessment shall be identified and either included for assessment or shown to be less than the least dominant impact previously selected. The following is an overview of the requirements in this section:

- (B3.9-1) An impact discovery process shall be implemented to identify previously unrecognized impacts, based on the developing information from the on-going CRCIA.
- (B3.9-2) Impacts discovered in the course of the CRCIA shall be considered for inclusion in the Selected Impact Set in consultation with the CRCIA Board.
- (B3.9-3) Ecological/environmental impact measures shall be quantified in consultation with the CRCIA Board.
- (B3.9-4) Impacts on cultural and socio-economic groups shall be quantified well enough to assess the impact tolerance and sustainability of each group. Assessment shall be prudent, meaning that high probability upper bounds—for example, 0.95—shall be provided, whether mean (expectation) values are provided.
- (B3.9-5) Population loss shall be quantified for specified individual species belonging to the Selected Receptors Set.
- (B3.9-6) Uncertainties in impacts shall be assessed.
- (B3.9-7) Past injury shall be considered to the extent that it affects future population and ecosystem impact tolerance and sustainability.
- (B3.9-8) Dose response parameters used shall take into account the exposure duration.



B.3.9.1 Required Selected Impact Set

The requirements in this section call for a Selected Impact Set that identifies the impacts to be assessed. The requirements in this section are as follows:

- (B3.9.1-1) The Selected Impact Set shall be formed by eliminating, over one or more screening iterations, impacts from the Candidate Impact Set.
- (B3.9.1-2) Impacts associated with toxicant tissue concentrations or energy deposition in receptors shall be assessed iteratively until they can be prudently eliminated from the Selected Impact Set.
- (B3.9.1-3) Criteria for retaining, at each iteration, impacts in the Selected Impact Set shall be established in consultation with the CRCIA Board and shall be subject to its approval.
- (B3.9.1-4) The criteria established shall explicitly consider equity between receptor categories, particularly human socio-cultural categories.

B.3.10 Assessment Scenarios: River, Climate, Geological, and Political

The requirements in this section call for selecting the dominant scenarios from among the candidates required to be considered in Section II-A.10. Dominant scenarios are chosen based on both the severity of their effects on impact and the likelihood of their occurrence. Scenarios provide stakeholders and decision makers a measure of the effectiveness of cleanup solutions.

B.3.10.1 Required Limiting Scenarios Set

The requirements in this section call for a Limiting Scenarios Set that identifies the scenarios which shall be assessed. The requirements in this section are as follows:

- (B3.10.1-1) The Limiting Scenarios Set shall be formed by eliminating, over one or more screening iterations, scenarios from the Candidate Scenarios Set defined in Appendix II-A.
- (B3.10.1-2) Criteria for retaining, at each iteration, scenarios in the Limiting Scenarios Set shall be established in consultation with the CRCIA Board and shall be subject to its approval.

B.4 Required Assessment Reporting

The requirements in this section call for reporting assessment results objectively and prudently, in a way that communicates insight into the nature or character of the risks brought about by the conditions projected to exist on the river, and that acknowledges unknowns and uncertainties existing there. The following is an overview of the requirements in this section:



- (B4.0-1) Any risk assessment shall characterize the risks for each receptor in the Selected Receptor Set.
- (B4.0-2) Uncertainty in data and estimates shall be recognized explicitly in forming impact assessment conclusions. For an assessment conclusion to be applicable within a geographic region (segment), the data or estimates within that region shall support the conclusion with a prudently high probability, to be specified by the CRCIA Board (for example, 0.95). Conclusions not supported by data or estimates to the required degree of certainty shall be excluded from the risk assessment.
- (B4.0-3) Presentation of impact uncertainties shall be planned. An uncertainty map shall be designed to illustrate the geographic locations of uncertainties early in the assessment program, subject to CRCIA Board approval.
- (B4.0-4) Any risk assessment produced shall be introduced with an uncertainty map, showing explicitly the areas where conclusions are precluded by a high level of uncertainty.
- (B4.0-5) An evaluation of environmental justice shall be reported (for example, Executive Order 12898).
- (B4.0-6) The concentrations of all contaminants estimated to be at habitat locations within the study zone, and at concentrations elevated above the impact comparison baseline, shall be reported, subject to CRCIA Board approval.
- (B4.0-7) Conditions leading to each assessed impact shall be reported.

B.4.1 Required Risk Characterization

The requirements in this section call for reporting impacts, their associated stressors, and co-risk factors, as they exist now and will exist over time. Stressors include chemical, radiological, physical, and thermal stressors; biological species; legal, political, and financial stressors; sensory stressors; and natural disasters, such as seismic events, floods, and fires. Co-risk factors (including sociocultural), such as background exposures, species-specific bioconcentration, ethnopharmacological factors, background community health status, and nutrition, modify responses for each impact. The requirements in this section are as follows:

- (B4.1-1) Individual impacts shall be reported, including combined effects on individual endpoints from multiple stressors, with co-risk factors identified.
- (B4.1-2) Geological resource impacts, including groundwater quality impacts and surface water quality impacts, shall be reported.
- (B4.1-3) Biological and ecological resource impacts shall be reported.



- (B4.1-4) Cumulative impacts across multiple endpoints and receptors shall be evaluated and reported.
- (B4.1-5) Temporal and spatial risk variation shall be reported, as well as cumulative impacts over time, including multi-generational impacts and total regional spatial burdens and impacts over time.

B.4.1.1 Required Reporting of Biological and Ecological Impacts

The requirements in this section call for reporting biological and ecological resource impacts. The requirements in this section are as follows:

- (B4.1.1-1) Ecotoxicological effects to vegetation and animals shall be reported.
- (B4.1.1-2) Impacts to threatened and endangered species, sensitive habitats, and unique communities shall be reported.
- (B4.1.1-3) Habitat-level impacts (terrestrial, aquatic, wetlands, and riparian) shall be reported.
- (B4.1.1-4) Landscape-level impacts shall be reported.
- (B4.1.1-5) Irreversible and irretrievable commitment of natural resources shall be reported.
- (B4.1.1-6) Impacts on nature's functions and services—systems and microsystems—shall be reported.
- (B4.1.1-7) Culturally important ethno-habitat or eco-cultural impacts shall be reported.
- (B4.1.1-8) Impacts on human uses and health shall be reported.
- (B4.1.1-9) Impacts on access and other treaty-reserved rights shall be reported.
- (B4.1.1-10) Impacts on natural resource trusteeship shall be reported.
- (B4.1.1-11) Impacts on historic and cultural resources, traditional cultural properties, and historic use areas shall be reported.
- (B4.1.1-12) Impacts on individual and community public health across demographic/ethnic groups shall be reported.
- (B4.1.1-13) Socio-cultural impacts shall be reported.
- (B4.1.1-14) Socio-economic impacts shall be reported.
- (B4.1.1-15) Impacts on other values and principles that are identified as important by the CRCIA Board shall be reported.



B.4.1.2 Required Evaluation and Reporting of Cumulative Impacts

The requirements in this section call for reporting cumulative impacts across multiple endpoints and receptors. The integrated effects of all impacts (risk characterization) are to be understood and reported. The requirements in this section are as follows:

- (B4.1.2-1) The assessment shall report impacts integrated by type of effect, such as human health, environmental, socio-cultural, socio-economic, and ethno-habitats.
- (B4.1.2-2) The assessment shall report impacts integrated by web, for example, foodweb, cultural web, and economic web.
- (B4.1.2-3) The assessment shall report impacts integrated by level of organization, such as individual organisms and people, communities of organisms or people, biosphere/regional ecosystems, and eco-cultural systems.
- (B4.1.2-4) Overall impacts to ways of life embedded within the environment shall be evaluated and reported.
- (B4.1.2-5) Hanford impacts in combination with impacts from other sources shall be reported.

B.4.2 Required Environmental Justice Evaluation

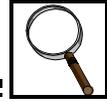
The requirements in this section call for evaluating and reporting environmental justice consequences of Hanford-derived risks. The requirements in this section are as follows:

- (B4.2-1) The distribution of each of the above impacts across demographic and ethnic groups and their resources over time (with constructed scales and bar charts) shall be evaluated and reported.
- (B4.2-2) The proportion of the most-affected group actually affected after integrating all impacts for selected population segments shall be evaluated and reported.
- (B4.2-3) The historical disproportionality and cumulative disproportionality over time shall be evaluated and reported.

B.5 Assessment Software Requirements

The requirements in this section call for using software in the assessment whose characteristics meet the needs of the assessment. The requirements in this section are as follows:

- (B5.0-1) Software shall be designed, implemented, or procured on the basis of explicit requirements.



- (B5.0-2) Model representation of dominant contaminants and pathways shall include all elements necessary to describe dominant elements of dose.
- (B5.0-3) Verification and validation shall be performed on software.
- (B5.0-4) A Quality Assurance Plan shall be established before any software is developed or procured.
- (B5.0-5) A Software Test Plan shall be established during software requirements phase.
- (B5.0-6) Software reviews (walk-throughs) shall be held for each software module. Reviews shall include verification of software interfaces.
- (B5.0-7) Formal technical reviews shall be held at the end of the software requirements phase, the software design phase, and for analysis software integration before assessment results are calculated.
- (B5.0-8) Software design quality shall be evaluated and reviewed for acceptability by qualified independent reviewers approved by the CRCIA Board.
- (B5.0-9) Software testing requirements shall be established during the software requirements phase.

B.6 Reference

Executive Order 12898. February 11, 1994. "Federal Actions to Address Environmental Justice in minority Populations and Low-Income Populations."