



**Scientific Analysis/Calculation
Administrative Change Notice**

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Complete only applicable items.

1. Document Number:	ANL-WIS-MD-000006	2. Revision:	REV 02	3. ACN:01	
4. Title:	Radionuclide Screening				
5. No. of Pages Attached:	5				

6. Approvals:		
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7. Affected Pages	8. Description of Change:
Change History	The Change History for REV02 ACN01A has been added as follows: Added CR 7925 to the set of applicable CRs and implemented changes to address DOE Deliverable Review Comments.
1-1	Omission of CR 7925 from the set of applicable CRs in Section 1. 3 rd paragraph. Change the third paragraph in Section 1. page 1-1 to add CR 7925 as follows: The purpose of this revision (Revision 02) is to update the radionuclide inventory and screening factor input data (Condition Reports (CRs) 5925, 5600, and 7925). Consistent with this purpose, the current revision incorporates the content of previous revisions that has not been updated or superseded.
1-2	Correct technical work plan (TWP) title in Section 1. page 1-2. The first two lines in the first paragraph on page 1-2 are changed to delete the word <i>Postclosure</i> from the TWP title as follows: This document was prepared in accordance with <i>Technical Work Plan for Waste Form Testing and Modeling</i> (BSC 2006 [DIRS 177389]), with the following exceptions:



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Complete only applicable items.

1. Document Number:	ANL-WIS-MD-000006	2. Revision:	REV 02	3. ACN:01	
4. Title:	Radionuclide Screening				
3-1	<p>Definition of the function of the RadNuScreen Version 1.0 software.</p> <p>A sentence has been added to the last paragraph in Section 3.1 to provide a cross reference to Section 6.2.6 where the function of the RadNuScreen Version 1.0 software is described. This paragraph is revised as follows:</p> <p>This analysis also used RadNuScreen Version 1.0 (RadNuScreen V1.0 [DIRS 157983], STN: 10732-1.0-00). RadNuScreen V1.0 is qualified baseline software. It was obtained from Software Configuration Management and installed on a Dell Optiplex GX 260 personal computer (Serial No. HZ5N921) in accordance with Section 4.1 of IT-PRO-0011, <i>Software Management</i>. RadNuScreen 1.0 is appropriate for this application because it was designed specifically for use in radionuclide screening analyses. The functions of the RadNuScreen 1.0 software are described in Section 6.2.6. The software was used with Excel 2000 9.0.6923 SP-3 and the Windows 2000 (Version 5.0, Build 2195, Service Pack 4) operating system. This software was used within the documented validation range (BSC 2002 [DIRS 158525], Section 2.5). Input and output workbook files are provided in Appendix C. Except for the Screening Summary file, which is an output summary, the first two worksheets in each workbook file provide the inputs, while the remaining worksheets provide the outputs. There are no limitations on the output due to the use of RadNuScreen V1.0.</p>				

01	Completely revise: (1) drop the inventory projections (the old Attachments I and II) to simplify the organization of the analysis and because of an updated CSNF waste stream is expected after the approval of this analysis; (2) revise the screening method to include (a) an intermediate solubility class, (b) external exposure, and (c) effects of the biosphere. Change bars are not used due to extensive revision. This revision (01) fulfills the commitments regarding radionuclide screening that were made in response to Technical Error Report TER-02-0064 (see AP-15.3Q, Control of Technical Product Errors).
02	This is a complete revision of the document. This revision addresses Condition Reports 5925 and 5600 by updating the radionuclide inventory and screening factor input data. Consistent with this purpose the current revision incorporates the content of previous revisions that has not been updated or superseded. Change tracking is not used because the changes in the document are too extensive.
02 ACN01	Added CR 7925 to the set of applicable CRs and implemented changes to address DOE Deliverable Review Comments.

1. PURPOSE

The waste forms under consideration for disposal in the repository at Yucca Mountain contain scores of radionuclides. It would be impractical and highly inefficient to model all of these radionuclides in a total system performance assessment (TSPA). Thus, the purpose of this radionuclide screening analysis is to remove from further consideration (screen out) radionuclides that are unlikely to significantly contribute to radiation dose to the public from a nuclear waste repository at Yucca Mountain. The remaining nuclides (those screened in) are recommended for consideration in TSPA modeling for license application. This analysis also covers radionuclides that may not be screened in based on dose, but need to be included in TSPA modeling for other reasons. For example, U.S. Environmental Protection Agency (EPA) and U.S. Nuclear Regulatory Commission (NRC) regulations require consideration of the combined activity of ^{226}Ra and ^{228}Ra in groundwater (40 CFR 197.30 [DIRS 173176], 10 CFR 63.331 [DIRS 173176]). In addition, parent radionuclides (e.g., ^{245}Cm and ^{241}Pu) that contribute to the inventory of the screened-in progeny should be included in TSPA modeling.

The radionuclide screening analysis considers two different postclosure time periods: the period up to 10,000 years and the period after 10,000 years up to 1 million years after emplacement. For the purposes of the screening analysis, four modeling cases are considered within the nominal and disruptive scenario classes: (1) nominal, which entails long-term degradation of disposal containers and waste forms, (2) human-intrusion, (3) intrusive igneous, and (4) eruptive igneous. Because the first three cases require groundwater transport, they are called groundwater scenarios below. The screening analysis considers the following waste form types: commercial spent nuclear fuel (CSNF) from light water reactors; U.S. Department of Energy (DOE) spent nuclear fuel (SNF), excluding navy spent fuel, which is not considered in this analysis; and high-level waste (HLW) in the form of borosilicate glass. Within these waste form types, average and outlying (high-burnup, high-initial enrichment, low-age, or otherwise exceptional) waste forms are considered.

The purpose of this revision (Revision 02) is to update the radionuclide inventory and screening factor input data (Condition Reports (CRs) 5925, 5600, and 7925). Consistent with this purpose, the current revision incorporates the content of previous revisions that has not been updated or superseded.

In a review of Revision 00 of this radionuclide screening analysis, the NRC found that “processes that affect transport in the biosphere, such as uptake by plants and bioaccumulation are not accounted for,” and that “the direct exposure pathway is not accounted for” (Beckman 2001 [DIRS 156122], Section 5.3.2.1). The NRC also found that the solubility and sorption classes were too broadly defined, noting, for example, that Se is in the same solubility and sorptivity groups as neptunium and uranium, yet is “more soluble than neptunium and uranium by several orders of magnitude” (Beckman 2001 [DIRS 156122], Section 5.3.2.1). This revision includes the responses to the specific concerns raised by the NRC and other reviewers that were documented in Revision 01 (BSC 2002 [DIRS 160059]). As does Revision 01 (BSC 2002 [DIRS 160059]), this revision uses screening factors that take into account various environmental transport and exposure pathways in the biosphere. It also retains the three

solubility and sorption classes used in Revision 01 (BSC 2002 [DIRS 160059]) to better segregate the radionuclides into appropriate groups for radionuclide screening.

This document was prepared in accordance with *Technical Work Plan for Waste Form Testing and Modeling* (BSC 2006 [DIRS 177389]), with the following exceptions:

- The procedure used for this scientific analysis was SCI-PRO-005, *Scientific Analyses and Calculations*.
- Inputs were managed in accordance with SCI-PRO-004, *Managing Technical Product Inputs*.
- Although it was not identified in Section 9 of the technical work plan (TWP) (BSC 2006 [DIRS 177389]), GoldSim V 8.02.500 (see Section 3.1) was used for radionuclide inventory decay calculations.

These deviations from the TWP are justified because SCI-PRO-005 superseded LP-SIII.9Q-BSC and SCI-PRO-004 superseded LP-3.15Q-BSC, which were the corresponding procedures identified in the TWP (BSC 2006 [DIRS 177389], Section 4.2). Current revisions of applicable procedures were used. Also, the use of GoldSim V 8.02.500 is justified because an application was needed to calculate the radionuclide inventories at selected decay times up to one million years after emplacement, and the radionuclide transport module in GoldSim V 8.02.500 is qualified and suitable for performing the needed calculations.

3. USE OF SOFTWARE

3.1 SOFTWARE APPROVED FOR QUALITY ASSURANCE WORK

This section identifies and describes the controlled and baselined software (as defined in IM-PRO-003, *Software Management*) used in this analysis and how the requirements of SCI-PRO-005 (Attachment 2, Section 3) were satisfied for the use of this software.

This analysis used GoldSim Version 8.02.500 (GoldSim V. 8.02.500 [DIRS 174650], STN: 10344-8.02-05), run under Windows 2000 on the computer identified as Master06, to do radionuclide inventory decay calculations for selected times up to a million years. These calculations were performed using the radionuclide transport module within the range of use of GoldSim V. 8.02.500. This software was selected because it is qualified baseline software and the radionuclide transport module in GoldSim V. 8.02.500 simulates radioactive decay and is suitable for calculating the radionuclide inventories at the selected decay times. It was obtained from Software Configuration Management and installed on a workstation with Windows NT Server (CPU QWS-151635) in accordance with Section 6.1 of IM-PRO-003. The GoldSim run files are included in Appendix C and are discussed in Section 6.2.3. The use of GoldSim V. 8.02.500, as described above, was consistent with the intended use and within the documented validation range of the software. There are no limitations on the output due to the use of the GoldSim V. 8.02.500 software.

This analysis also used RadNuScreen Version 1.0 (RadNuScreen V1.0 [DIRS 157983], STN: 10732-1.0-00). RadNuScreen V1.0 is qualified baseline software. It was obtained from Software Configuration Management and installed on a Dell Optiplex GX 260 personal computer (Serial No. HZ5N921) in accordance with Section 4.1 of IT-PRO-0011, *Software Management*. RadNuScreen 1.0 is appropriate for this application because it was designed specifically for use in radionuclide screening analyses. The functions of the RadNuScreen 1.0 software are described in Section 6.2.6. The software was used with Excel 2000 9.0.6923 SP-3 and the Windows 2000 (Version 5.0, Build 2195, Service Pack 4) operating system. This software was used within the documented validation range (BSC 2002 [DIRS 158525], Section 2.5). Input and output workbook files are provided in Appendix C. Except for the Screening Summary file, which is an output summary, the first two worksheets in each workbook file provide the inputs, while the remaining worksheets provide the outputs. There are no limitations on the output due to the use of RadNuScreen V1.0.

3.2 COMMERCIAL OFF-THE-SHELF SOFTWARE USED

This section identifies and describes the exempt software (as defined in IM-PRO-003, Section 2) used in this analysis and how the requirements of SCI-PRO-005 (Attachment 2, Section 3) were satisfied for the use of this software.

Microsoft Excel 2003 (11.8033.8036) SP2, a commercially available spreadsheet software package, was used to process radionuclide inventory data and GoldSim and RadNuScreen inputs and results. Excel is appropriate for these uses because the calculations require simple mathematical expressions and operations that are available as standard functions in Excel. The

specific standard functions of Excel that were used for calculations are described at the point of use (Appendices A and C). These standard functions of Excel are exempt from the software