



**GEOSCIENCES AND ENGINEERING DIVISION  
DOCUMENT REVIEW REQUEST AND TRANSMITTAL CONTROL (REF. QAP-002)**

**I. DOCUMENT INFORMATION**

a. TITLE: Fiscal Year 2012 Summary of Completed Improvements to BDOSE Model

**b. DOCUMENT TYPE**

<input checked="" type="checkbox"/> Technical Report, Trip Report	<input type="checkbox"/> CQAM, QAPs, APs	<input type="checkbox"/> Abstracts*	<input type="checkbox"/> Posters*
<input type="checkbox"/> Guidance Documents	<input type="checkbox"/> TOPs	<input type="checkbox"/> Conference Papers*	<input type="checkbox"/> Presentations*
<input type="checkbox"/> Operations Plans, Proposals	<input type="checkbox"/> Project, Test, Validation Plans	<input type="checkbox"/> Journal Articles*	*Peer Reviewed Y <input type="checkbox"/> N <input type="checkbox"/>

\*Conference/Journal Title: NA  
Date/Location/Publisher/City, State: \_\_\_\_\_

Copyright Permission Required and Obtained: Y  N

c. DOCUMENT CLASSIFICATION: Classified: Y  N  Sensitive Unclassified: Y  N  Export Controlled: Y  N

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**d. PROJECT INFORMATION**

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CNWRA DOCUMENT NO.: Y  N  Assigned No.: CNWRA 2000X-XXX

e. SCHEDULE Today's Date: 11/27/2012 Scheduled Transmittal Date: 11/29/2012

Author: P. LaPlante Manager: R. Lenhard Assigned Secretary: L. Selvey

**II. REVIEW (See QAP-002 Table 1 for applicable review types.)**

Approvals of

<u>Robert Lenhard</u> (Manager Signature)	<u>11/27/2012</u> (Date)
<u>John Stamatakos</u> (Director Signature)	<u>11/27/2012</u> (Date)

		Req'd Date	Initials/Date Completed
	TECHNICAL (Attached Form QAP-12.) Reviewer(s): <b>NA: No technical content</b>		
X	EDITORIAL Reviewer: <b>R. Lenhard</b>	<b>11/27/2012</b>	<b>RJL 11/27/2012</b>
	QUALITY ASSURANCE Reviewer:		
X	PROGRAMMATIC/COPYRIGHT PERMISSION VERIFIED Reviewer: <b>R. Lenhard</b>	<b>11/27/2012</b>	<b>RJL 11/27/2012</b>
X	FORMAT Reviewer: <b>B. Street</b>	<b>11/28/2012</b>	<b>BS 11/27/2012</b>

GED calculations and analyses supporting this report are documented in Scientific Notebook(s): (If none, state "None") 1144E

Verification of Compliance with QAP-002, Records Management Staff \_\_\_\_\_

**IV. TRANSMITTAL**

TO: M. George FROM: R. Lenhard  
COPIES TO: \_\_\_\_\_



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ATTN: Document Control Desk  
U.S. Nuclear Regulatory Commission  
Mr. Mathews George  
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Subject: Delivery of Fiscal Year 2012 Summary of Completed Improvements to  
BDOSE Model (AI 20.14003.01.006.200)

Dear Mr. George:

This letter transmits a summary description of Task 6 accomplishments as part of the Center for Nuclear Waste Regulatory Analyses (CNWRA) technical assistance for evaluating non-high-level waste determinations for U.S. Department of Energy (DOE) facilities in accordance with the National Defense Authorization Act of 2005. This letter summarizes fiscal year 2012 task work completed on improvements to the BDOSE biosphere dose modeling software (Task 6) that was developed by CNWRA to support U.S. Nuclear Regulatory Commission (NRC) reviews of DOE waste determinations.

The software improvements are expected to improve BDOSE functionality and enhance existing NRC waste determination review capabilities. The varied nature of the focused fiscal year 2012 BDOSE enhancements and an emphasis on maximizing utility of limited resources culminated in an agreement with the NRC technical monitor to document the accomplishments in this summary letter rather than produce a technical report. The attached CD contains draft working files that document the work completed in fiscal year 2012 in a manner sufficient to allow NRC review. The CD includes detailed input parameter lists documenting hundreds of input parameters, intruder calculation test plans and results, and a modified BDOSE input file that includes a new transfer factor sampling approach with the updated input parameter values.

This letter describes the specific technical code enhancements that the NRC program manager and CNWRA principal investigator agreed were within the broad scope of initial 2012 tasking. Based on limited available fiscal year 2012 resources relative to the initial broad scope of tasking, agreement was reached on specific subtasks to be given focused attention for completion in fiscal year 2012.

The focused work involved subtasks to (i) update the generic/default input parameter set for BDOSE, (ii) review and test BDOSE intruder scenario calculations, (iii) modify BDOSE to allow sampling of plant transfer factors, and (iv) develop an initial conceptual design of a buried waste/radon basement scenario in BDOSE. The following paragraphs describe in more detail



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the work completed on each of the subtasks. To facilitate NRC review and comment, a CD has been attached that contains working files, drafts, and code files that document in detail the results of the work conducted for Task 6. The model enhancement and default input parameter work conducted in fiscal year 2012 is expected to be formally documented in the BDOSE User's Manual that is planned to be updated in fiscal year 2013.

#### Update the BDOSE Default Input Parameter Set

The CNWRA effort to update the BDOSE default data set involved evaluating a variety of default input parameters and providing an initial revised set of inputs and revised BDOSE input data file to reflect the updated default input parameters. Because the BDOSE default input parameter set has not been updated since 2008, the fiscal year 2012 effort took advantage of updated data sources and insights gained from site-specific BDOSE tasking since that time. Because BDOSE uses a large number of input parameter values (over 1,000), the input parameter review effort has been optimized to focus on input parameters of interest to NRC staff that are most likely to benefit from a review and update. To the extent possible, the CNWRA staff utilized the updated input parameter values that were selected for the latest BDOSE sensitivity analysis task in 2011 to the greatest extent possible because a number of the best available references for input parameters in that analysis were general sources that are also suitable for deriving default parameter values. This prior work provided sound bases for an updated set of distribution coefficients, general agricultural inputs, human consumption rates and local diet fractions, inhalation rates, resuspension factors, and exposure times. Utilizing the prior information to support updates for a portion of BDOSE input parameters allowed staff to focus on parameter revisions to other inputs including approximately 450 plant and 300 animal transfer factor distributions, intruder model inputs, and soil model parameters. Plant and animal transfer factors were updated, in part, based on recent revisions in 2010 by the International Atomic Energy Agency to their compilation of transfer factors from available scientific literature supplemented, as necessary, by other well known information sources to address data gaps. The complex and incomplete nature of the source information for selecting transfer factors for the default data set required the CNWRA staff to develop a detailed selection protocol (included in the attached CD) to ensure all values were selected from the available data sources in a consistent manner. The overall result of leveraging prior work is a much more comprehensive initial update of the default data set than would have been possible based on the limited available resources. The attached CD provides files that document the initial draft set of proposed inputs for the default data set that is being provided for NRC staff review.

#### Review and Test BDOSE Intruder Scenario Calculations

NRC staff review of the intruder scenario in BDOSE suggested additional testing was needed to check if the model were operating as intended and producing results that were within technical intruder model and input parameters to evaluate whether results are within technical expectations. Tests included a benchmarking-style of test using source terms set to 10 CFR Part 61 low-level radioactive waste (Class C) classification limits, comparisons of acute and chronic intruder calculation results using the same input parameters, and evaluation of the propagation of expected dosimetry differences in the results of the intruder calculations. All test

expectations. In this subtask, CNWRA conducted additional reviews and tests of the BDOSE results concluded the model is producing results that fall within technical expectations. The benchmarking-style test indicated the default input parameter selections that had not been reviewed or updated since 2008 lead to higher intruder dose results than expected; however, technically supported refinements to influential input parameters demonstrated the model produced results within technical expectations. Insights gained supported recommendations to revise some of the default input parameters in the BDOSE intruder model. The attached CD contains excerpts from CNWRA staff scientific notebooks that document the BDOSE draft intruder test plans and results that are being provided for NRC review.

#### Modify BDOSE to Allow Sampling of Plant Transfer Factors

Based, in part, on the large volume of plant transfer factor input parameters required by BDOSE, the software was originally designed use constant values for these input parameters. To support evaluating the effects of input parameter uncertainty and variability on results, a subtask under Task 6 involved modifying the BDOSE input container to allow sampling of plant transfer factor input parameters from probability distributions. CNWRA staff familiar with the Goldsim software made the requested modifications and provided demonstration versions for NRC review and comment. The resulting enhancement provides the capability to sample any of the element-specific and food product type-specific plant transfer factors from a wide variety of probability distributions (e.g., normal, log-normal, triangular, uniform). For consistency, the same enhancement was added to convert the existing BDOSE sampling approach for animal transfer factors to match the new plant transfer factor sampling approach at no additional cost to NRC. Probability distribution data for both plant and animal transfer factors were derived from available data sources as described above as part of the tasking to update the BDOSE default input parameter set. The new sampling approach was tested to verify it was operating as designed. The attached CD includes a draft copy of the updated BDOSE file (with sampling and loaded input distributions) and a copy of the scientific notebook entry that describes the testing and results.

#### Initial Conceptual Design of a Buried Waste Radon Basement Scenario in BDOSE

Tasking directed the CNWRA staff to develop the conceptual design and modeling approach for an additional module in BDOSE to evaluate radon emanation and dose from buried Ra-226 waste. The model was to be based on calculation approaches found in NRC Regulatory Guides and NUREGs and consider engineered barriers, attenuation by a concrete home foundation, various source geometries, attenuation by multiple subsurface layers of varying properties, separate groundwater-based radon pathways (showering, soil contamination by irrigation), and dose to residents above buried waste and at the site boundary. CNWRA staff collected and reviewed a variety of NRC regulatory guides and NUREGs applicable to radon modeling and engaged NRC staff in discussions about the overall conceptual approach. A broad outline of the conceptual approach was drafted along with a list of applicable references when Task 6 subtasks were evaluated with the NRC technical monitor based on effort and available resources. That review resulted in other subtasks being emphasized for completion and the radon model subtasks to be completed on an as-funding-permitted basis with deferral of much

Mr. Mathews George  
November 29, 2012  
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of the radon model work to fiscal year 2013. The competing demands of the default input parameter, transfer factor sampling, and intruder testing efforts limited further progress on the radon conceptual model in fiscal year 2012. The radon model conceptual approach outline and reference list are provided on the attached CD. Additional details will be added to the conceptual outline to finalize the conceptual design in coordination with the NRC technical monitor under the current fiscal year 2013 tasking.

In summary, CNWRA work on Task 6 in fiscal year 2012 has implemented enhancements to BDOSE and conducted related work to improve NRC staff capabilities to conduct and support incidental waste determination reviews. These enhancements include providing an initial update of the default input parameter set, conducting reviews and tests of BDOSE intruder scenario calculations, updating the BDOSE input container to allow sampling of plant transfer factors, and progressing on the an initial conceptual design of a buried waste/radon basement scenario in BDOSE.

If you have any questions regarding this summary of accomplishments, please contact Patrick LaPlante at (301) 881-0291 or me at (210) 522-6418.

Sincerely,



Robert Lenhard, Ph.D.  
Program Manager  
Environmental Protection and Waste  
Management for Non-High Level  
Radioactive Waste

PL/RL/ls  
cc:

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CNWRA Directors/Managers  
P. LaPlante  
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Attachment to M. George: Compact Disk—Draft working files for Task 6: Enhancements to the Biosphere Model (BDOSE) and Related Work (Fiscal Year 2012)