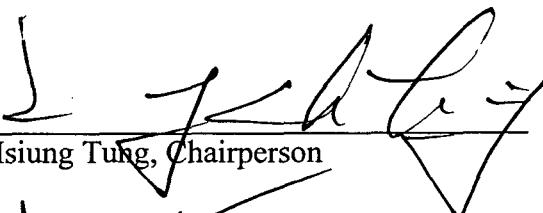QA: QA

Civilian Radioactive Waste Management System

Management and Operating Contractor

Data Qualification Report: DTN: MO0012RIB00065.002

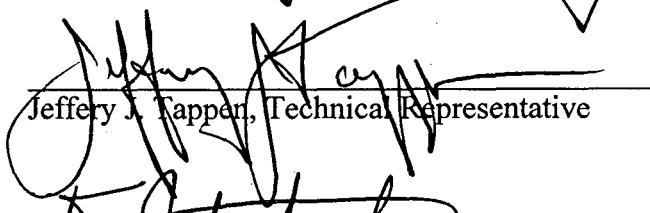*Parameter Values for Transfer Coefficients*

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December, 2000
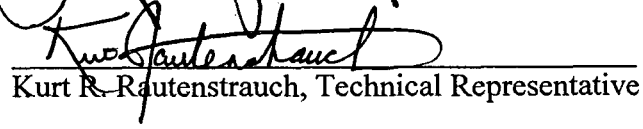
Chao-Hsiung Tung, Chairperson	1/3/2001
	Date
Jeffery J. Tappen, Technical Representative	1/3/2001
	Date
Kurt R. Rautenstrauch, Technical Representative	1/3/2001
	Date
Glen T. Hanson, Responsible Manager	1/3/2001
	Date
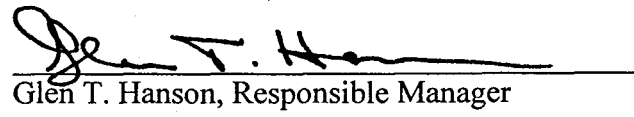
Executive Summary

A data-qualification evaluation was conducted on Reference Information Base (RIB) data set MO0012RIB00065.002, *Parameter Values for Transfer Coefficients.* The corroborating data method was used to evaluate the data. This method was selected because it closely matches the literature-review method followed to select parameter values. Five criteria were considered when the corroborating method was used: adequacy of the corroborative literature, sufficiency of value-selection criteria, implementation of the selection criteria, documentation of the process, and whether the analysis was conducted in accordance with applicable quality assurance (QA) procedures. Three criteria were used when a literature review was not conducted: appropriate logic used to select parameters, documentation of the process, and whether the analysis was conducted in accordance with applicable QA procedures.

The RIB data item, the associated Analysis and Model Report (AMR), the corroborative literature, and the results of an audit revision 0/ICN 0 of the AMR were examined. All calculations and the selection process for all values were repeated and confirmed.

The qualification team concluded:

- A sufficient quantity of corroborative literature was reviewed and no additional literature was identified that should have been considered.

- The selection criteria were sufficient and resulted in valid parameter values.

- The process was well defined, adequately documented in the AMR, and correctly followed.

- The analysis was developed in accordance with applicable QA procedures.

No negative findings were documented that resulted in questions about the quality of the data. The qualification team therefore recommends that the qualification status of RIB data set MO0012RIB00065.002 be changed to qualified.

1. INTRODUCTION

This Data Qualification Report summarizes the results of an evaluation conducted to qualify the RIB data set MO0012RIB00065.002, *Parameter Values for Transfer Coefficients.* The parameters (and associated identification numbers) in this data set are Soil-to-Plant Transfer Factor (6897), Transfer Coefficient for Animal Products (6898), Bioaccumulation Factor (6899), and Scale Factor (6900). This qualification was conducted in accordance with AP-SIII.2Q, the *Technical Work Plan for Biosphere Modeling And Expert Support* (CRWMS M&O 2000a), and the data qualification plan for this activity (Civilian Radioactive Waste Management System Management and Operating Contractor [CRWMS M&O] 1999a).

Data set MO0012RIB00065.002 contains parameter values required as inputs for the computer code GENII-S. The GENII-S code is being used to estimate radionuclide-specific biosphere dose conversion factors. The Performance Assessment Organization of the CRWMS M&O will use the biosphere dose conversion factors to calculate potential radiation doses to a hypothetical human receptor group as part of the postclosure Total System Performance Assessment.

Data set MO0012RIB00065.002 contains two values for most parameters, a "reasonable, conservative" value and a high bounding value. Reasonable is defined as being reasonably expected to occur based on the environmental conditions (i.e., in the Yucca Mountain region), and conservative is defined as a value that would result in a higher dose conversion factor. A high bounding value is defined as a value based on extreme environmental conditions that would result in the highest radiation exposure. The data set MO0012RIB00065.002 contains:

- Reasonable case and bounding soil-to-plant transfer factors for four types of plant crops specific to 19 elements (total of 152 values).

- Reasonable case and bounding transfer coefficients for four types of animal products specific to 19 elements (total of 152 values).

- Reasonable case and bounding bioaccumulation factors for fresh water fish specific to 18 elements (36 values).

- Distribution type and 0.1, 50, and 99.9 percentile values for soil-to-plant transfer scale factor and animal uptake scale factor (6 values).

The process followed to select parameter values for MO0012RIB00065.002 is described in the AMR *Transfer Coefficient Analysis* (CRWMS M&O 2000b). Most of the reasonable, conservative parameter values were selected by conducting a literature review to identify potential, applicable parameter values and then following a defined set of decision criteria to select the most appropriate reasonable case value (CRWMS M&O 2000b, p. 15). Distributions for scale factors were developed based on the variability of transfer factors and coefficients reported in the literature. Bounding values were calculated by multiplying the reasonable values by a factor based on the variability reported in the literature or by selecting the highest value reported in the literature.

2. METHODS

2.1 DATA QUALIFICATION TEAM

The former responsible manager for this activity, Larry D. Croft, (Manager, Radiological and Regional Programs Department), assigned three individuals to the qualification team. Glen T. Hanson, (Manager, EIS Strategy & Support, Regional Transportation and Biosphere Analysis Department), concurred with the composition of the qualification team. Personnel were selected because of their expertise and experience in environmental characterization, biosphere modeling, qualification of data, and because they were independent of the initial process of parameter-value selection. As per AP-SIII.2Q, revision 0, ICN 2, step 5.1.4; the Technical Data Management System Data Qualification Oversight Point of Contact, Raymond E. Keeler, designated selection of the qualification chairperson.

<u>Chao-Hsiung Tung – Chairperson</u>. Chao-Hsiung Tung has a B.S., M.S., and Ph.D. in Forestry and Ecology. Dr. Tung has more than 11 years of experience associated with the Yucca Mountain Project. He was the lead manager of the biosphere modeling effort during the viability assessment phase of the Project. He has taught classes on data qualification and validation in various workshops.

<u>Jeffery J. Tappen – Technical Representative</u>. Jeff Tappen has a B.S. in Geology and a M.S. in Health Physics. He has more than 12 years of experience on the Yucca Mountain Project. Mr. Tappen is a senior scientist on the Project and participates in the International Atomic Energy Agency biosphere-related programs as the Project representative.

<u>Kurt R. Rautenstrauch – Technical Representative</u>. Kurt Rautenstrauch is a supervisor in the Environmental Sciences Department. He has a B.S., M.S., and Ph.D. in Wildlife Ecology and Management. Dr. Rautenstrauch has more than 11 years of experience on the Yucca Mountain Project and was the data qualification lead for the biosphere modeling effort.

2.2 QUALIFICATION METHODS

This qualification was conducted using the corroborating data method (as defined in Attachment 2 of AP-SIII.2Q). This method was selected instead of others identified in AP-SIII.2Q because it closely matches the literature-review method followed to select the parameter values in the associated RIB data items. For two radionuclides (francium and carbon) a literature review was not possible. For these two radionuclides a technical assessment (as defined in Attachment 2 of AP-SIII.2Q) was used to evaluate these parameters.

To conduct this evaluation, the qualification team reviewed the RIB data item, the associated AMR, the corroborative literature (CRWMS M&O 2000b, pp. 11-13), source data sets, and the results of an audit on revision 0/ICN 0 of the AMR. Interviews were conducted with the originator of the AMR. All calculations and the

selection process for all values were repeated and confirmed. At the time this evaluation was conducted, the RIB data set (MO0012RIB00065.002) had been placed online. No data were generated as a result of this qualification process.

The qualification evaluation of RIB data set MO0012RIB00065.002 was conducted in accordance with the plan for this activity (CRWMS M&O 1999a) except the qualification activities related to the evaluation of RIB data item M09911RIB00064.000 were addressed in a separate report (CRWMS M&O 1999b).

2.3 EVALUATION CRITERIA

Five criteria were considered to evaluate the quality of MO0012RIB00065.002 when the corroborating data method was used. These criteria were selected to incorporate the considerations in Attachment 2 of AP-SIII.2Q and the applicable qualification process attributes listed in Attachment 3 of AP-SIII.2Q.

1. Was the literature (i.e., corroborative data) reviewed in the AMR adequate and comprehensive?

2. Were the selection criteria defined in CRWMS M&O (2000b, p. 15) sufficient for selecting values appropriate for their intended use?

3. Were the selection criteria defined in CRWMS M&O (2000b, p. 15) followed?

4. Were the inferences and decisions made to select the parameter values clearly identified, justified, and documented?

5. Was the analysis conducted in accordance with applicable QA procedures?

Three criteria were considered for those parameter values evaluated by a technical assessment (carbon and francium only).

1. Was the logic used to select parameter values appropriate for the biosphere model, GENII-S software code, or other applicable criteria and constraints associated with the methods being used to calculate biosphere dose conversion factors?
2. Were the inferences and decisions made to select the parameter values clearly identified, justified, and documented?
3. Was the analysis conducted in accordance with applicable QA procedures?

2.4 RECOMMENDATION CRITERIA

The following recommendation criteria were considered. The data were to be recommended as qualified if:

1. The extent and quality of the corroborative data are sufficient and no additional data sources are identified that should have been considered.

2. The selection criteria identified in CRWMS M&O (2000b, p. 15) result in the selection of data that demonstrate the properties of interest required by the GENII-S code.

3. The selection process was sufficiently documented and correctly followed so that it can be repeated and the same values selected.

4. QA procedures were followed to control the process for development of the analysis.

Thus, a change in qualification status was to be recommended if there were no negative findings in any of these criteria that would result in questions about the technical validity of the parameter values. Each recommendation criteria is addressed individually in Section 3 below.

3. EVALUATION RESULTS

3.1 ADEQUACY OF CORROBORATIVE LITERATURE

Fourteen documents were examined to select values for transfer coefficients. These documents are listed and described on pages 11 through 13 of the AMR (CRWMS M&O 2000b) for MO0012RIB00065.002. Some of the reports reviewed present values specific to the GENII-S code. Others present values intended for other computer codes or methods of analysis that have a similar purpose to the GENII-S code. These reports included regulatory guides, a textbook, review reports, and computer program manuals or guides that contain suggested values for radionuclide transfer factors required by GENII-S.   The sources for these documents included regulatory guidance reports and contractor reports from the Nuclear Regulatory Commission, International Atomic Energy Agency, national laboratories, and other well-established and accepted industry sources. The literature search for the AMR was conducted with a focus on reports and documents that summarize and present comprehensive reviews of the parameters considered. Thus, no journal articles or original sources of literature were reviewed in the AMR.   Lack of review of an original source for a specific transfer coefficient or factor may contribute to the uncertainty associated with a given parameter. This was an efficient and effective method of identifying applicable parameter values as the documents reviewed represent a vast amount of information encompassing hundreds of individual articles and reports.

According to the originator of the AMR, other potential data sources (e.g., U.S. Environmental Protection Agency) were also reviewed, but did not contain information on transfer coefficients. The review team agreed that the literature search conducted by the AMR author was complete in its scope, and therefore concludes that there are no other pertinent summary or review reports that should have been reviewed or included in this analysis.

There were six to nine sources of information available for most parameters and elements (CRWMS M&O 2000b, Tables 3-11). Some elements had fewer sources than others, but the vast majority of elements had at least five sources for each parameter. The two largest exceptions to this pattern were carbon and francium. There were only three sources of information for fruit, poultry, and eggs for carbon. The element francium had a maximum of two sources for all food types. When few sources were available, they generally were reports that documented the use of the GENII-S code; thus, the values recommended in the reports have been proven to be compatible with that code and result in acceptable output. The qualification team was not aware of any additional sources of information that could have been looked at to improve the sample size for those parameters with a limited number of sources. Nor did they believe that there were any problems with the literature sources used that would lead to risks by choosing them from the limited number of other confirmatory sources.

The qualification team concluded that the literature reviewed represents a compendium of available literature on transfer coefficients that were derived from international agencies, regulatory agencies, and the scientific community. The consensus of the qualification team was that a sufficient quantity of corroborative literature was reviewed and that this literature was comprehensive enough to represent the subject. No additional literature was identified that should have been considered. Much of the literature reviewed was from industry-standard sources such as the Nuclear Regulatory Commission and International Atomic Energy Agency. One purpose of these industry-standard sources is to document recommended parameter values for GENII-S or similar models, hence the quality of corroborative data was good. Therefore it was concluded that the corroborative literature reviewed in the AMR was complete, and meets the qualification process attributes 7 (prior uses of the data and associated verification processes) and 10 (extent and quality of corroborative data or confirmatory testing results) of AP-SIII.2Q, Attachment 3.

3.2 SUFFICIENCY OF SELECTION CRITERIA

3.2.1 Reasonable Case

Parameter values for the reasonable case were selected based on the three criteria listed below in order of preference (CRWMS M&O 2000b, p. 15).

1. If one single value appeared in at least half of the number of reviewed documents, that value was selected, because it was considered that this generic value was agreed upon by the scientific community.

2. If one value appeared in at least half of the recently published documents (i.e., after 1988), that new value was selected, because it was considered that it reflects more recent studies. The GENII-S default values were not considered recent, even though the reference was published after 1988, because the values in the 1993 revision were the same as those in the original (1988) version except for the addition of one element (francium).

3. If no single agreed value from available literature data met the above two criteria, the values were ranked from lowest to highest and the value with the middle rank was selected from all available data. If there was an even number of values, the one with a rank higher than the middle was chosen (e.g., the 4th was chosen if there were 6 values).

4. The GENII-S default value was selected when only very limited literature data were available.

The first criterion emphasized consensus among literature sources. Seventy-one of 170 (19 elements for each of four soil-to-plant transfer factors and four animal-product transfer coefficients [total of 152], and one bioaccumulation factor for fish [total of 18] [CRWMS M&O 2000b, Table 12]) values were chosen based on this criterion. This criterion resulted in the selection of parameters commonly used and accepted that are therefore defensible as valid for their intended use.

The second criterion, which resulted in selection of values commonly used in literature sources published after 1988, was used to select 38 values. This criterion was valid because it relied upon values recommended by important, recent reports such as the comprehensive compilation of radionuclide transfer factors compiled by Argonne National Laboratory and the updated handbook of radionuclide transfer values published by the International Atomic Energy Agency.

The third criterion, which required the use of the medium value if there was no consensus value, was used to select 45 values. Selection of the medium value matches well with the definition of reasonable and conservative. Choosing a more conservative value, such as the highest value, would not have been reasonable because the range of values for many parameters differed by more than an order of magnitude. This criterion therefore was a good compromise if there was no consensus among literature sources.

The fourth criterion, where GENII-S default values were chosen, was used only for francium (eight values since no data was available for fresh water fish). Francium-223 is an decay product of actinium-227, has a half life of about 22 minutes, and is very uncommon. It is not often considered in dose calculations and there is no original research known to the qualification team on environmental transfer rates of this radionuclide. Relying upon default values as a "last resort" for this radionuclide ensured, at a minimum, that the values selected had been tested as part of the computer program being used and that they resulted in reasonable output from that program. Therefore, these values are valid for the intended use and are representative of the properties of interest required by the GENII-S code.

Eight values of zero were chosen for all carbon transfer coefficients and factors (except for freshwater fish) because the GENII-S code uses a special carbon-14 model that does not require these parameter values. Only the carbon bioaccumulation factor for freshwater fish is used in the GENII-S code, which was chosen from the most recent of seven sources using the corroborating method (criterion two).

3.2.2   Scale Factors

Scale factors are used in GENII-S to statistically simulate or sample the variation associated with soil-to-plant transfer factors and animal product transfer coefficients, which are entered as fixed values. These scale factors are unique to the GENII-S code so there is little information available from which to derive or compare values. The geometric standard deviations of the distributions were conservatively calculated and based on the most important elements. The values in MO0012RIB00065.002 were developed from the range of the elements (Ni, Sr, Tc, I, Cs, Pb, Ra, Th, U, Np, Pu, and Am) reported in IAEA TRS-364 (IAEA 1994, p. 17-25). Calculations were repeated and confirmed to have been performed correctly. The distribution type (lognormal) with a similar range was the consensus among the corroborative literature (CRWMS M&O 2000b, p. 18 and 26). GENII-S does not require a scale factor for the bioaccumulation factor for freshwater fish.

3.2.3   Bounding Values

Bounding values for soil-to-plant transfer coefficients and animal-product transfer coefficients were derived by multiplying the reasonable, conservative value by a scale factor approximately equal to the 95th percentile of the associated scale factor. Specifically a factor of 10 was obtained for plant products and 4 for animal products, respectively (CRWMS M&O 2000b, p. 19 and 26). Because these multipliers are based on the same corroborative published information used to develop the transfer factors, this approach is valid, defensible, and consistent with other selected values.

Because there is no scale factor for the fish bioaccumulation factor, the highest value reported in the literature was chosen. Nonetheless, the method chosen is valid and resulted in conservatively high values that are suitable for their intended use of evaluating a bounding case.

It was concluded that the criteria used to select the reasonable-case and bounding parameter values are sufficient and resulted in valid parameter values. It also was concluded that the criteria were appropriate for selecting data demonstrating the properties of interest required by the GENII-S code, per attribute 3 (extent to which the data demonstrates the properties of interest) of AP-SIII.2Q, Attachment 3.

3.3   EXECUTION OF THE SELECTION PROCESS

The qualification team checked all parameter values in MO0012RIB00065.002 to ensure that they were selected in accordance with the selection criteria. All calculations used to develop bounding values were repeated, using a calculator when necessary, to ensure they were done correctly. No mistakes were found and the qualification team concluded that the procedures used to develop the data were technically adequate, per attribute 2 (technical adequacy of equipment and procedures used to collect and analyze the data) of AP-SIII.2Q, Attachment 3.

3.4 DOCUMENTATION OF VALUE SELECTION

The qualification team examined the text and tables in CRWMS M&O (2000b) to evaluate whether parameter selection and documentation was adequate. It was concluded that the criteria were explained clearly enough that the process could be repeated and the same results obtained. The text in Section 6 (Analysis) of the AMR provided explanations of how values were selected from each literature source. The tables included a column that defined the criteria used to select the values. The corroborative data were correctly cited, included in the Document Input Reference System, and available through the Technical Information Center, Records Information System, or Technical Data Management System. The qualification team therefore concluded that the inferences and decisions made to select the parameter values were sufficiently identified, justified, and documented so that the process could be repeated. The extent and reliability of the documentation associated with the data is sufficient, per attribute 9 (extent and reliability of the documentation associated with the data) in AP-SIII.2Q, Attachment 3.

3.5 ADHERENCE TO APPLICABLE QA PROCEDURES

A performance-based audit (Audit M&O-ARP-00-02) was conducted during November 1999 to evaluate the effectiveness of the analysis and model process for the Biosphere Process Model Report and the adequacy of selected AMRs. The audit was preformed by a team of auditors and technical representatives from the Office of Quality Assurance and the Yucca Mountain Site Characterization Office, and was observed by a representative from the Nuclear Regulatory Commission. Revision 0 /ICN 0 of the AMR, *Transfer Coefficient Analysis* (CRMWS M&O 1999c) was one of three biosphere AMRs audited. The audit evaluated all phases of the process followed for development of the AMR and procedural compliance with all applicable QA procedures. Because a thorough audit had been conducted recently on the QA process followed to develop the analysis of MO00011RIB00065.002, the qualification team relied in part on the results of that audit to evaluate adherence to applicable QA procedures. The qualification team also conducted an independent evaluation to consider whether applicable QA procedures were used to control the process of selecting data.

The audit team did not identify any deficiencies in the process followed during the development of CRWMS M&O (1999c) that would have affected the quality of the data generated from that report. Changes made to produce CRWMS M&O (2000b) were minor and would not have resulted in a change in that conclusion.

The qualification team evaluated whether the data in MO0012RIB00065.002 were developed in accordance with AP-3.10Q and other procedures required by AP-3.10Q. It was concluded that the analysis was conducted in accordance with those procedures.

Based on these evaluations, the qualification team concluded that applicable QA procedures were followed to control the process for selection of the data and that an

adequate independent audit of the process that generated the data was conducted, per attribute 11 (independent audits of the process that generated the data were conducted) of AP-SIII.2Q, Attachment 3.

4. RECOMMENDATION FOR QUALIFICATION

No negative findings were documented that resulted in questions about the quality of the data. The qualification team therefore recommends that the status of data set MO0012RIB00065.002 be changed to qualified.

5. REFERENCES

5.1 DOCUMENTS CITED

CRWMS M&O 1999a. *Data Qualification Plan: Environmental Transport Parameter Values for Dose Assessment (MO9901RIB00064.000) and Parameter Values for Transfer Coefficients (DTN: MO9901RIB00065.000)*. TDP-MGR-MD-000017 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19991201.0561.

CRWMS M&O 1999b. *Data Qualification Report, DTN: MO9911RIB00064.000, Environmental Transport Parameter Values for Dose Assessment*. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000210.0225.

CRWMS M&O 1999c. *Transfer Coefficient Analysis*. ANL-MGR-MD-000008 REV 00 ICN 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19991115.0237

CRWMS M&O 2000a. *Technical Work Plan for Biosphere Modeling And Expert Support*. TWP-MGR-MD-000009 REV 0. Las Vegas, Nevada: CRWMS M&O. ACC:MOL.20001102.0378.

CRWMS M&O 2000b. *Transfer Coefficient Analysis*. ANL-MGR-MD-000008 REV 00 ICN 02. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001016.0005

IAEA 1994. *Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Temperate Environments*. Technical Report Series No. 364. Vienna, Austria: International Atomic Energy Agency. TIC:232035.

5.2 PROCEDURES

AP-3.10Q, *Analyses and Models*. Washington, D.C.: DOE/OCRWM.

AP-SIII.2Q, *Qualification of Unqualified Data and the Documentation of Rationale for Accepted Data*. Washington, D.C.: DOE/OCRWM.

AP-SIII.4Q, *Development, Review, Online Placement, and Maintenance of Individual Reference Information Base Data Items*. Washington, D.C.: DOE/OCRWM.