CONF- 980516--/

RECEIVED

JUN 08 1998

OSTI

PRELIMINARY PATHWAY ANALYSIS
FOR YMP PRECLOSURE BIOSPHERE DOSE ASSESSMENT

De Wu
CRWMS M&O/SAIC
1180 Town Center Drive
Las Vegas, NV 89134
(702)-295-5032

Ning Liu
CRWMS M&O/SAIC
1180 Town Center Drive
Las Vegas, NV 89134
(702)-295-5072

Jeffery J. Tappen
CRWMS M&O/SAIC
1180 Town Center Drive
Las Vegas, NV 89134
(702)-295-5027

Chao-Hsiung Tung
CRWMS M&O/SAIC
1180 Town Center Drive
Las Vegas, NV 89134
(702)-295-5085

INTRODUCTION

The preliminary preclosure biosphere dose assessment for the Yucca Mountain Project (YMP) involves the calculation of a radiation dose to a subsistence farmer living near the proposed Yucca Mountain repository. Eight radionuclides, H-3, Co-60, Kr-85, Sr-90, Ru-106, I-129, Cs-134, and Cs-137, are considered in this study¹. Radiation doses resulting from unit release rates of these radionuclides are analyzed. Total dose has been broken down into components that result from various exposure pathways. By using this approach, the most important pathways that deliver a radiation dose to a subsistence farmer can be clearly identified.

MODEL DESCRIPTION

For this study, it is assumed that radionuclide release to the accessible environment is from a stack, and atmospheric dispersion is the only radionuclide transport mechanism. The radionuclides under consideration are released at a unit rate of 1 $\mu\text{Ci/sec}$ with 1-hour duration. It is also assumed that the atmospheric dispersion factor at a location of interest is equal to one, that is $\chi/Q = 1 \text{ sec/m}^3$, where χ is the concentration at the location (Ci/m^3), and Q is the release rate (Ci/sec). Since radiation dose is directly proportional to χ/Q , by using this approach the dose fraction (%) through various exposure pathways can be evaluated without specific information about meteorological conditions.

A computer code, GENII-S², was used to calculate the radiation dose. Environmental and agricultural data were taken from the results of a site-specific survey and/or literature survey³. As a design feature of GENII-S, four-season doses were calculated to model a short-term radionuclide release. Seasonal dose effects are due

to different mechanisms of radionuclide accumulation in crops⁴. All applicable pathways were evaluated in order to calculate dose to humans. These pathways were inhalation, ingestion (leafy vegetables, root vegetables, fruit, grain, beef, poultry, milk, egg, drinking water, and soil ingestion), and external (plume submersion and surface soil exposure).

RESULTS AND DISCUSSION

The radiation dose fractions (%) for each pathway for the eight radionuclides in the four seasons are shown in Table 1. For each radionuclide, the highlighted numbers indicate the identified important pathways.

As can be seen, each pathway contributes a different fraction of radiation dose to humans during different seasons. In autumn, consumption of leafy vegetables, beef, and milk contributes more than 90% of the total dose for some radionuclides. Due to model assumptions that a release occurs immediately prior to harvest, the highest dose occurs in autumn. Thus, it is possible that radionuclides on the leafy vegetables are ingested by humans, and radionuclides on fresh forage are ingested by animals eventually contributing to human dose, without radiological and weathering decays. This assumption results in the worst case scenario for the release, which serves as the most conservative radiation dose estimation. In contrast, inhalation and external exposure become the important pathways during the winter, based on the assumption of no leafy vegetables and fresh forage available for consumption at that time. The ingestion pathway is mainly through plant root uptake of radionuclides from the soil for a winter release. The ingestion dose fraction is lowest in the winter, increases during the spring and summer, and is highest in autumn.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DTIC QUALITY INSPECTED 1

MASTER

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

CONCLUSIONS

The calculated dose fractions for the radionuclides of interest show that each pathway contributes a different dose to humans during different seasons. In the worst scenario season, three ingestion pathways, leafy vegetables, beef, and milk consumption, are the critical pathways for potential human dose. Inhalation and soil exposure are important pathways during the winter.

ACKNOWLEDGEMENT

This work was supported by the Yucca Mountain Site Characterization Office as part of the Civilian Radioactive Waste Management Program. This project is managed by the U.S. Department of Energy, Yucca Mountain Site Characterization Project.

REFERENCES

1. U.S. Nuclear Regulatory Commission (1997). *Standard Review Plan for Dry Cask Storage Systems*, NUREG-1536.
2. C.D. Leigh et al. (1993). *User's Guide for GENII-S: A Code for Statistical and Deterministic Simulation of Radiation Doses to Humans from Radionuclides in the Environment*, SAND91-0561/UC-721.
3. YMP Biosphere Working Group (1997). Biosphere Modeling Input Data Files, Internal data collection.
4. B.A. Napier et al. (1988). *GENII - The Hanford Environmental Radiation Dosimetry Software System*, PNL 6584 Vol.1.

Table 1. Dose Fraction (%) by Exposure Pathway and Radionuclide in Four Seasons

<i>Winter</i>	Co-60	I-129	Ru-106	H-3	Cs-134	Cs-137	Sr-90	Kr-85
Inhalation	74.99	50.11	98.73	100.00	37.74	38.44	82.19	0.00
Leafy Veg.	0.07	0.24	0.05	0.00	0.48	0.67	6.23	0.00
Other Veg.	0.03	1.59	0.01	0.00	0.20	0.29	3.14	0.00
Fruit	0.05	2.34	0.02	0.00	1.34	1.91	1.44	0.00
Cereals	0.00	2.42	0.00	0.00	0.10	0.14	1.15	0.00
Meat	0.12	23.37	0.20	0.00	16.63	23.55	2.93	0.00
Poultry	0.02	0.00	0.02	0.00	2.41	3.35	0.02	0.00
Cow Milk	0.01	16.69	0.00	0.00	7.62	10.42	2.69	0.00
Eggs	0.00	1.34	0.00	0.00	0.10	0.15	0.05	0.00
Soil Ing.	0.02	1.67	0.01	0.00	0.10	0.13	0.11	0.00
Water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plume	0.49	0.00	0.02	0.00	0.70	0.38	0.00	100.00
Surface Soil	24.19	0.22	0.94	0.00	32.57	20.57	0.05	0.00
<i>Spring</i>								
Inhalation	54.23	0.49	63.73	100.00	4.46	4.34	24.52	0.00
Leafy Veg.	16.43	18.59	8.43	0.00	15.87	16.40	37.92	0.00
Other Veg.	0.02	0.02	0.01	0.00	0.03	0.03	0.94	0.00
Fruit	0.04	0.02	0.01	0.00	0.17	0.22	0.45	0.00
Cereals	0.00	0.02	0.00	0.00	0.01	0.02	0.34	0.00
Meat	10.58	50.11	27.18	0.00	53.84	54.61	19.77	0.00
Poultry	0.01	0.00	0.02	0.00	0.31	0.38	0.01	0.00
Cow Milk	0.82	30.72	0.00	0.00	21.36	21.60	16.00	0.00
Eggs	0.00	0.01	0.00	0.00	0.01	0.02	0.02	0.00
Soil Ing.	0.01	0.02	0.01	0.00	0.01	0.01	0.03	0.00
Water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plume	0.35	0.00	0.01	0.00	0.08	0.04	0.00	100.00
Surface Soil	17.49	0.00	0.60	0.00	3.85	2.32	0.01	0.00

Table 1. Dose Fraction (%) by Exposure Pathway and Radionuclide in Four Seasons (Cont.)

<i>Summer</i>	Co-60	I-129	Ru-106	H-3	Cs-134	Cs-137	Sr-90	Kr-85
Inhalation	42.42	0.32	54.16	100.00	3.14	2.90	14.64	0.00
Leafy Veg.	12.85	12.27	7.16	0.00	11.19	10.95	22.64	0.00
Other Veg.	4.18	4.32	1.74	0.00	3.39	3.76	7.93	0.00
Fruit	5.96	6.40	2.43	0.00	5.01	5.42	11.09	0.00
Cereals	8.70	9.07	3.75	0.00	7.10	7.98	16.51	0.00
Meat	10.56	41.08	29.27	0.00	45.87	46.76	15.24	0.00
Poultry	0.55	0.00	0.96	0.00	2.50	2.77	0.04	0.00
Cow Milk	0.78	25.61	0.00	0.00	18.90	17.75	11.77	0.00
Eggs	0.03	0.91	0.00	0.00	0.10	0.12	0.11	0.00
Soil Ing.	0.01	0.01	0.00	0.00	0.01	0.01	0.02	0.00
Water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plume	0.28	0.00	0.01	0.00	0.06	0.03	0.00	100.00
Surface Soil	13.68	0.00	0.51	0.00	2.71	1.55	0.01	0.00
<i>Autumn</i>								
Inhalation	8.24	0.02	10.53	3.98	0.29	0.24	1.53	0.00
Leafy Veg.	41.26	16.78	18.59	21.59	16.33	16.01	41.26	0.00
Other Veg.	3.61	1.44	1.61	9.68	1.38	1.39	3.50	0.00
Fruit	5.07	2.04	2.19	20.10	1.97	1.93	4.94	0.00
Cereals	7.81	3.08	3.38	13.65	3.00	2.96	7.62	0.00
Meat	28.67	47.96	62.71	7.20	54.03	54.79	22.53	0.00
Poultry	0.48	0.00	0.88	1.08	0.96	0.92	0.02	0.00
Cow Milk	2.13	28.38	0.01	21.54	21.74	21.60	18.55	0.00
Eggs	0.03	0.30	0.00	1.18	0.04	0.04	0.05	0.00
Soil Ing.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plume	0.05	0.00	0.00	0.00	0.01	0.00	0.00	100.00
Surface Soil	2.66	0.00	0.10	0.00	0.25	0.13	0.00	0.00

M98005501

Report Number (14) CONF-980516--1

Publ. Date (11) 19980513

Sponsor Code (18) DOE/RW, XF

UC Category (19) UC-800, DOE/ER

19980706 072

DOE