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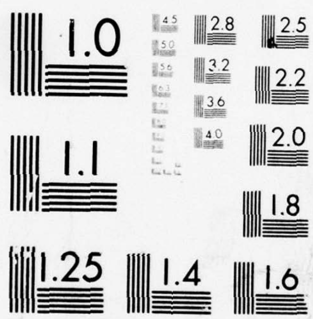

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TECHNICAL REPORT ARBRL-TR-02091

THE EFFECTS OF MOISTURE CONTENT AND SOIL COMPOSITION UPON AIR/GROUND TACTICAL NUCLEAR ENVIRONMENTS

N. E. Banks
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H. Lichtenstein

July 1978

US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The SAMCEP code (BRL CR 330) is used to perform sensitivity studies to determine the effects of moisture content in the air and ground and different ground compositions upon the predicted tactical nuclear environments produced by a nuclear burst. Neutron and secondary gamma fluences, energy deposition rates and Compton electron currents are given for various combinations of 0% - 6% water vapor content of the atmosphere; Nevada Test Site (NTS), typical German dry and German wet soils; and different weapon sources and burst heights.

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1. INTRODUCTION

A series of time-dependent air-over-ground tactical nuclear environment calculations has been performed to assess the effects of moisture content and material composition in the air and ground upon the predicted results. The correlated Monte Carlo code SAMCEP[1] was used to characterize the detailed environments. This code system has been under development for BRL over the past several years by the Mathematical Applications Group, Inc. (MAGI). The basic capabilities of SAMCEP are to predict, in a statistically significant way, the effects of perturbations in the nuclear properties of a transporting medium, upon the neutron and secondary gamma ray fluence and flux. More recently its capabilities have been expanded to include the effects of given perturbations upon neutron energy deposition, gamma-ray ionization and Compton currents for EMP drivers. These quantities or related functionals are needed to derive requirements for lethality[2] and hardening of tactical Army systems.[3]

As a result of the enhanced capabilities of SAMCEP, the Harry Diamond Laboratories[4] requested that sensitivity studies be conducted to determine the effects of moisture content in the air and ground and the effects of the differences in soil composition between the (Nevada Test Site) NTS and West Germany upon the predicted tactical nuclear environments produced by a nuclear burst. At the same time, the HDL employed the MAGI to perform a series of calculations to determine the energy deposition and Compton currents, in standard air and NTS soil, due to neutron and secondary photon interactions from low-altitude nuclear bursts.[5] These calculations were made using the latest version of SAM-CE.[6] In the SAM-CE calculations, three point-isotropic sources of primary neutron radiation were considered:

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[1] *H. Lichtenstein, H. Steinberg, and J. Brooks, "The SAMCEP Neutron and Secondary Gamma Code with Bounded Flux-at-a Point Estimation," BRL CR 330, Feb 1977.* (AD #A036469)

[2] *New York Times and Washington Post, comments on the Effectiveness of Tactical Neutron Bomb.*

[3] *DNA EMP (Electromagnetic Pulse) Handbook, Vol. 3 - Environments and Applications (U), Sep 1974.*

[4] *Private communications with Mr. William T. Wyatt, HDL, Woodbridge, VA, Mar 1976.*

[5] *M.O. Cohen, H.S. Schlechter and H.A. Steinberg, "Time-Dependent Energy Deposition and Compton Electron Currents from Three Selected Low-Altitude Bursts," HDL-CR-76-029-1, Aug 1976.*

[6] *M.O. Cohen et al., "SAM-CE: A Three-Dimensional Monte Carlo Code for the Solution of the Forward Neutron and Forward and Adjoint Gamma Ray Transport Equations - Rev D," MR-702, Oct 1975.*

a. degraded fission weapon[7] at 50-m and 100-m height of burst (HOB)

b. 14-MeV source at a 100-m HOB.

The energy deposition rates and Compton electron sources were determined as a function of time in 74 radial and altitude (r,z) bins surrounding the burst points. The atmosphere was taken to be homogeneous at an assumed density of 1.11 x 10^{-3} g/cm^3. Results were obtained for penetrations in air ranging out to 2.4 km which corresponds to a depth of 266 g/cm^2 at this density.

The scope of work within the AH-75 program did not allow us to perform sensitivity-effects studies for all combinations of HOB and sources that were requested. As a result, one source height-of-burst at 100 metres with a degraded fission spectrum was considered for the perturbation investigations of the transport in moist and dry air with the soil composition that of the NTS. Also a 1-metre HOB calculation was performed with the same source spectrum to investigate the sensitivity of radiation transport in an air/ground geometry to the moisture content in West German soil. A by-product of the above calculations allows a comparison of the radiation transport over NTS and West German soils.

The differential details of the quantities calculated include the energy dependence of the neutron fluence as a function of distance from the burst point at all directions in the atmosphere. Energy deposition rates for both neutrons and secondary photons are calculated for times out to 10 msec in local time. Local time is determined in reference to the arrival of an uncollided photon from the source.

2. COMPUTATIONAL METHODS

The SAMCEP correlated stochastic code has been installed on the BMDATC (ARC) CDC 7600 computer in Huntsville, AL. The installation of the code was achieved via the CDC update utility routines which also facilitate implementation of any subsequent new developments in the code.

SAMCEP is a Monte Carlo neutron and secondary gamma-ray transport code which is designed to calculate differences in fluences and flux functionals, such as dose, as a function of perturbations in the basic nuclear and materials input data. The code is an extension of the SAM-CE Monte Carlo procedure. The mathematical basis for this extension is that several Monte Carlo problems are run simultaneously and, through the use of correlated sampling, differences among the results of these problems are determined. The statistics of the differences

[7] *L. Huser and W. Woolson, "Version 3 of Air Transport of Radiation," DNA 3819F, p. 27, July 1975.*

are on the order of the statistics of the problems themselves and they are achieved with very little time in excess of the execution time for a single problem solution.

Recently, the SAMCEP code has had a major increase in its capabilities:

- 0 Secondary gamma-ray capability
  - o Klein-Nishina scattering algorithms
  - o Algorithms for computing and storing nonelastic interactions
  - o Banding of gamma-ray cross sections
  - o Perturbation of gamma-ray production data
    - o yield
    - o angular distributions
    - o energy
- 0 Neutron slowing-down in air
  - o Generation of a good representation of the secondary gamma-ray source distribution from neutron capture
- 0 Extension of the Bounded Flux-at-a-point estimation (BFAP)
  - o Efficient BFAP at interface between dissimilar media
- 0 A priori angle biasing
  - o A posteriori angle biasing algorithm has been changed to a more effective a priori biasing technique

3. DESCRIPTION OF THE CALCULATIONS

Several series of Monte Carlo calculations have been performed with the improved version of SAMCEP to determine the neutron and secondary gamma-ray fluences, energy deposition rates due to the neutron and secondary gamma-ray interactions, and Compton electron currents for EMP drivers. The neutron and gamma-ray fluences are generated as a function of position and energy integrated over all times. Energy deposition and EMP drivers are predicted as a function of space, energy and time. Sensitivity investigations have been studied to determine the differences in the above environments as a function of the perturbations made in the moisture contents in the air and ground and in the soil composition of NTS and West Germany.

3.1 Sources Considered

The sources of neutrons which are considered in this study are the "S-device" fission spectrum at 14 shakes[8] (see Figure 1), a degraded fission spectrum and a 14-MeV (22.4 pJ) neutron source. The energy groups specified for the S-device were made compatible with those acceptable to the SAMCEP code. Only the results of the calculations for the degraded fission source will be reported in this document. An extensive effort on the 14-MeV source has been reported by ORNL[9] and MAGI.[5] The S-device fission spectrum at 14 shakes is very similar to a Pu fission spectrum. The average energy of the S-device is a little higher than the average energy of the Pu spectrum.

3.2 Air/Ground Geometry

The atmosphere was divided into a cylindrical grid structure for the purpose of tallying the quantities of interest as a function of position. Figure 2 shows the grid structure in the (r,z) plane. Ground level is the abscissa. Distances are indicated in the vertical and horizontal direction in mean-free-paths (mfp) referenced to 14-MeV neutrons. Also mfp in gm/cm^2 are indicated. In order to investigate, in more detail, the behavior of the interesting quantities at the air/ground interface, regions 2, 4 and 10 are further subdivided by a finer mesh. Table 1 shows the finer mesh structure. The mfp for a 14-MeV neutron is approximately 150 metres in normal density air.

3.3 Unperturbed Base Cross Sections and Response Functions

The following data given in Table 2 is the neutron and secondary gamma-ray basic cross section information for the transport processes. The ENDF/B files listed are the latest DNA cross sections as distributed by the Radiation Shielding Information Center, ORNL, Oak Ridge, TN, or by the National Neutron Cross Section Center at Brookhaven. The average range data for the Compton electrons were taken from the work in Reference 5.

The environmental conditions assumed for the unperturbed or base problem are dry atmosphere at 0.328 km (1000 ft.) altitude (NTS altitude) with a density of 1.11×10^{-3} gm/cm^3. The composition of the referenced atmosphere is listed in Table 3. Argon is included only for the transport of photons and the concentrations are changed accordingly.

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[8] *Ltr dtd 20 Aug 1975 from HDL.*

[9] *J.V. Pace III, D.E. Bartine, F.R. Mynatt, "Neutron and Secondary Gamma Ray Transport Calculations for 14-MeV and Fission Neutron Sources in Air-Over-Ground and Air-Over-Seawater Geometry," ORNL TM 4841, 8 Aug 1975.*

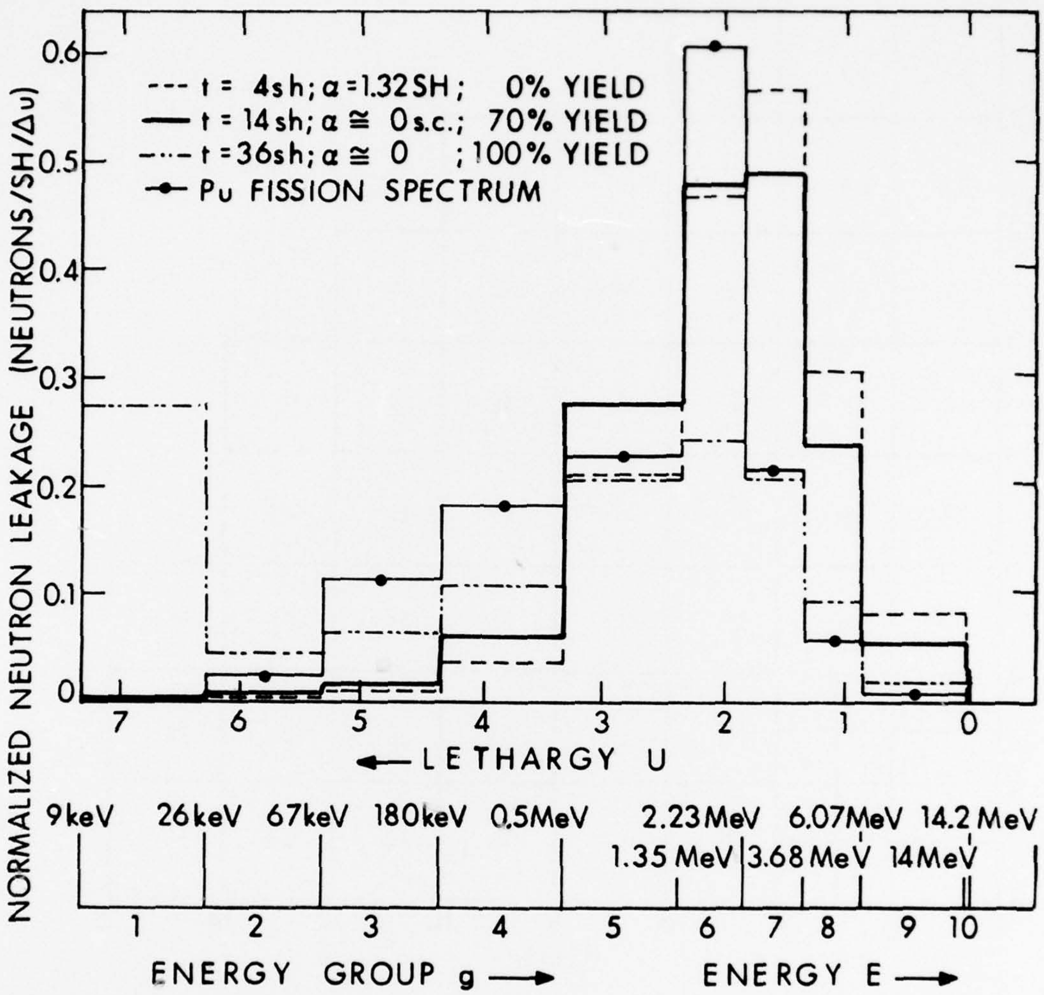

Figure 1. Dynamic HENRE leakage rate spectra of S-device at 4, 14 and 36 shakes.

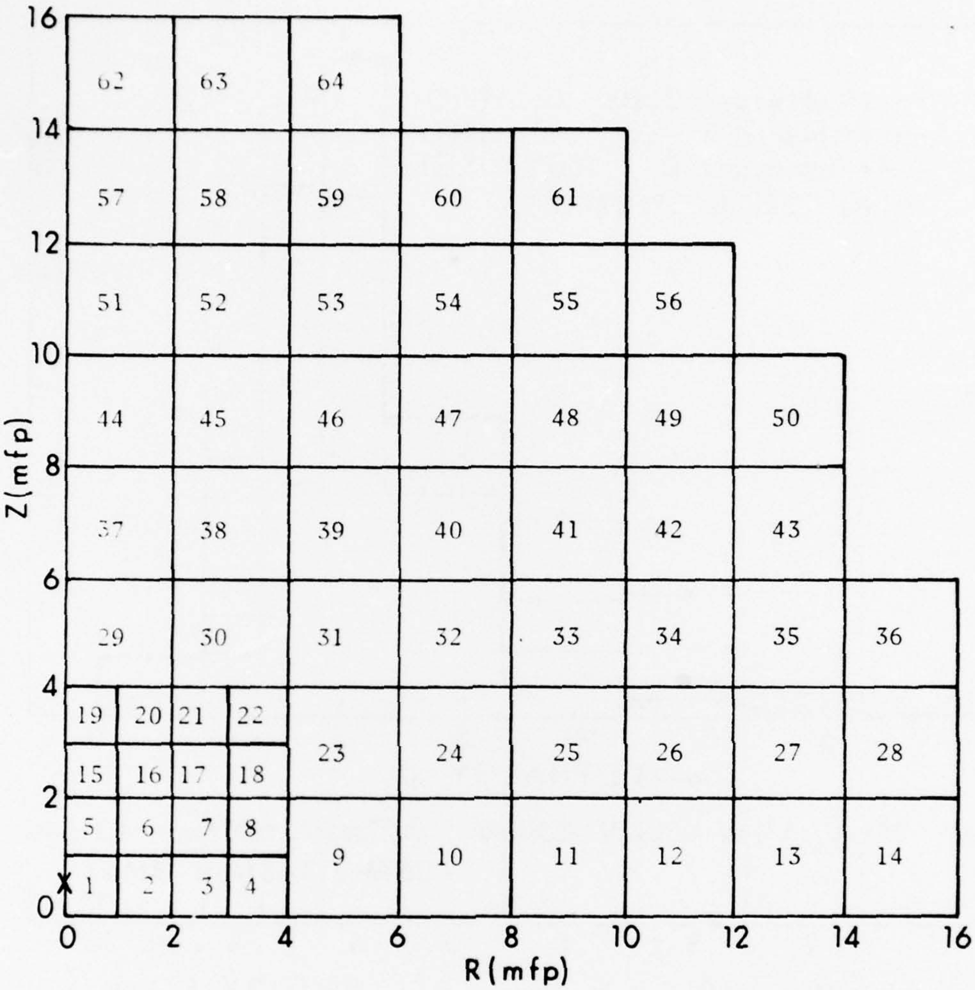

Figure 2. Description of Scoring Regions. Distances are in mean free paths (mfp) for 14-MeV neutrons. In a standard atmosphere, 2 mfp = 300m = 33.3 gm/cm^2. Source is marked with an x at 100m above ground zero.

TABLE 1. Additional Subdivision of Selected Regions Near the Air/Ground Interface

Nominal Region	Subdivisions (Region Number)	Altitude Range (Metres)
2	65	0-25
	66	25-50
	67	50-100
	2	100-150
4	68	0-25
	69	25-50
	70	50-100
	4	100-150
10	71	0-25
	72	25-50
	73	50-100
	74	100-150
	10	150-300

TABLE 2. Cross Section Data Base

Element	Neutron Transport and Photon Production Data	Photon Transport Data
H	DNA 4148-Mod 2	ENDF/B as disseminated by RSIC as Tape DLC-7 D
N	DNA 4133-Mod 4	
O	DNA 4134-Mod 2	
Al	DNA 4135-Mod 2	(all elements including Argon)
Si	DNA 4151-Mod 2	

TABLE 3. Composition of Dry Air ($\rho = 1.11 \times 10^{-3}$ gm/cm^3)

Nuclide	Conc. (Atom/barn·cm)
N	3.625-5*
O	9.725-6

*Read 3.625×10^{-5}

The composition of the ground in the base calculation (unperturbed) for the neutron and photon transport is given in Table 4. The Nevada Test Site and West German soils are used at a density of 1.7 gm/cm^3.

TABLE 4. Composition of Dry Soil ($\rho = 1.7$ gm/cm^3)

Nuclide	Conc. (Atom/barn·cm)	
	NTS	German
H	7.665-3	1.960-3
O	3.5025-2	3.390-2
S	1.258-2	1.750-3
Al	2.824-3	1.219-2

TABLE 5. Compositions for SAMCEP Sensitivity Studies

Nuclide	2% Moist Air	6% Moist Air	German Wet Soil
H	9.193-7	2.758-6	2.151-2
O	9.999-6	1.052-5	3.796-2
Al			1.442-3
Si			1.004-2
N	3.553-5	3.407-5	0.00

3.4 Perturbations in the Environmental Conditions

This sensitivity investigation examines the effects of environmental conditions upon the predicted radiation transport from a nuclear burst. Two perturbations are considered interesting from a tactical Army engagement standpoint. The first perturbation which is considered is the variation of the moisture content in the atmosphere above a ground composition similar to that of the NTS. The second case describes the effects of the moisture content in a soil composition similar to that of the Federal Republic of Germany. For the second study a dry atmosphere above the ground will be assumed. Compositions for the perturbed environments are listed in Table 5. In all the calculations stated above the basic nuclear cross section data are not changed. Only the sensitivity of the nuclear environments to the quantity and type of material constituents in an air-over-ground geometry is calculated.

3.5 Output Quantities Calculated

The primary neutron and secondary gamma-ray fluences are obtained in three spatial locations along the ground and at a 45° angle with the ground in the energy bin structure shown in Table 6. Total fluences were produced from an integration over the total time interval from 0 to 10 msec (local time).

TABLE 6. Energy Bin Structure for SAMCEP Sensitivity Calculations

Energy (MeV)
15.00
12.20
10.00
8.19
6.36
4.97
4.07
3.01
2.46
2.35
1.83
1.11
0.11
0.0335
0.025-6

The energy deposition and deposition rates for the neutrons and for four secondary gamma-ray sources are determined in each of the spatial regions. The time bins over which the rates are predicted are given in Table 7. The radial and polar Compton currents for the base problems

TABLE 7. Time Bin Structure

Time Bin	Time Interval (Local Time)(μsec)
1	0 - .1
2	.1 - .215
3	.215 - .464
4	.464 - 1.
5	1. - 2.15
6	2.15 - 4.64
7	4.64 - 10.
8	10. - 21.5
9	21.5 - 46.4
10	46.4 - 100.
11	100. - 215.
12	215. - 464.
13	464. - 1000.
14	1000. - 2150.
15	2150. - 4640.
16	4640. - 10,000

are calculated and reported in Reference 5. The four components of the secondary gamma sources are as follows:

1. Photons generated by the interaction of "high energy" neutrons ($E > 0.11$ MeV) in the air

2. Photons generated by the interaction of high energy neutrons in the ground

3. Photons generated by the interaction of "low energy" neutrons ($E < 0.11$ MeV) in the air

4. Photons generated by the interaction of low energy neutrons in the ground.

The units of the fluences are neutrons or photons per eV per cm^2 per source neutron. The units of energy deposition rates are

$$(eV/cm^3 \cdot sec \cdot source\ neutron)$$

and the units of both radial and polar currents are

$$(electrons/cm^2 \cdot sec \cdot source\ neutron).$$

4. PRESENTATION AND DISCUSSION OF RESULTS

4.1 General

The problems which are addressed involve difficult Monte Carlo importance sampling strategies and much help was gleaned from the previous work of Reference 5. Answers are needed with low statistical uncertainties, over the entire domain out to 2.4 km and for a long temporal range. Some of the techniques used to ensure adequate solutions include the following:

a. A special tracking procedure for neutrons below the inelastic threshold and a special thermal diffusion model.

b. Energy importance sampling to generate a sufficient number of high energy neutrons for the (degraded fission) source.

c. Energy importance sampling to discriminate against those low energy inelastic neutron collisions which would be unlikely to generate secondary gamma radiation.

d. Spatial importance sampling to generate a sufficient number of neutron high energy interactions at shallow penetrations (since the gamma rays which they generate dominate the temporal ranges).

e. Spatial importance sampling to obtain adequate solutions at the deep penetrations.

f. Spatial importance sampling to "push" a sufficient number of neutron events towards the ground and towards the special subdivided volumes shown in Table 1.

g. Directional importance sampling to discriminate against ground-generated gamma radiation initially headed deeper into the ground.

4.2 100-Metre Height-of-Burst (HOB) Study

4.2.1 100-Metre HOB Study for the Perturbation in the Atmosphere Over the NTS

The SAMCEP code is used to calculate the sensitivity of the transport of neutron and secondary gamma-rays through an atmosphere which is perturbed by moisture. The particular case discussed in this section is for the degraded fission source at a 100-metre HOB above the NTS. In order to bracket the sensitivity of the transport of the neutrons and secondary gamma to this perturbation, the moisture content of the air is varied from 0% (dry) to 6% by volume. Some typical results will be presented in the succeeding paragraphs to illustrate the trends of the data.

Table 8 displays the total neutron fluence as a function of distance from the source in spatial regions located on a 45° angle with respect to the ground. The normal falloff in fluence is seen as a function of distance from the source. However, the fluence falls off more rapidly for the atmosphere with the higher water content, as expected, because the hydrogen which is present thermalizes the neutrons more quickly, thereby reducing the fluence.

TABLE 8. Total Neutron Fluence Vs. Distance for 45° Angle of Elevation Over NTS

Region	Neutron Fluence (Neut./cm^2·Source Neut)		
	Dry Air	2% Moisture	6% Moisture
1	2.356E-09	2.259E-09	2.087E-09
6	3.012E-10	2.570E-10	2.010E-10
17	5.571E-11	4.480E-11	2.850E-11
22	1.209E-11	8.670E-11	4.870E-12
31	1.649E-12	1.061E-12	5.239E-13
40	1.175E-13	6.495E-14	2.872E-14
48	1.061E-14	5.343E-15	2.281E-15

Tables 9-15 show the dependence of the neutron fluence spectrum upon energy and distance from the source for the energy structure chosen in Table 6. Again the effects of moisture content in the atmosphere are apparent. Since region 48 is at approximately 14 mfp from the source for a 14-MeV neutron, the number of mfp at this point for neutrons whose average energy is around 1.0 MeV is much higher. Therefore, the statistics for the quantities listed in Table 15 are quite large for this depth of penetration.

In general, differences in the effects of water content in the atmosphere upon the the transport of the energy dependent neutrons vary by a factor of 2 or more at the lower energies and on the order of 25 percent at the higher energies.

Tables 16-22 show the same type of data along the air/ground interface. These regions are represented by numbers 1, 2 (subdiv. 65), 3, 4 (subdiv. 68), 9, 10 (subdiv. 71), 11 and 12.

The spectral neutron fluence has been folded with several dose response functions, which are tabulated in Table 23, in order to give an indication of how the dose varies with distance from the source. The units of the dose response are given in terms of a unit source strength of neutrons. Table 24 shows the Rad-Si dose as a function of ground range for detectors immediately above the ground (scoring region 0-25m altitude). Table 25 gives the Auxier-Snyder tissue dose response for the same positions along the ground. Tables 26 and 27 exhibit the Rad-Si and tissue dose distributions for the regions which are located at a 45° angle of elevation out to distances of approximately 2 km. A comparison between the results shown in Table 27 and some recent infinite air calculations[10] performed by Science Applications, Inc., shows excellent agreement with the tissue dose in regions 17 and 40.

A discussion is now presented on the results of the neutron energy deposition in each of the scoring regions cited above for the 100-metre HOB case. The neutron energy deposition is needed to infer the total ionization and ionization rate produced by the neutrons directly as opposed to the ionization produced by subsequent gamma rays. Only the energy deposition and deposition rates will be presented in this report since the trends produced by the perturbations in the Compton currents are quite similar and published elsewhere[5].

Table 28 displays the time-integrated neutron energy deposition in the spatial regions located at a 45° angle of elevation for the 100-metre HOB source. The perturbation of the atmosphere considered for the energy deposition calculation is a 6% variation in the water content by volume. The change is equivalent to approximately 3.8% variation in the water content by weight. The appropriate numbers used

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[10] *Private communications with Dr. Bill Woolson, SAI, La Jolla, CA.*

TABLE 9. Energy Dependent Neutron Fluence in Region 1

		Neutron Fluence Vs. Energy ($Neut/eV \cdot cm^2 \cdot Source\ Neut$)		
	Energy (eV)	Dry Air	2% Moist Air	6% Moist Air
1	.14995000E+08			
	.2785E+07†	0.00 (0.00)*	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08			
	.2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08			
	.1813E+07	3.77 - 18** (1.05)	3.76 - 18 (1.05)	3.74 - 18 (1.04)
4	.81870000E+07			
	.1827E+07	7.80 - 18 (1.12)	7.70 - 18 (1.12)	7.78 - 18 (1.11)
5	.63600000E+07			
	.1394E+07	1.54 - 17 (0.87)	1.53 - 17 (0.85)	1.51 - 17 (0.82)
6	.49660000E+07			
	.9000E+06	1.85 - 17 (1.34)	1.83 - 17 (1.30)	1.80 - 17 (1.25)
7	.40660000E+07			
	.1054E+07	5.60 - 17 (0.71)	5.55 - 17 (0.70)	5.46 - 17 (0.72)
8	.30120000E+07			
	.5460E+06	8.42 - 17 (1.31)	8.29 - 17 (1.28)	8.05 - 17 (1.23)
9	.24660000E+07			
	.1160E+06	1.01 - 16 (3.03)	9.89 - 17 (2.97)	9.52 - 17 (2.87)
10	.23500000E+07			
	.5230E+06	2.41 - 16 (1.20)	2.38 - 16 (1.20)	2.31 - 16 (1.22)
11	.18270000E+07			
	.7190E+06	3.51 - 16 (1.10)	3.43 - 16 (1.04)	3.27 - 16 (0.96)
12	.11080000E+07			
	.5578E+06	7.89 - 16 (1.03)	7.65 - 16 (0.96)	7.21 - 16 (0.88)
13	.55020000E+06			
	.4391E+06	1.32 - 16 (1.00)	1.27 - 15 (1.04)	1.17 - 15 (1.21)
14	.11110000E+06			
	.1077E+06	7.26 - 15 (2.49)	6.78 - 15 (1.83)	5.97 - 15 (1.88)
15	.33550000E+04			
	.3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.25300000E-01			

† Energy bin width

* Quantity in parenthesis indicates fractional s.d. x 100%

** Read as 3.77 x 10^{-18}

TABLE 10. Energy Dependent Neutron Fluence in Region 6.

Energy (eV)			Neutron Fluence Vs. Energy ($Neut/eV \cdot cm^2 \cdot Source\ Neut$)		
			Dry Air	2% Moist Air	6% Moist Air
1	.1499500E+08	.2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.1221000E+08	.2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.1000000E+08	.1813E+07	1.94 - 19 (5.70)	1.91 - 19 (5.68)	1.86 - 19 (5.65)
4	.8187000E+07	.1827E+07	4.99 - 19 (3.71)	4.90 - 19 (3.72)	4.73 - 19 (3.81)
5	.6360000E+07	.1394E+07	1.18 - 18 (4.68)	1.15 - 18 (4.62)	1.09 - 18 (4.52)
6	.4966000E+07	.9000E+06	1.45 - 18 (3.89)	1.41 - 18 (3.69)	1.33 - 18 (3.59)
7	.4066000E+07	.1054E+07	3.22 - 18 (4.62)	3.12 - 18 (4.46)	2.94 - 18 (4.17)
8	.3012000E+07	.5460E+06	6.78 - 18 (3.25)	6.52 - 18 (3.27)	6.04 - 18 (3.38)
9	.2466000E+07	.1160E+06	9.94 - 18 (9.28)	9.52 - 18 (9.02)	8.59 - 18 (8.56)
10	.2350000E+07	.5230E+06	1.64 - 17 (5.89)	1.58 - 17 (5.50)	1.45 - 17 (4.97)
11	.1827000E+07	.7190E+06	3.57 - 17 (3.55)	3.28 - 17 (3.54)	2.79 - 17 (3.61)
12	.1108000E+07	.5578E+06	8.84 - 17 (2.81)	7.90 - 17 (2.68)	6.38 - 17 (2.86)
13	.5502000E+06	.4391E+06	2.05 - 16 (3.19)	1.75 - 16 (3.26)	1.36 - 16 (3.54)
14	.1111000E+06	.1077E+06	1.07 - 15 (5.11)	8.54 - 16 (4.33)	6.21 - 16 (4.21)
15	.3355000E+04	.3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.2530000E-01				

TABLE 11. Energy Dependent Neutron Fluence in Region 17

	Energy (eV)	Neutron Fluence vs. Energy (Neut/eV·cm^2·Source Neut)		
		Dry Air	2% Moist Air	6% Moist Air
1	.14995000E+08			
	.2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08			
	.2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08			
	.1813E+07	2.67 - 20 (17.66)	2.59 - 20 (17.42)	2.44 - 20 (16.96)
4	.81870000E+07			
	.1827E+07	7.88 - 20 (5.13)	7.67 - 20 (5.32)	7.26 - 20 (5.66)
5	.63600000E+07			
	.1394E+07	1.87 - 19 (5.49)	1.80 - 19 (4.82)	1.66 - 19 (3.86)
6	.49660000E+07			
	.9000E+06	2.61 - 19 (8.07)	2.50 - 19 (7.86)	2.30 - 19 (7.56)
7	.40660000E+07			
	.1054E+07	3.73 - 19 (9.54)	3.55 - 19 (9.44)	3.26 - 19 (9.24)
8	.30120000E+07			
	.5460E+06	1.09 - 18 (5.34)	1.02 - 18 (5.29)	8.83 - 19 (5.66)
9	.24660000E+07			
	.1160E+06	1.32 - 18 (24.13)	1.25 - 18 (22.17)	1.13 - 18 (20.27)
10	.23500000E+07			
	.5230E+06	2.43 - 18 (10.28)	2.27 - 18 (10.47)	1.97 - 18 (11.51)
11	.18270000E+07			
	.7190E+06	5.26 - 18 (5.06)	4.58 - 18 (4.99)	3.50 - 18 (5.53)
12	.11080000E+07			
	.5578E+06	1.53 - 17 (4.59)	1.27 - 17 (4.31)	8.80 - 18 (5.67)
13	.55020000E+06			
	.4391E+06	3.72 - 17 (4.95)	2.92 - 17 (4.95)	1.92 - 17 (5.88)
14	.11110000E+06			
	.1077E+06	1.99 - 16 (7.04)	1.37 - 16 (4.30)	7.47 - 16 (6.54)
15	.3355000E+04			
	.3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.2530000E-01			

TABLE 12. Energy Dependent Neutron Fluence in Region 22

	Energy (eV)		Neutron Fluence Vs. Energy (Neut/eV·cm^2·Source Neut) Dry Air	2% Moist Air	6% Moist Air
1	.14995000E+08	.2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08	.2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08	.1813E+07	5.31 - 21 (19.47)	5.08 - 21 (19.53)	4.65 - 21 (19.69)
4	.81870000E+08	.1824E+07	1.83 - 20 (10.43)	1.76 - 20 (9.72)	1.63 - 20 (8.37)
5	.63600000E+07	.1054E+07	4.25 - 20 (5.85)	4.05 - 20 (5.00)	3.68 - 20 (4.17)
6	.49660000E+07	.9000E+06	6.03 - 20 (12.75)	5.68 - 20 (12.86)	5.03 - 20 (13.28)
7	.40660000E+07	.1054E+07	7.05 - 20 (8.36)	6.70 - 20 (8.91)	6.05 - 20 (9.66)
8	.30120000E+07	.5460E+06	2.08 - 19 (4.25)	1.89 - 19 (4.13)	1.55 - 19 (4.61)
9	.24660000E+07	.1160E+06	4.63 - 19 (16.10)	4.19 - 19 (13.04)	3.50 - 19 (17.57)
10	.23500000E+07	.5230E+06	5.24 - 19 (11.76)	4.72 - 19 (11.99)	3.85 - 19 (13.74)
11	.18270000E+07	.5578E+06	1.15 - 18 (6.63)	9.56 - 19 (6.82)	6.61 - 19 (8.21)
12	.11080000E+07	.5578E+06	3.31 - 18 (1.78)	2.57 - 18 (1.71)	1.60 - 18 (3.85)
13	.55020000E+06	.4391E+06	8.70 - 18 (1.84)	6.21 - 18 (2.08)	3.41 - 18 (2.55)
14	.11110000E+06	.1077E+06	4.58 - 17 (9.01)	2.97 - 17 (8.54)	1.37 - 17 (15.97)
15	.33550000E+04	.3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.25300000E-01				

TABLE 13. Energy Dependent Neutron Fluence in Region 31

Energy (eV)		Neutron Fluence Vs. Energy (Neut/eV·cm²·Source Neut) Dry Air	2% Moist Air	6% Moist Air
1	.14995000E+08 .2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08 .2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08 .1813E+07	8.22 - 22 (14.53)	7.74 - 22 (14.58)	6.88 - 22 (14.74)
4	.81870000E+07 .1827E+07	2.87 - 21 (9.03)	2.70 - 21 (8.36)	2.34 - 21 (7.27)
5	.63600000E+07 .1394E+07	7.59 - 21 (5.22)	7.09 - 21 (4.45)	6.17 - 21 (4.17)
6	.49660000E+07 .9000E+06	1.24 - 20 (6.85)	1.14 - 20 (6.16)	9.61 - 21 (6.22)
7	.40660000E+07 .1054E+07	8.86 - 21 (1.97)	8.33 - 21 (2.14)	7.30 - 21 (6.45)
8	.30120000E+07 .5460E+06	2.66 - 20 (9.63)	2.34 - 20 (10.05)	1.94 - 20 (11.29)
9	.24660000E+07 .1160E+06	5.24 - 20 (11.03)	4.63 - 20 (12.14)	3.72 - 20 (16.51)
10	.23500000E+07 .5230E+06	7.00 - 20 (8.01)	5.85 - 20 (6.73)	4.15 - 20 (5.50)
11	.18270000E+07 .7190E+06	1.26 - 19 (6.21)	9.84 - 20 (6.59)	6.42 - 20 (7.78)
12	.11080000E+07 .5578E+06	3.88 - 19 (4.85)	2.83 - 19 (3.75)	1.61 - 19 (2.77)
13	.55020000E+06 .4391E+06	1.14 - 18 (3.11)	7.82 - 19 (2.45)	3.88 - 19 (4.19)
14	.11110000E+06 .1077E+06	6.93 - 18 (6.57)	3.76 - 18 (5.93)	1.40 - 18 (10.68)
15	.3355000E+04 .3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.2530000E-01			

TABLE 14. Energy Dependent Neutron Fluence in Region 40

		Neutron Fluence Vs. Energy ($Neut/eV \cdot cm^2 \cdot Source\ Neut$)		
	Energy (eV)	Dry Air	2% Moist Air	6% Moist Air
1	.14995000E+08 .2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08 .2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08 .1813E+07	6.24 - 23 (27.25)	5.75 - 23 (27.41)	4.92 - 23 (27.76)
4	.81870000E+08 .1827E+07	3.23 - 22 (9.50)	2.89 - 22 (9.30)	2.33 - 22 (9.02)
5	.63600000E+07 .1054E+07	6.63 - 22 (8.16)	5.87 - 21 (7.37)	4.61 - 22 (6.09)
6	.49660000E+07 .9000E+06	1.10 - 21 (12.62)	1.00 - 21 (9.84)	8.11 - 22 (7.83)
7	.40660000E+07 .1054E+07	9.09 - 22 (18.01)	7.79 - 22 (15.32)	5.72 - 22 (11.94)
8	.30120000E+07 .5460E+06	2.24 - 21 (15.63)	1.93 - 21 (13.53)	1.40 - 21 (10.81)
9	.24660000E+07 .1160E+06	3.99 - 21 (19.01)	3.22 - 21 (20.01)	2.11 - 21 (22.07)
10	.23500000E+07 .5230E+06	4.66 - 21 (10.71)	3.54 - 21 (11.29)	2.13 - 21 (11.14)
11	.18270000E+07 .5578E+06	8.63 - 21 (17.37)	6.26 - 21 (17.28)	3.43 - 21 (17.29)
12	.11080000E+07 .5578E+06	2.69 - 20 (11.37)	1.69 - 20 (12.40)	7.52 - 21 (15.25)
13	.55020000E+06 .4391E+06	8.20 - 20 (5.14)	4.36 - 20 (7.11)	1.80 - 20 (20.03)
14	.11110000E+06 .1077E+06	4.98 - 19 (12.40)	2.36 - 19 (11.96)	8.85 - 20 (22.16)
15	.33550000E+04 .3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.25300000E-01			

TABLE 15. Energy Dependent Neutron Fluence in Region 48

	Energy (eV)	Neutron Fluence Vs. Energy (Neut/eV·cm^2·Source Neut)		
		Dry Air	2% Moist Air	6% Moist Air
1	.14995000E+08			
	.2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08			
	.2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08			
	.1813E+07	9.43 - 24 (70.93)	8.48 - 24 (70.70)	6.88 - 24 (70.20)
4	.81870000E+08			
	.1827E+07	2.91 - 23 (22.21)	2.52 - 23 (22.21)	1.87 - 23 (22.23)
5	.63600000E+07			
	.1054E+07	7.57 - 23 (38.11)	6.28 - 23 (37.30)	4.34 - 23 (35.81)
6	.49660000E+07			
	.9000E+06	1.49 - 22 (38.12)	1.26 - 22 (38.03)	8.89 - 23 (39.03)
7	.40660000E+07			
	.1054E+07	7.64 - 23 (39.20)	7.43 - 23 (37.16)	5.81 - 23 (41.95)
8	.30120000E+07			
	.5460E+06	2.00 - 22 (37.46)	1.67 - 22 (30.14)	1.06 - 22 (25.42)
9	.24660000E+07			
	.1160E+06	7.57 - 22 (32.03)	6.04 - 22 (23.44)	3.67 - 22 (19.86)
10	.23500000E+07			
	.5230E+06	5.15 - 22 (54.93)	4.44 - 22 (46.54)	2.70 - 22 (42.26)
11	.18270000E+07			
	.7190E+06	5.01 - 22 (33.68)	5.56 - 22 (38.10)	4.24 - 22 (44.30)
12	.11080000E+07			
	.5578E+06	1.29 - 21 (32.78)	8.56 - 22 (20.02)	4.64 - 22 (34.02)
13	.55020000E+06			
	.4391E+06	6.02 - 21 (25.56)	3.04 - 21 (20.99)	1.08 - 21 (38.98)
14	.11110000E+06			
	.1077E+06	5.59 - 20 (39.66)	2.27 - 20 (21.21)	7.01 - 21 (49.82)
15	.33550000E+04			
	.3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.25300000E-01			

TABLE 16. Energy Dependent Neutron Fluence in Region 2 (Subdivision 65)

	Energy (eV)	Neutron Fluence Vs. Energy ($Neut/eV.cm^2 \cdot Source\ Neut$)		
		Dry Air	2% Moist Air	6% Moist Air
1	.14995000E+08 .2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08 .2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08 .1813E+07	2.58 - 19 (6.25)	2.55 - 19 (6.15)	2.47 - 19 (5.98)
4	.81870000E+08 .1827E+07	6.15 - 19 (5.53)	6.02 - 19 (5.51)	5.81 - 19 (5.50)
5	.63600000E+07 .1394E+07	1.27 - 18 (5.76)	1.24 - 18 (5.71)	1.18 - 18 (5.64)
6	.49660000E+07 .9000E+06	1.92 - 18 (6.84)	1.86 - 18 (6.71)	1.77 - 18 (6.53)
7	.40660000E+07 .1054E+07	3.68 - 18 (3.92)	3.60 - 18 (3.79)	3.47 - 18 (3.69)
8	.30120000E+07 .5460E+06	8.05 - 18 (4.43)	7.79 - 18 (4.36)	7.32 - 18 (4.41)
9	.24660000E+07 .1160E+06	1.22 - 17 (15.99)	1.16 - 17 (15.59)	1.06 - 17 (14.87)
10	.23500000E+07 .5230E+06	1.79 - 17 (4.94)	1.71 - 17 (5.11)	1.55 - 17 (5.44)
11	.18270000E+07 .7190E+06	3.62 - 17 (5.06)	3.40 - 17 (4.87)	3.00 - 17 (4.80)
12	.11080000E+07 .5578E+06	9.58 - 17 (3.31)	8.88 - 17 (3.13)	7.68 - 17 (3.42)
13	.55020000E+06 .4391E+06	2.02 - 16 (3.45)	1.81 - 16 (3.21)	1.50 - 16 (3.60)
14	.11110000E+06 .1077E+06	9.32 - 16 (8.26)	8.53 - 16 (6.18)	6.88 - 16 (5.29)
15	.33550000E+04 .3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.25300000E-01			

TABLE 17. Energy Dependent Neutron Fluence in Region 3

	Energy (eV)	Neutron Fluence Vs. Energy (Neut/eV·cm^2·Source Neut) Dry Air	2% Moist Air	6% Moist Air
1	.14995000E+08 .2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08 .2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08 .1813E+07	5.51 - 20 (6.79)	5.44 - 20 (6.68)	5.31 - 20 (6.56)
4	.81870000E+08 .1827E+07	1.58 - 19 (6.60)	1.53 - 19 (6.33)	1.46 - 19 (5.88)
5	.63600000E+07 .1394E+07	3.63 - 19 (3.45)	3.50 - 19 (3.51)	3.26 - 19 (3.72)
6	.49660000E+07 .9000E+06	5.23 - 19 (7.32)	4.97 - 19 (7.23)	4.49 - 19 (7.17)
7	.40660000E+07 .1054E+07	8.59 - 19 (6.76)	8.18 - 19 (6.63)	7.45 - 19 (6.51)
8	.30120000E+07 .5460E+06	2.23 - 18 (5.68)	2.09 - 18 (5.50)	1.86 - 18 (5.19)
9	.24660000E+07 .1160E+06	4.11 - 18 (14.73)	3.77 - 18 (14.53)	3.20 - 18 (14.16)
10	.23500000E+07 .5230E+06	4.63 - 18 (8.53)	4.33 - 18 (8.17)	3.78 - 18 (7.69)
11	.18270000E+07 .7190E+06	9.64 - 18 (5.64)	8.88 - 18 (5.42)	7.52 - 18 (5.19)
12	.11080000E+07 .5578E+06	2.52 - 17 (4.31)	2.24 - 17 (4.13)	1.76 - 17 (4.39)
13	.55020000E+06 .4391E+06	5.73 - 17 (3.93)	4.81 - 17 (2.83)	3.55 - 17 (4.16)
14	.11110000E+06 .1077E+06	3.10 - 15 (6.81)	2.42 - 16 (4.00)	1.69 - 16 (6.19)
15	.33550000E+04 .3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00))
16	.25300000E-01			

TABLE 18. Energy Dependent Neutron Fluence in Region 4 (Subdivision 68)

	Energy (eV)	Neutron Fluence Vs. Energy (Neut/eV·cm^2·Source Neut)		
		Dry Air	2% Moist Air	6% Moist Air
1	.14995000E+08			
	.2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08			
	.2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08			
	.1813E+07	1.62 - 20 (28.44)	1.57 - 20 (28.15)	1.47 - 20 (27.59)
4	.81870000E+08			
	.1827E+07	5.19 - 20 (18.49)	4.95 - 20 (18.32)	4.50 - 20 (17.97)
5	.63600000E+07			
	.1394E+07	9.71 - 20 (12.39)	9.28 - 20 (12.27)	8.50 - 20 (12.31)
6	.49660000E+07			
	.9000E+06	1.58 - 19 (18.74)	1.48 - 19 (18.00)	1.30 - 19 (16.66)
7	.40660000E+07			
	.1054E+07	1.66 - 19 (18.38)	1.56 - 19 (17.62)	1.38 - 19 (16.62)
8	.30120000E+07			
	.5460E+06	5.19 - 19 (10.25)	4.72 - 19 (9.83)	3.93 - 19 (9.18)
9	.24660000E+07			
	.1160E+06	9.99 - 19 (28.13)	9.16 - 19 (25.63)	7.89 - 19 (22.41)
10	.23500000E+07			
	.5230E+06	9.19 - 19 (16.59)	8.66 - 19 (14.79)	7.63 - 19 (13.92)
11	.18270000E+07			
	.7190E+06	2.07 - 18 (7.25)	1.87 - 18 (7.24)	1.51 - 18 (8.77)
12	.11080000E+07			
	.5578E+06	6.26 - 18 (6.13)	5.34 - 18 (5.66)	3.86 - 18 (9.16)
13	.55020000E+06			
	.4391E+06	1.40 - 17 (6.49)	1.11 - 17 (7.27)	6.99 - 18 (9.29)
14	.11110000E+06			
	.1077E+06	5.96 - 17 (10.17)	5.58 - 17 (13.50)	3.28 - 17 (13.39)
15	.33550000E+04			
	.3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.25300000E-01			

TABLE 19. Energy Dependent Neutron Fluence in Region 9

		Neutron Fluence Vs. Energy (Neut/eV·cm^2·Source Neut)		
	Energy (eV)	Dry Air	2% Moist Air	6% Moist Air
1	.14995000E+08			
	.2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08			
	.2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08			
	.1813E+07	2.51 - 21 (7.55)	2.41 - 21 (7.44)	2.21 - 21 (7.22)
4	.81870000E+08			
	.1827E+07	1.14 - 20 (7.53)	1.10 - 20 (7.39)	1.03 - 20 (7.13)
5	.63600000E+07			
	.1054E+07	2.61 - 20 (8.32)	2.50 - 20 (8.85)	2.28 - 20 (9.76)
6	.49660000E+07			
	.9000E+06	4.28 - 20 (4.40)	3.99 - 20 (4.49)	3.46 - 20 (4.89)
7	.40660000E+07			
	.1054E+07	4.08 - 20 (3.91)	3.75 - 20 (3.10)	3.18 - 20 (2.43)
8	.30120000E+07			
	.5460E+06	1.15 - 19 (6.38)	1.03 - 19 (6.64)	8.29 - 20 (6.97)
9	.24660000E+07			
	.1160E+06	2.61 - 19 (16.37)	2.34 - 19 (14.28)	1.86 - 19 (12.00)
10	.23500000E+07			
	.5230E+06	3.03 - 19 (8.56)	2.64 - 19 (7.81)	2.02 - 19 (8.28)
11	.18270000E+07			
	.7190E+06	5.43 - 19 (4.12)	4.62 - 19 (4.84)	3.38 - 19 (7.96)
12	.11080000E+07			
	.5578E+06	1.50 - 18 (4.12)	1.17 - 18 (3.44)	7.32 - 19 (2.92)
13	.55020000E+06			
	.4391E+06	4.15 - 18 (4.63)	2.92 - 18 (4.16)	1.61 - 18 (4.04)
14	.11110000E+06			
	.1077E+06	2.23 - 17 (3.38)	1.35 - 17 (4.19)	6.48 - 18 (6.88)
15	.33550000E+04			
	.3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.25300000E-01			

TABLE 20. Energy Dependent Neutron Fluence in Region 10 (Subdivision 71)

	Energy (eV)	Neutron Fluence Vs. Energy (Neut/eV·cm²·Source Neut)		
		Dry Air	2% Moist Air	6% Moist Air
1	.14995000E+08 .2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08 .2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08 .1813E+07	1.80 - 22 (66.44)	1.66 - 22 (66.45)	1.42 - 22 (66.46)
4	.81870000E+08 .1827E+07	1.33 - 21 (22.01)	1.24 - 21 (21.54)	1.08 - 21 (20.68)
5	.63600000E+07 .1054E+07	2.78 - 21 (4.65)	2.58 - 21 (4.99)	2.21 - 21 (6.84)
6	.49660000E+07 .9000E+06	5.20 - 21 (9.04)	4.86 - 21 (6.85)	4.21 - 21 (4.45)
7	.40660000E+07 .1054E+07	3.12 - 21 (8.16)	2.81 - 21 (5.78)	2.28 - 21 (9.86)
8	.30120000E+07 .5460E+06	9.40 - 21 (13.03)	8.07 - 21 (13.81)	6.06 - 21 (15.87)
9	.24660000E+07 .1160E+06	1.29 - 29 (29.70)	1.30 - 20 (27.46)	1.23 - 20 (34.06)
10	.23500000E+07 .5230E+06	1.75 - 20 (17.95)	1.47 - 20 (12.06)	1.02 - 20 (7.54)
11	.18270000E+07 .7190E+06	4.34 - 20 (11.23)	3.20 - 20 (10.02)	1.80 - 20 (13.21)
12	.11080000E+07 .5578E+06	1.27 - 19 (20.99)	9.28 - 20 (18.01)	5.03 - 20 (16.91)
13	.55020000E+06 .4391E+06	2.40 - 19 (10.05)	1.86 - 19 (9.00)	8.28 - 20 (4.07)
14	.11110000E+06 .1077E+06	1.30 - 18 (24.24)	8.11 - 19 (22.12)	3.81 - 19 (10.07)
15	.33550000E+04 .3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.25300000E-01			

TABLE 21. Energy Dependent Neutron Fluence in Region 11

	Energy (eV)	Neutron Fluence Vs. Energy (Neut/eV·cm^2·Source Neut)		
		Dry Air	2% Moist Air	6% Moist Air
1	.14995000E+08			
	.2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08			
	.2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08			
	.1813E+07	7.50 - 23 (19.83)	6.89 - 23 (19.23)	5.84 - 23 (17.93)
4	.81870000E+08			
	.1827E+07	2.57 - 22 (12.67)	2.37 - 22 (12.01)	2.02 - 22 (10.85)
5	.63600000E+07			
	.1394E+07	7.96 - 22 (9.91)	7.28 - 22 (9.62)	6.11 - 21 (9.45)
6	.49660000E+07			
	.9000E+06	1.62 - 21 (13.51)	1.42 - 21 (13.16)	1.10 - 21 (12.85)
7	.40660000E+07			
	.1054E+07	7.61 - 22 (8.35)	6.89 - 22 (7.15)	5.66 - 22 (7.37)
8	.30120000E+07			
	.5460E+06	2.38 - 21 (4.96)	2.02 - 21 (4.98)	1.50 - 21 (7.35)
9	.24660000E+07			
	.1160E+06	3.73 - 21 (21.81)	3.28 - 21 (23.90)	2.53 - 21 (25.72)
10	.23500000E+07			
	.5230E+06	5.36 - 21 (13.38)	4.60 - 21 (12.46)	3.32 - 21 (14.97)
11	.18270000E+07			
	.7190E+06	9.69 - 21 (17.48)	7.33 - 21 (16.35)	4.27 - 21 (16.70)
12	.11080000E+07			
	.5578E+06	2.45 - 20 (10.22)	1.68 - 20 (10.11)	8.11 - 21 (10.53)
13	.55020000E+06			
	.4391E+06	6.26 - 20 (7.38)	3.82 - 20 (8.65)	1.84 - 20 (14.18)
14	.11110000E+06			
	.1077E+06	3.22 - 19 (7.15)	1.78 - 19 (8.49)	6.79 - 20 (19.86)
15	.33550000E+04			
	.3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.25300000E-01			

TABLE 22. Energy Dependent Neutron Fluence in Region 12

	Energy (eV)	Neutron Fluence Vs. Energy (Neut/eV·cm^2·Source Neut) Dry Air	2% Moist Air	6% Moist Air
1	.14995000E+08 .2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08 .2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08 .1813E+07	1.50 - 23 (35.56)	1.36 - 23 (35.46)	1.14 - 23 (35.33)
4	.81870000E+08 .1827E+07	5.07 - 23 (17.99)	4.54 - 23 (17.16)	3.65 - 23 (15.75)
5	.63600000E+07 .1394E+07	1.44 - 22 (17.68)	1.31 - 22 (16.80)	1.07 - 22 (16.23)
6	.49660000E+07 .9000E+06	3.36 - 22 (12.62)	2.77 - 22 (12.02)	1.88 - 22 (11.89)
7	.40660000E+07 .1054E+07	2.33 - 22 (17.09)	1.87 - 22 (16.30)	1.25 - 22 (16.83)
8	.30120000E+07 .5460E+06	3.23 - 22 (18.66)	2.57 - 22 (19.53)	1.73 - 22 (21.99)
9	.24660000E+07 .1160E+06	1.27 - 21 (31.95)	1.17 - 21 (33.72)	8.89 - 22 (37.71)
10	.23500000E+07 .5230E+06	1.24 - 21 (31.31)	1.08 - 21 (29.42)	7.67 - 22 (29.82)
11	.18270000E+07 .7190E+06	1.67 - 21 (29.85)	1.14 - 21 (29.49)	5.71 - 22 (31.05)
12	.11080000E+07 .5578E+06	3.74 - 21 (17.05)	2.37 - 21 (20.35)	1.20 - 21 (33.74)
13	.55020000E+06 .4391E+06	8.15 - 21 (10.26)	4.13 - 21 (12.72)	1.61 - 21 (23.67)
14	.11110000E+06 .1077E+06	6.41 - 20 (23.54)	2.07 - 20 (28.45)	8.97 - 21 (51.14)
15	.33550000E+04 .3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.25300000E-01			

TABLE 23. Energy Dependent Dose Response Functions

	Energy (eV)	Rad-Si $Neut/cm^2$	Auxier-Snyder Tissue Dose $[Rad/(Neut/cm^2)]$
1	.14995000E+08		
	.2785E+07	0.86 - 9	0.761 - 8
2	.12210000E+08		
	.2210E+07	0.99 - 9	0.668 - 8
3.	.10000000E+08		
	.1813E+07	0.81 - 9	0.616 - 8
4	.81870000E+07		
	.1827E+07	0.55 - 9	0.587 - 8
5	.63600000E+07		
	.1394E+07	0.16 - 9	0.556 - 8
6	.49660000E+07		
	.9000E+06	0.90 - 10	0.515 - 8
7	.40660000E+07		
	.1054E+07	0.54 - 10	0.455 - 8
8	.30120000E+07		
	.5460E+06	0.36 - 10	0.403 - 8
9	.24660000E+07		
	.1160E+06	0.30 - 10	0.383 - 8
10	.23500000E+07		
	.5230E+06	0.27 - 10	0.374 - 8
11	.18270000E+07		
	.7190E+06	0.21 - 10	0.352 - 8
12	.11080000E+07		
	.5578E+06	0.17 - 10	0.292 - 8
13	.55020000E+06		
	.4391E+06	0.14 - 10	0.147 - 8
14	.11110000E+06		
	.1077E+06	0.00	0.521 - 9
15	.33550000E+04		
	.3355E+04	0.00	0.495 - 9
16	.25300000E-01		

TABLE 24. Effects of Water Content in the Atmosphere on the Rad-Si Neutron Dose Distribution for Air-Over-Ground (Along the Ground)

Region	Distance (m)	Dry Air	2% Moist	2% Moist / Dry Air	6% Moist	6% Moist / Dry Air
1	75	4.78 - 20 (0.45)	4.70 - 20 (0.44)	.981	4.53 - 20 (0.46)	.947
2(65)	225	4.79 - 21 (1.42)	4.51 - 21 (1.42)	.943	4.05 - 21 (1.38)	.846
3	375	1.27 - 21 (1.83)	1.16 - 21 (2.05)	.914	9.76 - 22 (2.38)	.768
4(68)	525	3.23 - 22 (5.97)	2.86 - 22 (6.62)	.884	2.28 - 22 (7.45)	.705
9	750	8.21 - 23 (3.51)	6.82 - 23 (3.08)	.829	5.03 - 23 (3.21)	.612
10(71)	1050	6.94 - 24 (8.12)	5.54 - 24 (8.20)	.798	3.83 - 24 (8.47)	.551
11	1350	1.62 - 24 (7.63)	1.28 - 24 (8.21)	.790	8.85 - 25 (8.47)	.546
12	1650	2.84 - 25 (11.40)	2.17 - 25 (11.35)	.764	1.47 - 25 (11.23)	.516

TABLE 25. Effects of Water Content in the Atmosphere on the Auxier-Snyder Tissue Dose Distribution for Air-Over-Ground (Along the Ground)

Region	Distance (m)	Dry Air	2% Moist	2% Moist / Dry Air	6% Moist	6% Moist / Dry Air
1	75	4.73 - 18 (0.71)	4.66 - 18 (0.68)	.971	4.35 - 18 (0.69)	.919
2(65)	225	5.34 - 19 (1.85)	4.96 - 19 (1.75)	.929	4.30 - 19 (1.89)	.806
3	375	1.47 - 19 (2.29)	1.30 - 19 (2.44)	.880	1.03 - 19 (2.68)	.702
4(68)	525	3.62 - 20 (4.25)	2.96 - 20 (4.19)	.819	2.10 - 20 (4.51)	.580
9	750	9.45 - 21 (2.67)	7.27 - 21 (2.17)	.769	4.73 - 21 (1.90)	.500
10(71)	1050	7.05 - 22 (5.45)	5.09 - 22 (4.62)	.721	3.00 - 22 (2.45)	.424
11	1350	1.61 - 22 (6.56)	1.14 - 22 (8.39)	.708	6.59 - 23 (10.07)	.409
12	1650	2.74 - 23 (13.66)	1.76 - 23 (14.86)	.642	1.00 - 23 (18.84)	.365

TABLE 26. Effects of Water Content in the Atmosphere on the Rad-Si Tissue Dose Distribution for Air-Over-Ground (45° Elevation)

Region	Distance (m)	Dry Air	2% Moist	2% Moist / Dry Air	6% Moist	6% Moist / Dry Air
1	75	4.78 - 20 (0.45)	4.70 - 20 (0.44)	.981	4.53 - 20 (0.46)	.947
6	320	4.39 - 21 (1.49)	4.02 - 21 (1.45)	.918	3.48 - 21 (1.55)	.793
17	460	1.27 - 21 (2.02)	1.08 - 21 (2.67)	.854	8.28 - 22 (2.85)	.654
22	740	1.50 - 22 (3.52)	1.31 - 22 (3.61)	.822	9.47 - 23 (4.91)	.593
31	1050	2.16 - 23 (1.10)	1.73 - 23 (1.82)	.800	1.20 - 23 (3.40)	.554
40	1500	1.72 - 24 (3.65)	1.25 - 24 (3.44)	.729	8.07 - 25 (4.36)	.470
48	1900	1.47 - 25 (16.53)	1.13 - 25 (16.79)	.768	7.37 - 26 (15.41)	.500

TABLE 27. Effects of Water Content in the Atmosphere on the Auxier-Snyder Tissue Dose Distribution for Air-Over-Ground (45° Elevation)

Region	Distance (m)	Dry Air	2% Moist	2% Moist / Dry Air	6% Moist	6% Moist / Dry Air
1	75	4.73 - 18 (0.71)	4.60 - 18 (0.68)	.971	4.35 - 18 (0.69)	.919
6	320	5.17 - 19 (1.96)	4.60 - 19 (1.71)	.890	3.79 - 19 (1.82)	.732
17	460	8.68 - 20 (2.31)	7.14 - 20 (2.01)	.822	5.10 - 20 (2.49)	.588
22	740	1.94 - 20 (1.95)	1.50 - 20 (3.05)	.772	9.54 - 21 (4.99)	.492
31	1050	2.49 - 21 (3.37)	1.80 - 21 (2.21)	.721	1.05 - 21 (3.13)	.423
40	1500	1.81 - 22 (6.36)	1.14 - 22 (6.97)	.632	5.88 - 23 (8.28)	.326
48	1900	1.43 - 23 (23.35)	9.33 - 24 (17.24)	.655	5.15 - 24 (19.35)	.361

in this calculation for the different concentrations are cited in Tables 3, 4 and 5. Only the atmosphere is perturbed and the soil composition for this case is that of the NTS.

TABLE 28. Neutron Energy Deposition as a Function of Distance Along the 45° Angle of Elevation from the Source

	Energy Deposition (eV/cm^3·Source Neut.)		
Region	SAM-CE (Dry Air)	SAMCEP (Dry Air)	SAMCEP (6% Moist Air)
1	1.89 - 8	1.89 - 8 (<1)*	2.55 - 8
6	1.95 - 9	1.89 - 9 (2)	2.04 - 8
17	3.40 - 10	3.21 - 10(2)	2.83 - 10
22	7.28 - 11	7.55 - 11 (6)	5.52 - 11
31	9.43 - 12	9.67 - 12 (3)	6.37 - 12
40	6.74 - 13	5.89 - 13 (6)	3.54 - 13
48	4.58 - 14	6.03 - 14 (20)	3.14 - 14

*Relative error is indicated in the parentheses. The moist air results have relative error comparable to the dry air results.

The trend in the data of Table 28 indicates that the hydrogen content in the atmosphere induces a larger energy deposition than the dry air for the portion of the transport which is close to the source. The energy deposited is approximately the same around region 17 (450m) for both dry and moist air with the energy deposition subsequently lower for moist air as the range increases. The results from SAM-CE show excellent agreement.

Table 29 gives the neutron energy deposition for the regions immediately above the ground and the trends are quite similar to those of the previous data. Table 30 shows the energy deposition rates in Region 1 as a function of the local time bins given in Table 7. The SAMCEP moist air results show that at very early times many high energy neutrons have collided with hydrogen and they are rapidly depositing energy in the region close to the source. At later times, the deposition rate slows because the neutrons have lost most of their energy. Table 31 exhibits the time dependence of the deposition for Region 31, farther out from the source and along the 45° angle-of-elevation line.

TABLE 29. Neutron Energy Deposition as a Function of Distance Along the Ground From the Source.

Region	Energy Deposition (eV/cm^3·Source Neut.) SAM-CE (Dry Air)	SAMCEP (Dry Air)	SAMCEP (6% Moist Air)
1	1.89 - 8	1.89 - 8 (<1)	2.55 - 8
2(subdiv 65)	2.07 - 9	2.07 - 9 (4)	2.45 - 9
3	5.66 - 10	5.66 - 10 (4)	6.04 - 10
4(subdiv 68)	1.21 - 10	1.37 - 10 (6)	1.29 - 10
9	3.54 - 11	3.54 - 11 (5)	2.51 - 11
10(subdiv 71)	2.38 - 12	2.43 - 12 (11)	1.52 - 12
11	6.16 - 13	6.03 - 13 (8)	3.93 - 13
12	8.14 - 14	1.05 - 13 (17)	5.89 - 14
13	1.90 - 14	1.54 - 14 (23)	8.25 - 15

TABLE 30. Neutron Energy Deposition Rate in Region 1

Time Bin (μsec) (local time)	Energy Deposition Rate ($eV/sec \cdot cm^3$·Source Neut.) SAM-CE (Dry Air)	SAMCEP (Dry Air)	SAMCEP (6% Moist Air)
0.0 - 0.100 - 5	2.17 - 3	2.17 - 3 (1)	3.11 - 3
- 0.215 - 5	2.08 - 3	1.98 - 3 (2)	2.83 - 3
- 0.464 - 5	1.00 - 3	1.51 - 3 (2)	2.17 - 3
- 0.100 - 4	8.11 - 4	8.02 - 4 (<1)	1.13 - 3
- 0.215 - 4	2.83 - 4	2.55 - 4 (2)	3.58 - 4
- 0.464 - 4	7.92 - 5	7.55 - 5 (2)	9.43 - 5
- 0.100 - 3	1.70 - 5	1.70 - 5 (3)	1.79 - 5
- 0.215 - 3	2.83 - 6	2.55 - 6 (4)	1.79 - 6

TABLE 31. Neutron Energy Deposition Rate in Region 31

Time Bin (μsec) (local time)	Energy Deposition Rate (eV/sec·cm^3·Source Neut.) SAM-CE (Dry Air)	SAMCEP (Dry Air)	SAMCEP (6% Moist Air)
0.0 - 0.100 - 5	0	0	0
- 0.215 - 5	0	0	0
- 0.464 - 5	0	0	0
- 0.100 - 4	0	0	0
- 0.215 - 4	3.30 - 9	3.07 - 9 (22)	3.07 - 9
- 0.464 - 4	4.95 - 8	4.48 - 8 (6)	5.42 - 8
- 0.100 - 3	6.60 - 8	6.60 - 8 (5)	5.66 - 8
- 0.215 - 3	3.07 - 8	3.30 - 8 (3)	1.46 - 8
	4.24 - 9	4.24 - 9 (6)	7.78 - 10

Besides the neutrons, the photons are a major contributor to the ionization phenomenon and the energy deposition. As a result of a special interest to the EMP community, the direction of the project was changed to investigate the sensitivity of the above two phenomena to the perturbations cited earlier. It was also interesting to tally, separately, the contributions to the photon energy deposition which came from low and high energy neutron interactions in the air and ground respectively. These four components were computed for all the regions shown in Figure 2; however, only samples of the voluminous amount of data are presented. Table 32 displays the contribution in regions along the 45° elevation line which is derived from the low energy neutrons (<0.111 MeV) in the ground. Again SAMCEP is in good agreement with the SAM-CE results. The moisture content in the air produces, in all regions, results which are approximately 30% lower than the dry air results. Table 33 shows the low-energy-air component's contribution to the total energy deposition in the regions along the 45° elevation. An analysis of the data in the two tables immediately above shows that, for the moist air, fewer neutrons reach the ground; however, for those that do, the conversion to photons via absorption is quite high (ground constituents vs. air composition). Also the presence of hydrogen in the atmosphere causes the neutrons to slow down early in the transport cycle. This effect is reflected in Table 33 since the regions close to the source show a larger contribution for wet than for dry air and this trend reverses as one moves away from the source.

TABLE 32. Contribution of Low Energy Neutrons in the Ground to the Photon Energy Deposition Along the 45° Line

	Energy Deposition (eV/cm^3·Source Neut.)		
Region	SAM-CE (Dry Air)	SAMCEP (Dry Air)	SAMCEP (6% Moist Air)
1	0.19 - 8	0.21 - 8 (14)	0.16 - 8
6	0.27 - 9	0.25 - 9 (18)	0.19 - 9
17	0.64 - 10	0.86 - 10 (20)	0.52 - 10
22	0.20 - 10	0.23 - 10 (14)	0.12 - 10
31	0.44 - 11	0.48 - 11 (10)	0.34 - 11
40	0.68 - 12	0.75 - 12 (5)	0.49 - 12
48	0.14 - 12	0.13 - 12 (17)	0.99 - 13

TABLE 33. Contribution of Low Energy Neutrons in the Air to the Photon Energy Deposition Along the 45° Line

	Energy Deposition (eV/cm^3·Source Neut.)		
Region	SAM-CE (Dry Air)	SAMCEP (Dry Air)	SAMCEP (6% Moist Air)
1	0.12 - 9	0.17 - 9 (22)	0.15 - 9 (26)
6	0.47 - 10	0.54 - 10 (18)	0.64 - 10 (17)
17	0.15 - 10	0.17 - 10 (24)	0.23 - 10 (16)
22	0.62 - 11	0.57 - 11 (15)	0.54 - 11 (23)
31	0.16 - 11	0.15 - 11 (15)	0.13 - 11 (11)
40	0.24 - 12	0.25 - 12 (20)	0.22 - 12 (11)
48	0.49 - 13	0.36 - 13 (20)	0.36 - 13 (24)

Note that the number of neutrons prevented from reaching the ground by the moist air represents only a small fraction of the total neutron population. Therefore, the low-energy-air component is affected very little by the presence of the water. This result is demonstrated in the data of Table 33.

Table 34 is the high-energy-ground component of the total energy deposition for the 45° elevation. Since the high-energy-ground component involves neutrons which have not suffered many collisions, the results for both the dry and moist air should be about the same.

TABLE 34. Contribution of High Energy Neutrons in the Ground to the Photon Energy Deposition Along the 45° Line

	Energy Deposition (eV/cm^3·Source Neut.)		
Region	SAM-CE (Dry Air)	SAMCEP (Dry Air)	SAMCEP (6% Moist Air)
1	0.13 - 9	0.12 - 9 (4)	0.12 - 9
6	0.15 - 10	0.12 - 10 (12)	0.11 - 10
17	0.33 - 11	0.24 - 11 (18)	0.24 - 11
22	0.69 - 12	0.55 - 12 (21)	0.54 - 12
31	0.10 - 12	0.92 - 13 (7)	0.83 - 13
40	0.16 - 13	0.14 - 13 (12)	0.13 - 13
48	0.22 - 14	0.22 - 14 (16)	0.17 - 14

The remaining component for the energy deposition is the energy deposited by photons which are born from high energy neutrons interacting with the air. These photons are generated primarily by the neutron inelastic scattering events with nitrogen and oxygen. Since the inelastic thresholds for these elements are well above the average neutron energy of the degraded source spectrum, one would not expect this component to be very sensitive to the water content in the atmosphere. The results shown in Table 35 affirm this conclusion in that the transport through wet and dry air is essentially the same except at extremely deep penetrations.

TABLE 35. Contribution of the High Energy Neutrons in the Atmosphere to the Photon Energy Deposition Along the 45° Line

Region	Energy Deposition (eV/cm^3·Source Neut.) SAM-CE (Dry Air)	SAMCEP (Dry Air)	SAMCEP (6% Moist Air)
1	0.29 - 9	0.49 - 9 (5)	0.47 - 12
6	0.53 - 10	0.10 - 9 (4)	0.92 - 10
17	0.14 - 10	0.26 - 10 (5)	0.24 - 10
22	0.43 - 11	0.76 - 11 (7)	0.66 - 11
31	0.63 - 11	0.15 - 11 (3)	0.13 - 11
40	0.19 - 12	0.22 - 12 (5)	0.18 - 12
48	0.29 - 13	0.33 - 13 (7)	0.27 - 13

As seen in Table 35, the results from SAM-CE differ from those of SAMCEP for dry air. This difference can be explained by the way in which SAM-CE and SAMCEP represent the degraded fission source spectrum. Although SAM-CE and SAMCEP have the same input source spectrum, they treat the numerical representation of it slightly differently. The former assumes a decaying exponential between the increasing energy values, whereas the latter assumes a piecewise constant value across an energy bin. It turns out that the high energy component in the air is sensitive to the difference in representation because the inelastic scattering thresholds are above the average energy of the source and the cross sections rise very rapidly with increasing energy. Because of the two different representations, the average energy of the spectrum in SAMCEP exceeds the average energy of the spectrum as represented by SAM-CE by approximately 10%. This difference could account for some of the disagreement between the SAM-CE and SAMCEP results.

4.2.2. Neutron Transport Over Dry NTS and West German Soils.

A brief investigation has been completed to assess the differences in the neutron transport in an air-over-ground environment for which different constituents of the ground are considered. In the discussion to follow, neutron fluences will be presented as a function of soil type and moisture content of the soil for the degraded fission source at a 100-metre HOB. Results for a dry NTS soil and a wet and dry West German terrain will be compared. The dry air composition is given in Table 3; NTS and West German dry soils are given in Table 4; and West German wet soil is stated in Table 5. The neutron fluence and dose are given in a manner similar to that of Section 4.2.1.

Tables 36 and 37 show the results for Regions 1 and 6 for the 45° angle of elevation. As can be seen in the data, the results are essentially the same for these two regions and deviate even less as the distance along the 45° line increases. This trend is as expected since one would not expect the perturbations in the ground to affect the transport high into the atmosphere. The same is not true along the ground as Tables 38-44 substantiate. The general trend of the data shows that at the higher energy levels, differences in the fluence at all ranges are not significant, whereas in the lower energy bin, at intermediate ranges, variations of approximately 25% occur. The following tables tabulate the Rad-Si and Auxier-Snyder tissue dose responses. In general the differences among NTS dry, German dry and German wet soils are 25% or less.

The total neutron energy deposition (eV/cm^3·source neutron) for the 100-metre HOB case has also been calculated and the results are reported in Tables 46 and 47. The perturbations again consider the transport over NTS, German dry and German wet soil. The atmosphere has no moisture content for this case. Results are presented for the air regions directly over the ground and those regions at a 45° angle of elevation. If one compares Table 46 with Table 29, it is immediately evident that the moisture content in the air causes a larger energy deposition for the regions along the ground that are close to the source. For a ground range of approximately 750 metres, the energy depositions become approximately equal and, at the longer ranges, the moisture content in the soil gives about a factor of 2 larger deposition. As expected, the data in Table 47 shows that the composition of the ground has little effect on the transport and deposition of neutrons for short distances away from the air/ground interface and at higher altitudes.

The results for the subsequent secondary photon energy deposition show that, for regions in the air, the moisture content in the ground enhances the deposition by about 30 to 50 percent for ranges out to 10 mfp. These results are shown in Tables 48 and 49.

4.3 One-Metre Height-of-Burst Study

SAMCEP calculations, similar to those described above, have been made for a one-metre HOB source over typical German soil. Simultaneous perturbation computations are treated in which the base, or unperturbed, calculation is dry air and German dry soil. Comparison calculations are made for dry NTS and German wet soils. The compositions of interest are those listed in Tables 3, 4 and 5.

Tables 50 and 51 show the neutron energy deposition in regions along the air/ground interface and along the 45° elevation angle, respectively.

TABLE 36. Energy Dependent Neutron Fluence in Region 1 for NTS Dry, German Dry and German Wet Soils

	Energy (eV)	Neutron Fluence Vs. Energy (Neut/eV·cm^2·Source Neut.)		
		NTS Dry	German Dry	German Wet
1	.14995000E+08 .2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08 .2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08 .1813E+07	3.77 - 18 (1.05)	3.77 - 18 (1.06)	3.77 - 18 (1.05)
4	.81870000E+07 .1827E+07	7.80 - 18 (1.12)	7.81 - 18 (1.12)	7.80 - 18 (1.13)
5	.63600000E+07 .1394E+07	1.54 - 17 (0.87)	1.55 - 17 (0.90)	1.53 - 17 (0.82)
6	.49660000E+07 .9000E+06	1.85 - 17 (1.34)	1.86 - 17 (1.39)	1.83 - 17 (1.22)
7	.40660000E+07 .1054E+07	5.60 - 17 (0.71)	5.61 - 17 (0.71)	5.58 - 17 (0.69)
8	.30100000E+07 .5460E+06	8.42 - 17 (1.31)	8.51 - 17 (1.36)	8.29 - 17 (1.30)
9	.24660000E+07 .1160E+06	1.01 - 16 (3.03)	1.03 - 16 (2.94)	9.91 - 17 (3.10)
10	.23500000E+07 .5230E+06	2.41 - 16 (1.20)	2.42 - 16 (1.25)	2.39 - 16 (1.06)
11	.18270000E+07 .7190E+06	3.51 - 16 (1.10)	3.56 - 16 (1.14)	3.46 - 16 (1.08)
12	.11080000E+07 .5578E+06	7.89 - 16 (1.03)	8.04 - 16 (1.17)	7.68 - 16 (0.94)
13	.55020000E+06 .4391E+06	1.32 - 15 (1.00)	1.39 - 15 (1.21)	1.25 - 15 (0.86)
14	.11110000E+06 .1077E+06	7.26 - 15 (2.49)	7.80 - 15 (2.56)	6.83 - 15 (2.22)
15	.33550000E+04 .3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.25300000E-01			

TABLE 37. Energy Dependent Neutron Fluence in Region 6 for NTS Dry, German Dry and German Wet Soils

	Energy (eV)		Neutron Fluence Vs. Energy (Neut/eV·cm^2·Source Neut.)		
			NTS Dry	German Dry	German Wet
1	.14995000E+08	.2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08	.2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08	.1813E+07	1.94 - 19 (5.70)	1.94 - 19 (5.70)	1.94 - 19 (5.70)
4	.81870000E+07	.1827E+07	4.99 - 19 (3.71)	5.00 - 19 (3.66)	4.98 - 19 (3.72)
5	.63600000E+07	.1394E+07	1.18 - 18 (4.68)	1.19 - 18 (4.66)	1.17 - 18 (4.67)
6	.49660000E+07	.9000E+06	1.45 - 18 (3.89)	1.47 - 18 (4.01)	1.42 - 18 (3.74)
7	.40660000E+07	.1054E+07	3.22 - 18 (4.62)	3.24 - 18 (4.71)	3.20 - 18 (4.52)
8	.30100000E+07	.5460E+06	6.78 - 18 (3.25)	6.85 - 18 (3.18)	6.69 - 18 (3.27)
9	.24660000E+07	.1160E+06	1.00 - 17 (9.28)	1.02 - 17 (9.20)	9.80 - 18 (9.29)
10	.23500000E+07	.5230E+06	1.64 - 17 (5.89)	1.66 - 17 (5.91)	1.62 - 17 (5.99)
11	.18270000E+07	.7190E+06	3.57 - 17 (3.55)	3.62 - 17 (3.64)	3.51 - 17 (3.52)
12	.11080000E+07	.5578E+06	8.84 - 17 (2.81)	9.03 - 17 (2.72)	8.57 - 17 (2.98)
13	.55020000E+06	.4391E+06	2.05 - 16 (3.19)	2.10 - 16 (3.05)	1.97 - 16 (3.24)
14	.11110000E+06	.1077E+06	1.07 - 15 (5.11)	1.15 - 15 (4.64)	9.89 - 16 (5.31)
15	.33550000E+04	.3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.25300000E-01				

TABLE 38. Energy Dependent Neutron Fluence in Region 2 (subd. 65) for NTS Dry, German Dry and German Wet Soils

		Neutron Fluence Vs. Energy (Neut/eV·cm^2·Source Neut.)		
	Energy (eV)	NTS Dry	German Dry	German Wet
1	.14995000E+08			
	.2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08			
	.2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08			
	.1813E+07	2.58 - 19 (6.25)	2.60 - 19 (6.34)	2.57 - 19 (6.22)
4	.81870000E+07			
	.1827E+07	6.14 - 19 (5.53)	6.18 - 19 (5.47)	6.05 - 19 (5.47)
5	.63600000E+07			
	.1394E+07	1.26 - 18 (5.76)	1.28 - 18 (5.75)	1.24 - 18 (5.93)
6	.49660000E+07			
	.9000E+06	1.91 - 18 (6.84)	1.96 - 18 (6.81)	1.88 - 18 (6.82)
7	.40660000E+07			
	.1054E+07	3.68 - 18 (3.92)	3.80 - 18 (4.22)	3.55 - 18 (3.87)
8	.30100000E+07			
	.5460E+06	8.06 - 18 (4.43)	8.37 - 18 (4.48)	7.62 - 18 (4.08)
9	.24660000E+07			
	.1160E+06	1.22 - 17 (15.99)	1.30 - 17 (16.00)	1.14 - 17 (16.13)
10	.23500000E+07			
	.5230E+06	1.79 - 17 (4.94)	1.84 - 17 (5.18)	1.74 - 17 (4.78)
11	.18270000E+07			
	.7190E+06	3.62 - 17 (5.06)	3.78 - 17 (4.69)	3.37 - 17 (5.14)
12	.11080000E+07			
	.5578E+06	9.59 - 17 (3.31)	1.04 - 16 (3.18)	8.61 - 17 (3.52)
13	.55020000E+06			
	.4391E+06	2.00 - 16 (3.45)	2.48 - 16 (4.13)	1.64 - 16 (3.44)
14	.11110000E+06			
	.1077E+06	9.31 - 16 (8.26)	1.28 - 15 (8.35)	7.24 - 16 (6.63)
15	.33550000E+04			
	.3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.25300000E-01			

TABLE 39. Energy Dependent Neutron Fluence in Region 3 for NTS Dry, German Dry and German Wet Soils

	Energy (eV)	Neutron Fluence Vs. Energy (Neut/eV·cm²·Source Neut.)		
		NTS Dry	German Dry	German Wet
1	.14995000E+08 .2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08 .2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08 .1813E+07	5.50 - 20 (6.79)	5.51 - 20 (6.79)	5.50 - 20 (6.84)
4	.81870000E+07 .1827E+07	1.58 - 19 (6.60)	1.58 - 19 (6.63)	1.55 - 19 (6.59)
5	.63600000E+07 .1394E+07	3.63 - 19 (3.45)	3.64 - 19 (2.49)	3.60 - 19 (3.55)
6	.49660000E+07 .9000E+06	5.23 - 19 (7.32)	5.34 - 19 (7.37)	5.13 - 19 (7.41)
7	.40660000E+07 .1054E+07	8.59 - 19 (6.76)	8.77 - 19 (6.65)	8.37 - 19 (7.01)
8	.30100000E+07 .5460E+06	2.23 - 18 (5.68)	2.29 - 18 (5.56)	2.14 - 18 (5.85)
9	.24660000E+07 .1160E+06	4.11 - 18 (14.73)	4.31 - 18 (14.84)	3.92 - 18 (14.87)
10	.23500000E+07 .5230E+06	4.63 - 18 (8.53)	4.76 - 18 (8.28)	4.54 - 18 (8.78)
11	.18270000E+07 .7190E+06	9.63 - 18 (5.64)	9.94 - 18 (5.65)	9.18 - 18 (5.88)
12	.11080000E+07 .5578E+06	2.52 - 17 (4.31)	2.68 - 17 (3.92)	2.35 - 17 (4.80)
13	.55020000E+06 .4391E+06	5.73 - 17 (3.93)	6.41 - 17 (4.13)	5.02 - 17 (3.87)
14	.11110000E+06 .1077E+06	3.10 - 16 (6.81)	3.66 - 16 (7.22)	2.66 - 17 (7.12)
15	.33550000E+04 .3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.25300000E-01			

TABLE 40. Energy Dependent Neutron Fluence in Region 4 (subdiv. 68) for NTS Dry, German Dry and German Wet Soils

	Energy (eV)	Neutron Fluence Vs. Energy (Neut/eV·cm^2·Source Neut.)		
		NTS Dry	German Dry	German Wet
1	.14995000E+08			
	.2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08			
	.2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08			
	.1813E+07	1.62 - 20 (28.44)	1.62 - 20 (28.44)	1.62 - 20 (28.44)
4	.81870000E+07			
	.1827E+07	5.19 - 20 (18.49)	5.19 - 20 (18.48)	5.16 - 20 (18.49)
5	.63600000E+07			
	.1394E+07	9.71 - 20 (12.39)	9.72 - 20 (12.22)	9.82 - 20 (12.69)
6	.49660000E+07			
	.9000E+06	1.58 - 19 (18.74)	1.62 - 19 (18.36)	1.53 - 19 (19.33)
7	.40660000E+07			
	.1054E+07	1.66 - 19 (18.38)	1.73 - 19 (17.99)	1.59 - 19 (18.97)
8	.30100000E+07			
	.5460E+06	5.19 - 19 (10.25)	5.18 - 19 (10.39)	5.02 - 19 (10.78)
9	.24660000E+07			
	.1160E+06	9.99 - 19 (28.13)	1.25 - 18 (31.39)	9.19 - 19 (30.60)
10	.23500000E+07			
	.5230E+06	9.19 - 19 (16.59)	9.28 - 19 (16.26)	9.22 - 19 (16.96)
11	.18270000E+07			
	.7190E+06	2.07 - 18 (7.25)	2.76 - 18 (8.01)	1.90 - 18 (7.88)
12	.11080000E+07			
	.5578E+06	6.26 - 18 (6.13)	7.05 - 18 (6.40)	5.36 - 18 (6.55)
13	.55020000E+06			
	.4391E+06	1.40 - 17 (6.49)	1.66 - 17 (8.54)	1.13 - 17 (6.02)
14	.11110000E+06			
	.1077E+06	5.96 - 17 (10.17)	7.03 - 17 (8.08)	4.46 - 17 (11.98)
15	.33550000E+04			
	.3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.25300000E-01			

TABLE 41. Energy Dependent Neutron Fluence in Region 9 for NTS Dry, German Dry and German Wet Soils

	Energy (eV)	Neutron Fluence Vs. Energy (Neut/eV·cm^2·Source Neut.)		
		NTS Dry	German Dry	German Wet
1	.14995000E+08			
	.2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08			
	.2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08			
	.1813E+07	2.51 - 21 (7.55)	2.52 - 21 (7.46)	2.50 - 21 (7.88)
4	.81870000E+07			
	.1827E+07	1.14 - 20 (7.53)	1.14 - 20 (7.15)	1.15 - 20 (8.16)
5	.63600000E+07			
	.1394E+07	2.61 - 20 (8.32)	2.63 - 20 (8.12)	2.60 - 20 (8.33)
6	.49660000E+07			
	.9000E+06	4.28 - 20 (4.45)	4.31 - 20 (4.64)	4.24 - 20 (4.37)
7	.40660000E+07			
	.1054E+07	4.08 - 20 (3.91)	4.18 - 20 (4.27)	4.03 - 20 (3.57)
8	.30100000E+07			
	.5460E+06	1.15 - 19 (6.38)	1.18 - 19 (7.00)	1.12 - 19 (5.55)
9	.24660000E+07			
	.1160E+06	2.61 - 19 (16.37)	2.76 - 19 (18.78)	2.43 - 19 (13.17)
10	.23500000E+07			
	.5230E+06	3.03 - 19 (8.56)	3.14 - 19 (7.44)	2.96 - 19 (8.40)
11	.18270000E+07			
	.7190E+06	5.43 - 19 (4.12)	5.64 - 19 (4.85)	5.17 - 19 (3.43)
12	.11080000E+07			
	.5578E+06	1.50 - 18 (4.12)	1.56 - 18 (4.62)	1.40 - 18 (4.77)
13	.55020000E+06			
	.4391E+06	4.15 - 18 (4.63)	4.49 - 18 (3.82)	3.80 - 18 (5.34)
14	.11110000E+06			
	.1077E+06	2.73 - 17 (3.38)	2.46 - 17 (3.04)	2.07 - 17 (3.16)
15	.33550000E+04			
	.3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.25300000E-01			

TABLE 42. Energy Dependent Neutron Fluence in Region 10 (subdiv. 71) for NTS Dry, German Dry and German Wet Soils

	Energy (eV)	Neutron Fluence Vs. Energy (Neut/eV·cm^2·Source Neut.)		
		NTS Dry	German Dry	German Wet
1	.14995000E+08 .2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08 .2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08 .1813E+07	1.80 - 22 (66.44)	1.80 - 20 (66.37)	1.82 - 22 (66.89)
4	.81870000E+07 .1827E+07	1.33 - 21 (22.01)	1.31 - 21 (21.25)	1.22 - 21 (18.91)
5	.63600000E+07 .1394E+07	2.78 - 21 (4.65)	2.88 - 21 (6.17)	2.56 - 21 (5.35)
6	.49660000E+07 .9000E+06	5.20 - 21 (9.04)	5.34 - 21 (9.01)	5.04 - 21 (9.51)
7	.40660000E+07 .1054E+07	3.12 - 21 (8.16)	3.24 - 21 (8.09)	2.95 - 21 (8.93)
8	.30100000E+07 .5460E+06	9.40 - 21 (13.03)	9.68 - 21 (6.12)	8.44 - 21 (13.56)
9	.24660000E+07 .1160E+06	1.29 - 20 (29.70)	1.57 - 20 (27.78)	1.05 - 20 (26.49)
10	.23500000E+07 .5230E+06	1.75 - 20 (17.95)	1.87 - 20 (16.64)	1.66 - 20 (19.46)
11	.18270000E+07 .7190E+06	4.34 - 20 (11.23)	4.74 - 20 (10.33)	3.75 - 20 (11.11)
12	.11080000E+07 .5578E+06	1.27 - 19 (20.99)	1.50 - 19 (23.85)	1.01 - 19 (16.96)
13	.55020000E+06 .4391E+06	2.90 - 19 (10.05)	3.18 - 19 (8.63)	2.21 - 19 (12.44)
14	.11110000E+06 .1077E+06	1.30 - 18 (24.24)	1.93 - 18 (29.16)	1.02 - 18 (23.36)
15	.33550000E+04 .3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.25300000E-01			

TABLE 43. Energy Dependent Neutron Fluence in Region 11 for NTS Dry, German Dry and German Wet Soils

	Energy (eV)	Neutron Fluence Vs. Energy (Neut/eV·cm^2·Source Neut.)		
		NTS Dry	German Dry	German Wet
1	.14995000E+08			
	.2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08			
	.2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08			
	.1813E+07	7.50 - 23 (19.53)	7.50 - 23 (19.72)	7.52 - 23 (20.15)
4	.81870000E+07			
	.1827E+07	2.57 - 21 (12.67)	2.56 - 22 (12.66)	2.53 - 22 (13.41)
5	.63600000E+07			
	.1394E+07	7.96 - 22 (9.91)	8.06 - 22 (10.06)	7.84 - 22 (10.12)
6	.49660000E+07			
	.9000E+06	1.62 - 21 (13.51)	1.68 - 21 (13.84)	1.55 - 21 (13.60)
7	.40660000E+07			
	.1054E+07	7.61 - 22 (8.35)	7.92 - 22 (7.40)	7.09 - 22 (9.11)
8	.30100000E+07			
	.5460E+06	2.38 - 21 (4.96)	2.39 - 21 (4.49)	2.32 - 21 (7.40)
9	.24660000E+07			
	.1160E+06	3.73 - 21 (21.88)	3.89 - 21 (22.40)	3.43 - 21 (22.84)
10	.23500000E+07			
	.5230E+06	5.36 - 21 (13.38)	5.54 - 21 (12.69)	4.97 - 21 (16.77)
11	.18270000E+07			
	.7190E+06	9.69 - 21 (17.48)	1.00 - 20 (18.48)	9.11 - 21 (16.19)
12	.11080000E+07			
	.5578E+06	2.45 - 20 (10.22)	2.60 - 20 (9.20)	2.29 - 20 (11.22)
13	.55020000E+06			
	.4391E+06	6.26 - 20 (7.38)	7.09 - 20 (7.62)	5.41 - 20 (6.69)
14	.11110000E+06			
	.1077E+06	3.22 - 19 (7.15)	3.72 - 19 (8.45)	2.74 - 99 (4.67)
15	.33550000E+04			
	.3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.25300000E-01			

TABLE 44. Energy Dependent Neutron Fluence in Region 12 for NTS Dry, German Dry and German Wet Soils

	Energy (eV)	Neutron Fluence Vs. Energy (Neut/eV·cm^2·Source Neut.)		
		NTS Dry	German Dry	German Wet
1	.14995000E+08			
	.2785E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
2	.12210000E+08			
	.2210E+07	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
3	.10000000E+08			
	.1813E+07	1.50 - 23 (35.56)	1.50 - 23 (35.56)	1.50 - 23 (35.56)
4	.81870000E+07			
	.1827E+07	5.07 - 23 (17.99)	5.00 - 23 (18.10)	5.13 - 23 (18.19)
5	.63600000E+07			
	.1394E+07	1.44 - 22 (17.68)	1.45 - 22 (17.75)	1.41 - 22 (16.80)
6	.49660000E+07			
	.9000E+06	3.36 - 22 (12.62)	3.45 - 22 (12.39)	3.28 - 22 (12.62)
7	.40660000E+07			
	.1054E+07	2.33 - 22 (17.09)	2.52 - 22 (18.40)	2.14 - 22 (15.96)
8	.30100000E+07			
	.5460E+06	3.23 - 22 (18.66)	3.31 - 22 (18.61)	3.15 - 22 (22.29)
9	.24660000E+07			
	.1160E+06	1.27 - 21 (31.95)	1.29 - 21 (31.78)	1.25 - 21 (31.94)
10	.23500000E+07			
	.5230E+06	1.24 - 21 (31.31)	1.25 - 21 (30.90)	1.23 - 21 (32.29)
11	.18270000E+07			
	.7190E+06	1.67 - 21 (29.85)	1.74 - 21 (26.59)	1.62 - 21 (33.64)
12	.11080000E+07			
	.5578E+06	3.74 - 21 (17.05)	4.00 - 21 (17.06)	3.38 - 21 (19.42)
13	.55020000E+06			
	.4391E+06	8.15 - 21 (10.26)	9.50 - 21 (14.07)	7.31 - 21 (9.01)
14	.11110000E+06			
	.1077E+06	6.41 - 20 (23.54)	6.62 - 20 (24.48)	5.51 - 20 (29.01)
15	.33550000E+04			
	.3355E+04	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
16	.25300000E-01			

TABLE 45. Comparison of Rad-Si and A-S Tissue Response for NTS Dry, German Dry and German Wet Soils as a Function of Ground Range

	Dose Response/Source Neutron					
	NTS Dry		German Dry		German Wet	
Region	Rad-Si	A-S	Rad-Si	A-S	Rad-Si	A-S
1	4.78 - 20 (0.45)	4.73 - 18 (0.71)	4.86 - 20 (0.50)	4.86 - 18 (0.78)	4.70 - 20 (0.30)	4.61 - 18 (0.57)
2(65)	4.79 - 21 (1.42)	5.34 - 19 (1.85)	5.22 - 21 (1.67)	6.04 - 19 (2.16)	4.38 - 21 (1.38)	4.72 - 19 (1.60)
3	1.27 - 21 (1.83)	1.47 - 19 (2.29)	1.34 - 21 (1.85)	1.59 - 19 (2.49)	1.20 - 21 (2.01)	1.36 - 19 (2.43)
4(68)	3.23 - 22 (5.97)	3.42 - 20 (3.97)	3.51 - 22 (6.04)	3.84 - 20 (4.18)	2.94 - 22 (6.73)	2.96 - 20 (4.95)
9	8.21 - 23 (3.51)	9.45 - 21 (2.67)	8.55 - 23 (2.78)	1.01 - 20 (2.28)	7.85 - 23 (3.93)	8.88 - 21 (3.07)
10(71)	6.93 - 24 (8.12)	7.14 - 22 (6.21)	7.44 - 24 (6.52)	8.21 - 22 (5.74)	5.96 - 24 (8.71)	5.88 - 22 (6.79)
11	1.62 - 24 (7.63)	1.61 - 22 (6.86)	1.70 - 24 (7.41)	1.74 - 22 (6.69)	1.52 - 24 (7.22)	1.47 - 22 (6.16)
12	2.84 - 25 (11.40)	2.74 - 23 (13.66)	2.98 - 25 (11.34)	2.91 - 23 (13.19)	2.73 - 25 (11.36)	2.54 - 23 (15.44)

TABLE 46. Total Neutron Energy Deposition (HOB = 100m) in Air Regions Directly Over the Ground

	Neutron Energy Deposition (eV/cm^2·Source Neut.)		
Region	NTS Dry	German Dry	German Wet
1	1.89 - 8	1.89 - 8 (<1)	1.89 - 8
2(65)	2.07 - 9	2.26 - 9 (4)	1.83 - 9
3	5.85 - 10	6.22 - 10 (4)	5.28 - 10
4(68)	1.29 - 10	1.54 - 10 (9)	1.13 - 10
9	3.54 - 11	3.54 - 11 (4)	3.30 - 11
10(71)	1.96 - 12	2.02 - 12 (13)	1.84 - 12
11	6.03 - 13	6.42 - 13 (10)	5.50 - 13
12	7.61 - 14	7.72 - 14 (18)	7.29 - 14
13	1.72 - 14	1.81 - 14 (39)	1.63 - 14

TABLE 47. Total Neutron Energy Deposition (HOB = 100m) in Air Regions at 45° Angle of Elevation

	Neutron Energy Deposition (eV/cm^2·Source Neut.)		
Region	NTS Dry	German Dry	German Wet
1	1.88 - 8	1.98 - 8 (<1)	1.89 - 8
6	1.92 - 9	1.95 - 9 (3)	1.85 - 9
17	3.40 - 10	3.40 - 10 (4)	3.21 - 10
22	7.00 - 11	7.14 - 11 (6)	6.74 - 11
31	9.20 - 12	9.20 - 12 (5)	8.96 - 12
40	6.57 - 13	6.74 - 13 (6)	6.57 - 13
48	4.19 - 14	4.45 - 14 (15)	3.93 - 14

TABLE 48. Secondary Photon Energy Deposition (HOB = 100m) in Air Regions Directly Over the Ground

Regions	NTS Dry	German Dry	German Wet
	Secondary Photon Energy Deposition (eV/cm^3.Source Neut.)		
1	4.43 - 9	3.21 - 9 (7)	6.60 - 9
2 (subdiv. 65)	8.11 - 10	5.85 - 10 (11)	9.43 - 10
3	2.26 - 10	9.24 - 11 (10)	2.64 - 10
4 (subdiv. 68)	5.50 - 11	4.20 - 11 (9)	6.79 - 11
9	1.98 - 11	1.49 - 11 (9)	2.00 - 11
10 (subdiv. 71)	2.83 - 12	2.43 - 12 (10)	2.22 - 12
11	7.99 - 13	6.81 - 13 (8)	7.60 - 13
12	1.82 - 13	1.93 - 13 (8)	1.93 - 13
13	5.35 - 14	5.44 - 14 (13)	5.17 - 14

TABLE 49. Secondary Photon Energy Deposition (HOB = 100m) in Air Regions at 45° Angle of Elevation

Regions	NTS Dry	German Dry	German Wet
	Secondary Photon Energy Deposition (eV/cm^3.Source Neut.)		
1	4.43 - 9	3.21 - 9 (7)	6.60 -9
6	4.72 - 10	3.77 - 10 (6)	6.60 - 10
17	9.43 - 11	8.87 - 11 (9)	1.26 - 10
22	3.37 - 11	2.69 - 11 (10)	4.04 - 11
31	7.07 - 12	5.66 - 12 (8)	8.25 - 12
40	8.94 - 13	7.31 - 13 (10)	9.70 - 13
48	2.23 - 13	1.83 - 13 (11)	2.36 - 13

TABLE 50. Neutron Energy Deposition (HOB = 1m) in Air Regions Along the 45° Line

	Neutron Energy Deposition (eV/cm^3·Source Neut.)		
Regions	NTS Dry	German Dry	German Wet
1	1.51 - 8	1.61 - 8 (1)	1.32 - 8
6	1.07 - 9	1.19 - 9 (3)	9.43 - 10
17	1.87 - 10	2.07 - 10 (4)	1.68 - 10
22	3.77 - 11	4.04 - 11 (4)	3.37 - 11
31	5.42 - 12	5.66 - 12 (4)	4.95 - 12
40	3.87 - 13	4.04 - 13 (10)	3.70 - 13
48	3.54 - 13	3.54 - 13	3.54 - 13

TABLE 51. Neutron Energy Deposition (HOB = 1m) in Air Regions Directly Over the Ground

	Neutron Energy Deposition (eV/cm^3·Source Neut.)		
Region	NTS Dry	German Dry	German Wet
1	1.51 - 8	1.61 - 8 (1)	1.32 - 8
2 (subdiv. 65)	1.79 - 9	2.07 - 9 (3)	1.57 - 9
3	4.34 - 10	5.09 - 10 (4)	3.77 - 10
4 (subdiv. 68)	1.13 - 10	1.29 - 10 (7)	8.89 - 11
9	2.36 - 11	2.59 - 11 (4)	2.10 - 11
10 (subdiv. 71)	2.02 - 12	2.43 - 12 (12)	1.78 - 12
11	4.19 - 13	4.45 - 13 (9)	3.67 - 13
12	8.15 - 14	8.47 - 14 (20)	7.50 - 14
13	1.45 - 14	1.72 - 14 (36)	1.27 - 14

From Table 50 we see that the results are essentially unchanged by soil composition although there is an indication that the energy deposition for German dry soil (least hydrogen in the ground) is slightly higher than for the other two cases and that the energy deposition for the German wet soil case (most hydrogen in the soil) is slightly lower than for the other two cases. Table 51 (along the interface) shows the trend even more clearly. These differences were actually shown by the SAMCEP printout (with uncertainties in the differences) to be statistically real. Nevertheless, the hydrogen content of the soil clearly does not significantly affect the neutron energy deposition in air.

5. CONCLUSION

A number of coding developments have been performed to effect a major upgrading of the SAMCEP system for the quantitative evaluation of cross section uncertainties on radiation transport. The principal development of this modernization of the system has been the implementation of a secondary-gamma capability. Thus, sensitivity studies, heretofore limited to evaluating effects of neutron cross section uncertainties on neutron transport, can now be extended to include subsequent effects upon gamma transport of uncertainties in neutron as well as gamma production data.

Using the neutron-gamma SAMCEP system, a series of problems have been solved. An important conclusion to be drawn from the results of these calculations is that the SAMCEP system is yielding correct results, as indicated by comparison and agreement with independently obtained solutions, using the SAM-CE system. Moreover, comparable statistics were obtained 3 to 4 times more efficiently using SAMCEP than would have been possible by performing independent and uncorrelated analyses.

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