M-643

Formerly Utilized Sites Remedial Action Program (FUSRAP)

ADMINISTRATIVE RECORD

for the Maywood Site, New Jersey

US Army Corps of Engineers®

M-643

DPRA CALCULATION SHEET

			CALC. NO.	138-CV-098	REV. 1
ORIGINATOR	Robert G. Robbins	DATE 4-SEP-97	CHECKED		DATE 9-8-97
PROJECT	FUSRAP -MISS		JOB NO.	14501	SHEET 1 of 16
SUBJECT	Dose From Excavation/Loading of Site Soils for Offsite Treatabiltiy Studies at MISS				

PURPOSE

This calculation estimates the inhalation dose from airborne radioactivity releases at the Maywood Interim Storage Site (MISS) generated during the excavation and loading of site soils for treatability testing at offsite locations.

SCOPE

This calculation uses MISS characterization results to calculate radioactivity releases and inputs them to the Clean Air Act Assessment Package - 1988 - Personal computer (CAP88-PC) model to estimate air doses to the hypothetical maximally exposed individual.

REFERENCES

Bechtel National, Inc. (BNI), 1995. "Natural Uranium Specific Activity," 14501-191-CV-005 rev 2, Oak Ridge, TN.

BNI, 1987. *Characterization Report for the Maywood Interim Storage Site, Maywood, New Jersey*, DOE/OR/20722-139, Oak Ridge, TN (June).

Cowherd, 1985. *Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination sites*, EPA/600/8-85/002, Washington D.C. (February).

Environmental Protection Agency (EPA), 1992. *User's Guide for CAP88-PC, Version 1.0*, 402-B-92-001, Office of Radiation Programs, Las Vegas, NV (March).

EPA, 1995. *Compilation of Air Pollutant Emission Factors, Fifth Edition*, AP-42, Office of Air Quality Planning and Standards, Research Triangle Park, NC (January)

McDaniel, 1995. "MIS-Maywood Density Determination", CCN 130331, Correspondence form Preston W. McDaniel, BNI, to Susan P. Rice, Envirocare of Utah, (May).

National Oceanic and Atmospheric Administration (NOAA), 1996. *Preliminary Local Climatological Data for Newark, NJ*, National Climatic Data Center, Ashville, NC.

NOAA, 1996. *Preliminary Local Climatological Data for Newark, NJ*, National Climatic Data Center, Ashville, NC.

Shleien, B., 1992. *The Health Physics and Radiological Health Handbook, Revised Edition*, Scinta Inc., Silver Springs, MD.

ASSUMPTIONS

The hypothetical maximally exposed individual is based on site knowledge of the nearest residents and offsite workers. The nearest residents are 310 m WSW, 200 m NW, 170 m N, 105 m N, 100 m NNE, 145 m NNE, 270 m NNE, 155 m NE, and 155 m ENE. The nearest offsite workers are 50 m SSW, 250 m NW, 160 m NW, 145 m NNW, 130 m NNW, and 230 m NNW. The occupancy factor is 100% for the resident and 24% for the offsite worker.

Daughters in the decay chains of radionuclides are considered to be in secular equilibrium with their parents until a radionuclide in the chain is encountered with a measured concentration, in which case the measured concentration is used. Radium daughters are not included since the daughter of radium is radon, a gas, and is not applicable to the analysis of particulate behavior.

This activity requires the excavation of a maximum of 1000 yd^3 (764.6 m^3) of soil and is expected to last less than ten working days. During the course of the work any stockpiled soil would be covered to eliminate wind erosion; therefore, the only particulate emission expected is from mechanical handling during the excavation and then once again during loading operations. The exposed soil at the bottom of the excavation will be covered during non-work hours to further reduce the airborne particulate emissions from this activity. The soil will be excavated from an area immediately west of the building 76 area.

CALCULATIONS

CAP88-PC Computer Program

The CAP88-PC model is a set of computer programs, databases, and associated utility programs that estimate the dose and risk from airborne radioactivity emissions. The EPA National Emission Standards for Hazardous Air Pollutants (NESHAP) compliance procedures for airborne radioactivity emissions at Department of Energy facilities (40 CFR 61.93a) require the use of the CAP88-PC model, or other approved procedures, to calculate the effective dose equivalents to members of the public. CAP88-PC is a Bechtel Standard Application Program, number EV101. A detailed description of CAP88-PC is provided in the user's guide (EPA 1992).

Computer Hardware Configuration

The CAP88-PC program was run on a COMPAQ Deskpro 5133 which is a pentium microcomputer running at 133 Mhz using Windows 95 and networked through a Digital Equipment Corporation VAX using PCSA/Pathworks for print and file services.

Input

The input parameters are listed in the attached "Synopsis Report." Input includes nearest resident and offsite worker (assumption), weather (NOAA 1996), and emission data calculated below.

Output

The output results are listed in the attached "Summary Report." Output includes the annual doses for individuals at given distances and direction from the source.

Test Problem

Prior to running this calculation, a test run was successfully completed using the Reactive Metals data set described in the CAP88-PC user's guide (EPA 1992).

Excavation/Loading Annual Emissions

The material handling particle size multiplier (k_h) corresponding to aerodynamic particle sizes less than 10 microns (EPA 1993), which is the particle size of concern for inhalation, is:

$$k_h = 0.35$$

The total mass (M) of soil to be excavated is calculated based on the volume of soil (V) to be excavated is 764.6 m^3 and the density of MISS soils (ρ)is 1600 kg/m^3 (McDaniel 1995).

$$M = \rho V$$

$$M = \left(764.6 m^3\right)\left(1600 \frac{kg}{m^3}\right) = 1.22x10^6 g \quad \text{OK} \quad kg$$

The mean annual wind speed (U) based on the last full year of weather data (NOAA 1996) is:

$$U = 4.33 \frac{m}{s}$$

The moisture content (X) of the soil (assumption) is:

$$X = 14\%$$

The emission (Eh) for material handling (EPA 1993) is:

$$E_h = \frac{k_h\left(0.0016 \frac{g}{kg}\right) M \left(\frac{U}{2.2 \frac{m}{s}}\right)^{1.3}}{\left(\frac{X}{2\%}\right)^{1.4}}$$

$$E_h = \frac{0.35\left(0.0016 \frac{g}{kg}\right) 1.22x10^6 kg \left(\frac{4.33 \frac{m}{s}}{2.2 \frac{m}{s}}\right)^{1.3}}{\left(\frac{14\%}{2\%}\right)^{1.4}} = 108.4g$$

The total emission for excavation and loading ($E_{h\text{-}tot}$) for this work will be twice E_h because the soil will be handled twice during the excavation of soil and loading for transport.

$$E_{h-tot} = 2E_h = (2)(108.4g) = 216.8g$$

Exposed Soil Annual Emission

The emission (E_w) from wind erosion is estimated here using the industrial wind erosion chapter of AP-42 (EPA 1995). This chapter is the closest match to conditions at the site, but the result must be adjusted because this method assumes dry soil with no credit taken

for vegetative cover.

The threshold friction velocity (U_t) for overburden (EPA 1995 Table 13.2.5-2) is:

$$U_t = 1.02\frac{m}{s}$$

The number of disturbances (N) is assumed to be 1 disturbance per day for the duration of the work (ten days) for a total of 10 disturbances. This is a conservative assumption because the only planned disturbances are the initial excavation and then backfilling, the additional disturbances were added to account for unknown or emergency actions that may be needed.

The fastest mile (two minute) wind speeds (Ua_N) for each period between disturbances (NOAA 1996) starting in January are:

$$Ua_1 = 32.2mph$$
$$Ua_2 = 40.3mph$$
$$Ua_3 = 30.8mph$$
$$Ua_4 = 32.2mph$$
$$Ua_5 = 24.2mph$$
$$Ua_6 = 27.5mph$$
$$Ua_7 = 29.9mph$$
$$Ua_8 = 32.2mph$$
$$Ua_9 = 26.4mph$$
$$Ua_{10} = 32.2mph$$

The actual anemometer height (Z_a) (EPA 1985) is:

$$Z_a = 7m$$

The reference anemometer height (Z_r) (EPA 1995) is:

$$Z_r = 10m$$

The roughness height (Z_0) for overburden (EPA 1995 Table 13.2.5-2) is:

$$Z_0 = 0.003m$$

The corrected wind speed (Ur_n) for each period (N) between disturbances (EPA 1995 Equation 5) is:

$$Ur_N = Ua_N \left[\frac{\ln\left(\frac{Z_r}{Z_0}\right)}{\ln\left(\frac{Z_a}{Z_0}\right)} \right]$$

The equivalent friction velocity (U_N) for each period between disturbances (EPA 1995 Equation 4) is:

$$U_N = 0.053 \cdot Ur_N$$

The following equation is obtained by substituting the equation for corrected wind speed into the equation for equivalent friction velocity. A calculation is shown for U_1.

$$U_N = 0.053 \left(Ua_N \left[\frac{\ln\left(\frac{Z_r}{Z_0}\right)}{\ln\left(\frac{Z_a}{Z_0}\right)} \right] \right)$$

$$U_1 = 0.053 \left(32.2 \left[\frac{\ln\left(\frac{10}{0.003}\right)}{\ln\left(\frac{7}{0.003}\right)} \right] \right) \left(0.447 \frac{m/s}{mph} \right) = 0.80 \frac{m}{s}$$

The calculated values for U1 and all other equivalent friction velocities are shown below:

$$U_1 = 0.80\frac{m}{s}$$

$$U_2 = 1.00\frac{m}{s}$$

$$U_3 = 0.76\frac{m}{s}$$

$$U_4 = 0.80\frac{m}{s}$$

$$U_5 = 0.60\frac{m}{s}$$

$$U_6 = 0.68\frac{m}{s}$$

$$U_7 = 0.74\frac{m}{s}$$

$$U_8 = 0.80\frac{m}{s}$$

$$U_9 = 0.65\frac{m}{s}$$

$$U_{10} = 0.80\frac{m}{s}$$

Because all equivalent friction velocities are less than the threshold friction velocity there is no erosion potential from the open excavation; therefore, there is no emission from the excavation.

$$E_w = 0$$

Total Emission Rate

The total emission rate (E) is the sum of the calculated emission rates:

$$E = E_{h-tot} + E_w = 216.8 + 0 = 216.8\frac{g}{yr}$$

Radionuclide Source Concentration

The average activity concentrations (S) (see attachments) from the area of excavation for uranium-238, radium-226, and thorium-232 (BNI 1987) are:

$$S_{U-238} = 66.9\frac{pCi}{g}$$

$$S_{Ra-226} = 60.8\frac{pCi}{g}$$

$$S_{Th-232} = 173.3\frac{pCi}{g}$$

Ratios of uranium isotopes can be calculated from the percentage of specific activity of uranium-238, -234, and -235 in natural uranium since these components make up total uranium. The percentage (P) contributed by each isotope ~~to the total specific~~ activity of ~~depleted~~ natural uranium (BNI 1995) is:

$$P_{U-238} = 47.249\%$$

$$P_{U-234} = 50.539\%$$

$$P_{U-235} = 2.212\%$$

The source concentration (S) of total uranium (U-tot), uranium-234, and uranium-235 are:

$$S_{U-tot} = \frac{S_{U-238}}{P_{U-238}} = \frac{66.9\frac{pCi}{g}}{47.249\%} = 141.6\frac{pCi}{g}$$

$$S_{U-234} = P_{U-234}S_{U-tot} = (50.539\%)\left(141.6\frac{pCi}{g}\right) = 71.6\frac{pCi}{g}$$

$$S_{U-235} = P_{U-235}S_{U-tot} = (2.212\%)\left(141.6\frac{pCi}{g}\right) = 3.1\frac{pCi}{g}$$

Multiplying the total emission rate (R) by each known radionuclide source concentration (S) gives the annual radioactivity emission rates ($R_{xx\text{-}xxx}$) for each known radionuclide.

$$R_{U-238} = S_{U-238}E = \left(66.9\frac{pCi}{g}\right)\left(216.8\frac{g}{yr}\right)\left(\frac{Ci}{10^{12}\,pCi}\right) = 1.45x10^{-8}\frac{Ci}{yr}$$

$$R_{U-234} = S_{U-234}E = \left(71.6\frac{pCi}{g}\right)\left(216.8\frac{g}{yr}\right)\left(\frac{Ci}{10^{12}\,pCi}\right) = 1.55x10^{-8}\frac{Ci}{yr}$$

$$R_{U-235} = S_{U-235}E = \left(3.1\frac{pCi}{g}\right)\left(216.8\frac{g}{yr}\right)\left(\frac{Ci}{10^{12}\,pCi}\right) = 6.72x10^{-10}\frac{Ci}{yr}$$

$$R_{Ra-226} = S_{Ra-226}E = \left(60.8\frac{pCi}{g}\right)\left(216.8\frac{g}{yr}\right)\left(\frac{Ci}{10^{12}\,pCi}\right) = 1.32x10^{-8}\frac{Ci}{yr}$$

$$R_{Th-232} = S_{Th-232}E = \left(173.3\frac{pCi}{g}\right)\left(216.8\frac{g}{yr}\right)\left(\frac{Ci}{10^{12}\,pCi}\right) = 3.76x10^{-8}\frac{Ci}{yr}$$

Using secular equilibrium the annual radioactivity releases (R_{xx-xxx}) in Ci/yr are:

$$R_{U-238} = 1.45x10^{-8}$$
$$R_{Th-234} = R_{U-238} = 1.45x10^{-8}$$
$$R_{Pa-234m} = R_{U-238} = 1.45x10^{-8}$$
$$R_{Pa-234} = 0.0016(R_{Pa-234m}) = 2.32x10^{-11}$$
$$R_{U-234} = 1.55x10^{-8}$$
$$R_{Th-230} = R_{U-234} = 1.55x10^{-8}$$
$$R_{Ra-226} = 1.32x10^{-8}$$
$$R_{U-235} = 6.72x10^{-10}$$
$$R_{Th-231} = R_{U-235} = 6.72x10^{-10}$$
$$R_{Pa-231} = R_{U-235} = 6.72x10^{-10}$$
$$R_{Ac-227} = R_{U-235} = 6.72x10^{-10}$$
$$R_{Ra-223} = R_{U-235} = 6.72x10^{-10}$$
$$R_{Th-227} = 0.9862(R_{Ac-227}) = 6.63x10^{-10}$$
$$R_{Fr-223} = 0.0138(R_{Ac-227}) = 9.27x10^{-12}$$
$$R_{Th-232} = 3.76x10^{-8}$$
$$R_{Ra-228} = R_{Th-232} = 3.76x10^{-8}$$
$$R_{Ac-228} = R_{Th-232} = 3.76x10^{-8}$$
$$R_{Th-228} = R_{Th-232} = 3.76x10^{-8}$$
$$R_{Ra-224} = R_{Th-232} = 3.76x10^{-8}$$

CAP88-PC Results

The CAP88-PC annual dose for the maximally exposed resident (d_r) and worker (d_w) were obtained by finding the maximum dose from the list of resident and workers listed in the assumptions. The maximally exposed resident was 105 m N and the maximally exposed worker was 50 m SSW.

$$d_r = 3.1x10^{-4}\ \frac{mrem}{yr}$$

$$d_w = 7.1x10^{-4}\ \frac{mrem}{yr}$$

Multiplying the annual doses by the occupancy factors (assumption), the effective doses for the nearest resident (D_r) and offsite worker (D_w) are:

$$D_r = (f_r)(d_r) = \left(3.1x10^{-4}\ \frac{mrem}{yr}\right)(100\%) = 3.1x10^{-4}\ \frac{mrem}{yr}$$

$$D_w = (f_w)(d_w) = \left(7.1x10^{-4}\ \frac{mrem}{yr}\right)(24\%) = 1.7x10^{-4}\ \frac{mrem}{yr}$$

SUMMARY OF RESULTS

The dose to the hypothetical maximally exposed individual (resident 105 m N) from inhalation of airborne radioactive releases generated from the excavation/loading of soil for offsite treatability testing at MISS (as described above) is 0.00031 mrem.

ATTACHMENTS

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Individual Assessment
Jul 26, 1995 11:56 am

Facility: Maywood Interim Storage Site
Address: 100 West Hunter Avenue
City: Maywood
State: NM Zip: 07607

Source Category: Airborne Radioactive Particulates
Source Type: Area
Emission Year: 1997

Comments: DPRA, Inc. for Bechtel National, Inc.
Calculation No. 14501-138-CV-098 Rev. 1

Dataset Name: MISS Treat. Exc.
Dataset Date: Sep 4, 1997 11:51 am
Wind File: C:\CAP88PC2\WNDFILES\LEA0189.WND

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

D O S E A N D R I S K E Q U I V A L E N T S U M M A R I E S

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Wind File: C:\CAP88PC2\WNDFILES\LEA0189.WND

Jul 26, 1995 11:56 am

SYNOPSIS
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RADIONUCLIDE EMISSIONS DURING THE YEAR 1997

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
U-238	Y	1.00	1.5E-08	1.5E-08
TH-234	Y	1.00	1.5E-08	1.5E-08
PA-234M	Y	1.00	1.5E-08	1.5E-08
PA-234	Y	1.00	2.3E-11	2.3E-11
U-234	Y	1.00	1.5E-08	1.5E-08
TH-230	Y	1.00	1.5E-08	1.5E-08
RA-226	W	1.00	1.3E-08	1.3E-08
U-235	Y	1.00	6.7E-10	6.7E-10
TH-231	Y	1.00	6.7E-10	6.7E-10
PA-231	Y	1.00	6.7E-10	6.7E-10
AC-227	Y	1.00	6.7E-10	6.7E-10
RA-223	W	1.00	6.7E-10	6.7E-10
TH-227	Y	1.00	6.6E-10	6.6E-10
FR-223	D	1.00	9.3E-12	9.3E-12
TH-232	Y	1.00	3.8E-10	3.8E-10
RA-228	W	1.00	3.8E-10	3.8E-10
AC-228	Y	1.00	3.8E-10	3.8E-10
TH-228	Y	1.00	3.8E-10	3.8E-10
RA-224	W	1.00	3.8E-10	3.8E-10

SITE INFORMATION

Temperature:	12 degrees C
Precipitation:	145 cm/y
Mixing Height:	1000 m

Jul 26, 1995 11:56 am

SYNOPSIS
Page 3

SOURCE INFORMATION

Source Number: 1

Source Height (m): 0.
Area (sq m): 765.

Plume Rise Pasquill Cat:	A	B	C	D	E	F	G
Zero:	0.	0.	0.	0.	0.	0.	0.

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.076	0.000	0.008
Fraction From Assessment Area:	0.924	1.000	0.992
Fraction Imported:	0.000	0.000	0.000

Food Arrays were not generated for this run.
Default Values used.

DISTANCES (M) USED FOR MAXIMUM INDIVIDUAL ASSESSMENT

50 100 105 130 145 155 160 170 200 230
250 270 310

Jul 26, 1995 11:56 am

SUMMARY
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INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

	Distance (m)						
Direction	50	100	105	130	145	155	160
N	1.0E-03	3.4E-04	3.1E-04	2.1E-04	1.7E-04	1.5E-04	1.5E-04
NNW	4.3E-04	8.5E-05	7.8E-05	5.4E-05	4.6E-05	4.1E-05	3.9E-05
NW	2.7E-04	7.9E-05	7.3E-05	5.1E-05	4.3E-05	3.9E-05	3.7E-05
WNW	2.9E-04	6.6E-05	6.0E-05	4.3E-05	3.6E-05	3.3E-05	3.1E-05
W	5.8E-04	1.7E-04	1.5E-04	1.1E-04	8.7E-05	7.8E-05	7.4E-05
WSW	7.9E-04	2.2E-04	2.0E-04	1.4E-04	1.1E-04	1.0E-04	9.6E-05
SW	8.2E-04	2.3E-04	2.1E-04	1.5E-04	1.2E-04	1.1E-04	1.0E-04
SSW	7.1E-04	1.8E-04	1.7E-04	1.1E-04	9.4E-05	8.4E-05	8.0E-05
S	7.3E-04	2.1E-04	1.9E-04	1.3E-04	1.1E-04	9.7E-05	9.2E-05
SSE	6.5E-04	1.7E-04	1.5E-04	1.1E-04	8.8E-05	7.8E-05	7.4E-05
SE	7.3E-04	2.0E-04	1.9E-04	1.3E-04	1.0E-04	9.3E-05	8.8E-05
ESE	7.8E-04	2.2E-04	2.1E-04	1.4E-04	1.2E-04	1.0E-04	9.7E-05
E	7.1E-04	1.9E-04	1.7E-04	1.2E-04	9.9E-05	8.8E-05	8.3E-05
ENE	7.2E-04	2.0E-04	1.8E-04	1.2E-04	1.0E-04	8.9E-05	8.5E-05
NE	7.6E-04	2.2E-04	2.0E-04	1.4E-04	1.1E-04	9.9E-05	9.4E-05
NNE	7.7E-04	1.8E-04	1.7E-04	1.1E-04	9.5E-05	8.4E-05	8.0E-05

	Distance (m)					
Direction	170	200	230	250	270	310
N	1.3E-04	9.8E-05	7.7E-05	6.7E-05	5.9E-05	4.7E-05
NNW	3.6E-05	2.8E-05	2.3E-05	2.1E-05	1.9E-05	1.6E-05
NW	3.3E-05	2.6E-05	2.2E-05	2.0E-05	1.8E-05	1.5E-05
WNW	2.8E-05	2.3E-05	1.9E-05	1.7E-05	1.6E-05	1.4E-05
W	6.7E-05	5.1E-05	4.1E-05	3.6E-05	3.2E-05	2.6E-05
WSW	8.7E-05	6.6E-05	5.2E-05	4.6E-05	4.0E-05	3.3E-05
SW	9.0E-05	6.8E-05	5.4E-05	4.7E-05	4.2E-05	3.4E-05
SSW	7.2E-05	5.5E-05	4.3E-05	3.8E-05	3.4E-05	2.8E-05
S	8.2E-05	6.2E-05	5.0E-05	4.3E-05	3.8E-05	3.1E-05
SSE	6.7E-05	5.1E-05	4.1E-05	3.6E-05	3.2E-05	2.6E-05
SE	7.9E-05	6.0E-05	4.8E-05	4.2E-05	3.7E-05	3.0E-05
ESE	8.7E-05	6.6E-05	5.3E-05	4.6E-05	4.1E-05	3.3E-05
E	7.5E-05	5.7E-05	4.6E-05	4.0E-05	3.5E-05	2.9E-05
ENE	7.6E-05	5.8E-05	4.6E-05	4.0E-05	3.6E-05	2.9E-05
NE	8.5E-05	6.4E-05	5.1E-05	4.5E-05	3.9E-05	3.2E-05
NNE	7.2E-05	5.5E-05	4.4E-05	3.8E-05	3.4E-05	2.8E-05