$U * HD/VG$, where U is the wind velocity, HD is the "dusty layer" thickness (nominally 1 m), and VG is the gravitational fall velocity for the particulate. Using Stoke's law for spherical particles and assuming a particle density of 2.0 g/cm^3 and a wind speed of 2.2 m/sec, one may readily compute values for the equilibrium buildup fetch of 9.4 km for 1 μ particles and 94 m for 10 μ particles.

If we take as the representative site extent the square root of the contaminated area A, then a tentative source strength correction fraction, F, may be computed using the ratio of site extent to equilibrium buildup fetch, or

$$F = \sqrt{A} * VG/U/HD. \quad (3)$$

For a contaminated area of large upwind extent, and over which wind blows a time fraction $TWIND$, the source strength YW for windblown re-suspension is

$$YW = \chi * HD * U * \sqrt{A} * TWIND. \quad (4)$$

With the stipulation that the value used for F may not exceed unity, we may write the corrected source term component for windblown suspension YWC as

$$YWC = RE * GNDCON * HD * U * \sqrt{A} * TWIND * F. \quad (5)$$

Application of Re-suspension Rate

The second source component results from non-wind associated mechanical disturbance of site surface soil, as might arise in land clearing or farming operations. We may define the fraction of time that the disturbance occurs to be $TMECH$. The source term component for non-wind mechanical disturbance YM is parameterized by the re-suspension rate RR (He80), having units of inverse seconds, to wit

$$YM = GNDCON * A * RR * TMECH. \quad (6)$$

The concept of a limited area source is implicit in the definition of RR, and no further correction need be considered. RR is usually treated as a disturbance dependent, time independent value, although it would be expected to vary, as does RE, due to the cumulative effects of processes that result in reduced contaminant availability. Successful parameterization of the time-dependence of RR awaits further data.

Conclusions

Atmospheric source strengths quantifying particulate re-suspension from wind and non-wind disturbance-driven processes may be computed for sites of small area. These values are useful in computing downwind air concentration values to evaluate risk to exposed populations. The net source strength YS for the site is the sum of the wind- and disturbance-driven components:

$$YS = YWC + YM. \quad (7)$$

A unified source strength approach includes both classes of re-suspension processes. More research is needed to satisfactorily express the time-dependence of re-suspension parameters, especially in non-arid climates where population densities are greater.

DAVID E. FIELDS
Health and Safety Research Division
Oak Ridge National Laboratory
P.O. Box X
Oak Ridge
TN 37830

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Numerical Analysis of Burial Ground Geography†

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Introduction

THE EVALUATION of consequences of low-level radionuclide waste disposal in shallow burial grounds by computer modeling requires specification of numerous parameters defining the local geography of the burial area. Numerical analysis of the information available in graphical form constitutes a convenient and time-efficient method of determining many such model parameters (Fi81a). As an example of numerical analysis of graphical data, we have used the MAGIC (Map Analysis and Graph Interpretation Code) program (Gl81a) to analyze survey plots of the Barnwell, South Carolina, burial ground to determine total surface area of burial trenches and the mean distance from trench areas to an identified aquifer surface seepage point located approx. 1 km distant from the burial area. The procedure we utilized required very little operator time, and updating the graphical information allows us to compute new geographic parameters appropriate to future configurations of burial areas at this site. This methodology and program may be of interest to other investigators needing to convert graphical information to numerical form.

Computer Methodology

The MAGIC digitization and image processing program is a stand-alone analysis and graphics package written for the Radio Shack TRS-80 micro-computer. The program features two methods of digitization—a keyboard-controlled cursor and a light pen. Image processing routines calculate perimeter, area, and distance to a specified point. An image overlay algorithm may be used to compute the intersection of two figures—the area common to both images. Several output options are offered in the MAGIC program. These include hard copy generation and cassette storage of figures. The program has a tutorial introduction, numerous user prompts, and a help command which generates expanded explanations of program options.

The code has been verified by computing perimeters and areas of regular polygons and by determining areas of selected states (GL81a). It has also been applied to the determination of denuded areas associated with strip mines in Tennessee and to finding the extent of overlapping drought-impacted areas in the California drought of 1976 and 1977 (Gl81b). Accuracy in determining polygon area is typically 1%.

Application to the Barnwell, South Carolina, Waste Disposal Area

Chem-Nuclear Systems, Inc., operates a 235-acre shallow land disposal area near Barnwell, South Carolina, that is used for the burial of low-level radionuclide waste. Approximately one tenth of this area is currently in use for waste disposal trenches, the remainder being buffer zone, administrative area, etc.

When performing estimates of potential health impact from the stored radionuclides, a parameter of interest is the distance of groundwater transport from the trench, or trenches, to a point of water usage. A description of the Barnwell facility (Ch80) identifies a spring 914 m southwest of the southern boundary of the disposal area. By utilizing a land utilization map of the Chem-Nuclear facility, we manually estimated the distance from the assumed centroid of the currently utilized

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Table 1. Relative γ radiation intensities in and relative strength of, different imported mantles

no	mantle	pCi/gm a	pCi/gm b	weight of mantle, (gm)	PSI	country imported from	import price per gross RLS[c]
1	Fargo	16	26	3.8213	48	India	770
2	Afshin	24	—	2.1989	>45	Hong Kong	828
3	Star	15	20	1.9691	—	Hong Kong	848
4	Sunshine	14	24	2.4606	21	China	—
5	Colem	13	22	2.3655	35	—	—
6	Yamaha	19	28	2.3306	>43	Hong Kong	1079
7	Optimus	18	30	3.0704	—	Sweden	888
8	National	12	—	1.2612	—	—	—
9	Unknown	12	14	2.9068	—	—	—
10	Unknown	13	18	3.0164	—	—	—
11	Day Light	16	22	1.3043	30	Hong Kong	780
12	General	23	25	2.2772	>47	Hong Kong	1088
13	Original	14	20	3.1155	49	Singapore	—
14	Coleman	23	29	2.0883	36	Canada	2001
15	Tiger Brand	24	28	1.6275	—	Hong Kong	—
16	International	23	—	1.5810	—	—	—
17	Anchor	32	35	2.4060	—	China	972
18	Red Heart	20	24	3.2313	29	Shanghai	—
19	Lion Brand	31	37	3.4863	33	Hong Kong	1032
20	Bee Lux	27	24	1.5902	59	Hong Kong	894
21	Light	14	18	2.4310	—	China	—
22	Luxor	16	17	2.4316	18	Austria	1292
23	Apollo	27	33	2.0649	37	Hong Kong	1071
24	Kayhan	23	15	1.6863	54	—	—
25	Afshin-Assl	21	24	3.4528	32	Hong Kong	828
26	Jam-Jaem	25	27	2.2295	42	Hong Kong	828

a- corrected against Cs-137
b- corrected against Th-232
c- one gross = 12 dozens
one Dollar = 86 Rials

unventilated shops, without covers, It is said that some people even apply mantle ash onto their wounds when it finally is torn down.

To determine the biological effect, a quantitative measurement of thorium is needed. It is a worthwhile effort to determine if these commercial products contain no more than 0.25% by weight thorium, the quantity stated by the ERDAs 10 CFR 40.13 (c) (I) Rules and Regulations, as unimportant. Selecting mantles that have more strength may result in fewer replacements and so, a less contaminated human environment. The method presented here might be a way to achieving such a goal, but is by no means conclusive.

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H. MOHAMMADI
S. MEHDIZADEH

Radiation Protection Center
Shiraz University
Iran

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Computation of Radionuclide Particulate Finite Area Fugitive Source Strengths*

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Introduction

COMPUTATION of risks from exposures to suspended particulates is required for both nuclear and nonnuclear assessments. This computation is often quite challenging due to the contribution from the resuspension of previously deposited material. This material may be resuspended by wind or by other mechanical disturbance and may constitute a significant source term leading to local and downwind exposures (Ko80). The release rate into the atmosphere is termed the source strength. A source strength must be known if downwind atmospheric concentration values are to be determined. Most previously developed numerical models of atmospheric transport (e.g. the ATM model (Mi73) and AIRDOS (Mo79) models) parameterize resuspension as a steady-state variable. The algorithm used is suitable only for sources of very large extent. The procedure we will develop here, a time-dependent parameterization suitable for finite sources, has been implemented in a recent transport and risk assessment model (Fi81; Li81).

Quantitative specification of the source strength must account for (1) the time dependence of the availability of deposited particulate when it becomes associated with soil particles and (2) the mechanically-driven particulate suspension by non-wind-derived forces. For both wind- and non-wind disturbances, source strength is directly dependent on the surface radionuclide inventory GNDCON, expressed as contaminant per unit area. The source strength is the arithmetic sum of two parts, that part parameterized by a time-dependent re-suspension factor *RE* (An75) and that part described by a re-suspension rate *RR* (He80).

A second consideration in computation of a source term is that account must be taken of non-infinite source areas and the diminished contribution expected from such areas.

Application of Re-suspension Factor

Re-suspension factors as usually compiled are appropriate only where the source area is very large. The re-suspension factor *RE* is defined as the ratio of the atmospheric concentration of a trace contaminant above such a contaminated area to the contaminant concentration on the surface. The surface concentration is taken to be the quantity per unit area previously deposited onto the site.

The value of *RE* is often assumed to be a site-specific constant value; more accurately, *RE* is a time dependent variable, the time-dependence of which reflects various physical processes that result in a lowered availability of contaminant for re-suspension. These processes include soil sorption, mechanical agglomeration, and downward migration of contaminant particles. Following Anspaugh, we may define

$$RE = 1.0E-4 * \exp(-0.15 * \sqrt{T}) + 1.0E-9, \quad (1)$$

where T is elapsed time (days) since termination of deposition and where *RE* has units of inverse meters. This time dependence of *RE* is derived from data collected in Nevada, and is probably conservative for more humid sites. If the contaminant is chemically active, further account should be taken of the effects of leaching, complexing, etc. As more data become available, re-suspension modelers will probably wish to modify the equation used for computing *RE*.

The atmospheric contaminant concentration may be computed using the expression

$$\chi = RE * GNDCON. \quad (2)$$

In this expression, χ is the atmospheric concentration of radionuclide immediately above the site at a height of about 1 m (Sh76), for a site of large upwind extent. Upwind extent may be interpreted as large if it exceeds the atmospheric build-up fetch, given by

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