SAND2004-2707
Printed June 2007

RADTRAN/RADCAT USER GUIDE

Ruth F. Weiner and G. Scott Mills, Sandia National Laboratories
Brandon O'Donnell and David Orcutt, University of Michigan
Terence Heames, Alion Science Inc.
Daniel Hinojosa

TABLE OF CONTENTS

WELCOME TO RADTRAN/RADCAT

RADTRAN is a program and code for calculating the risks of transporting radioactive materials. The first versions of the program, RADTRAN I and II, were developed for NUREG-0170 (USNRC, 1977), the first environmental impact statement on transportation of radioactive materials. RADTRAN and its associated software have undergone a number of improvements and advances consistent with improvements in computer technology.

DOWNLOADING AND CHECKING FOR THE LATEST VERSION

You can download the RADCAT/RADTRAN package from http://www.evolutionnext.com/radcat.

- On the web page, click on click here and fill out the application.
- When you are approved, you will be notified **by email**.
- When you are approved, you can click on Download Radcat. You will be asked for your username. Your username is the email address you listed in the application.
- When you sign in, you will be advised that you **may** want to download the Java Runtime Environment**.** Actually you **must** download the Java Runtime Environment if it is not already on your computer. To do this, go to http://www.java.com ; scroll to the green box at the upper right of the screen, and click on the yellow bar labeled "Get It Now."
- Download the Windows online installation. (You may want to download and read the instructions, but it isn't absolutely necessary.)
- Install the Java Runtime Environment (JRE) on your PC. If you are on a network, you may get a message indicating that you can't install. If this happens, you will need help from your network administrator to install it, or to give you access through a firewall. If you have a firewall (like ZoneAlarm) on the computer you are using, turn it off before installing the JRE.
- Once JRE is installed, you can go back to Download Radcat on the Main Menu and download RADCAT. You will be asked to integrate it to the desktop environment, which is suggested. When you launch RADCAT (the application), you may get a notice that says there is no certificate of authenticity; launch the application anyway. The process for applying for the certificate may not be complete.
- Once you have installed JRE, you can launch RADCAT either from JRE or from the RADCAT icon. If you want to download the latest version, go back to http://www.evolutionnext.com/radcat , click on Download Radcat, click on Launch the Application, and the latest version will be downloaded. you may get a notice that says there is no certificate of authenticity; launch the application anyway. The process for applying for the certificate may not be complete.

When you download RADCAT, you will be prompted to save the icon on your desktop. A Java Webstart icon can also be placed on your desktop. RADCAT/RADTRAN can be opened at any time from the desktop icon.

RUNNING RADTRAN WITH RADCAT

You can run an existing input file with RADCAT, by following these steps:

1. Open RADCAT.
2. In RADCAT, choose the file you want to run, either by using the **File** pull-down menu or by clicking on the **Open** icon. Your directory will appear and you can choose the file you wish to run. When you have selected a file, the title of the file will appear in the **Title** space.
3. Click on the **Run RADTRAN** icon (the icon showing a computer monitor). The output file will appear and can be saved to your computer.

SAVING AN INPUT FILE

You may save an input file at any time by clicking on the **Save** icon (the floppy disk). The **Save As** window will open and you can save the file in the normal Windows manner. Be sure to give your input file a ".in5" file extension (e.g. *filename*.in5).

GENERATING AN INPUT FILE WITH RADCAT

TITLE

When you try to enter a new title for a new file, the **Mode Selection** dialog box appears. You must select a transportation **mode** (highway, rail, or barge) before a new file can be created. A file cannot be created with more than one mode. Select a mode from the pull-down menu.

The **title** box says, e.g. "My Truck" (depending on the mode chosen). You may delete this and type a name for your file in the **title** box. Your file must have a title. After you type in the title, hit ENTER, otherwise the title will revert.

REMARKS

The **remarks** screen is for you to annotate your file; e.g., give a brief description of the problem, the sources of your input parameters, etc. When you click on **Add Remark** a line appears in the remarks screen. The word "REMARK" is on this line. You can delete it and enter your own remark (up to 80 characters per line. Click on **Add Remark** to append additional remarks.

CHOOSING YOUR ANALYSIS

Checking the **Incident Free** box results in analysis of routine, incident-free transportation only. Checking the **Accident** box results in analysis of transportation accidents only. Checking both the **Incident Free** and **Accident** boxes results in full analysis of both routine, incident-free transportation and transportation accidents.

OUTPUT

Output may be either as dose or as latent cancer fatalities. Dose output may be in historical units – rem or person-rem, as appropriate – or Standard International (SI) units – sievert (Sv) or person-sievert (person-Sv).

Some useful conversion factors are:

1 Sv = 100 rem
1 millisievert (mSv) = 100 mrem
1 gray (Gy) = 100 rad
(rem)*(5×10^{-4}) = latent cancer fatality probability (LCF) for the public
(rem)*(4×10^{-4}) = occupational latent cancer fatality probability (LCF)
1 becquerel (Bq) = one disintegration per second, the units of Bq are sec^{-1}
1 curie (Ci) = 3.7×10^{10} Bq

OUTPUT LEVEL

Four options are available for controlling output size:

1. Short output form. The input echo, incident-free, and accident and non-radiological risk tables printed. Size of output file is approximately 10 pages.
2. Output for #1 plus input tables, early effects values, ground contamination tables, intermediate tables and total expected population dose tables. Size of output file is approximately 24 pages.
3. Output for #2 plus consequence tables. Size of output file is approximately 27 pages.
4. Full output. Output for #3 plus sensitivity analysis. Size of output file is approximately 32 pages.

Check 1, 2, 3, or 4 under **Output Level**.

PACKAGE

If you are making a new input file or adding or deleting a package in an existing file, open the **Package** screen next after the **Title** screen. If you are editing an existing file without adding or deleting a package, the order in which you open the screens doesn't make any difference.

NAME

Give your package a name in the left-hand column. You can delete "SFUEL" and substitute any name that you like. If you wish to transport more than one package, click the **Add Package** bar and add as many packages as you wish. You will be adding packages to vehicles in later screens.

List all the packages that you will want for this run on this screen. You cannot add packages on other screens, nor can you delete them from other screens.

LONG DIMENSION

Enter the maximum dimension of the package, e.g. length of a cylinder if larger than the diameter, in meters. This is the "critical dimension" in RADTRAN.

DOSE RATE

Enter the external dose rate, at one meter from the package surface, in units of mrem/hr. Note that the regulations of 10 CFR Part 71 specify that the external dose rate *at two meters* from the package surface should not exceed 10 mrem/hour. This is equivalent to 14 mrem/hr at one meter from the package surface for a "critical dimension" of about 5 m. If the actual dose rate is not known, and one assumes that the shipper is abiding by regulations, one may use the regulatory maximum, 14 mrem/hr, as the external dose rate, recognizing that this value is conservative.

RADTRAN has a flag on the **Parameter** screen, REGCHECK, that imposes a regulatory constraint on the shipment (REGCHECK =1) such that RADTRAN will internally adjust the dose rate so that the external dose rate at two meters does not exceed 10 mrem/hr. If you want to lift this regulatory constraint, set REGCHECK = 0.

Remember that RADTRAN models the external dose rate as a source at the center of the package. The distance between the source and the receptor must take this into account.

GAMMA AND NEUTRON FRACTIONS

When you enter a value into either of these cells, RADCAT will automatically adjust the other cell so that the two add up to one.

RADIOISOTOPES

(NOTE: The title of this screen should really be "radionuclides". We have retained "radioisotopes" for RADTRAN historical reasons.)

If you are making a new input file, or adding or deleting a vehicle in an existing file, open the **Radioisotopes** screen next after the **Package** screen. If you are editing an existing file without adding or deleting a package, the order in which you open the screens doesn't make any difference.

At the upper left of the **Radioisotopes** screen is a pull-down menu of the packages you have created. Select the package whose inventory you wish to specify.

ADDING RADIOISOTOPES FROM THE INTERNAL LIBRARY

The window just below the package pull-down menu lists all of the radioisotopes in the internal RADTRAN radioisotope library. Radioisotopes may be added to your package by clicking on the **Add Library Isotope** arrow. The radioisotope name will then appear on the right-hand screen. Name the **Physical/Chemical Group** to which the radioisotope belongs. You may use any name you like, but the name can have no more than eight alpha-numeric characters. Remember that the release behavior in the event of an accident depends on the physical/chemical group (gas, particle, volatile substance, etc.). RADTRAN will accept up to 15 different physical chemical groups. Once you have added your first radioisotope, the **Physical/Chemical Group** entry will become a pull-down menu, so that you can select existing physical/chemical groups for other radioisotope entries. Physical/chemical groups must be entered at this screen; they cannot be entered on any other screen.

Enter the number of curies of the radioisotope in the **Curies** column.

ADDING RADIOISOTOPES THAT ARE NOT IN THE INTERNAL LIBRARY: USER-DEFINED RADIOISOTOPES

If the radioisotope your wish to add is not in the internal library, it may be added to your package. To do this, first click on the **Modify User Defined Isotopes** bar. The **User Defined Isotopes** screen will open. In this screen, click on the **Add User Defined Isotope** bar. You may then enter the name of the radioisotope in the left-hand cell (in place of ISOTOPE2), and it may be up to eight characters long.

You may then enter values for **Half Life, Photon Energy,** and dose conversion factors for **Cloudshine, Groundshine, Inhalation Dose, Gonad Inhalation Dose, Lung Inhalation Dose, Marrow Inhalation Dose. YOU MUST ENTER A VALUE LARGER THAN ZERO FOR THE HALF LIFE OF EVERY USER-DEFINED RADIONUCLIDE.** RADTRAN will crash if there is a radionuclide with a half-life of zero or with a negative half life.

If you fail to enter a value for the **Cloudshine** dose conversion factor, RADTRAN will run but will report zero for cloudshine dose. If you fail to enter a value for the **Groundshine** dose conversion factor, RADTRAN will run but will report zero for groundshine dose. If you fail to enter a value for the **Inhalation** dose conversion factor, RADTRAN will run but will report zero for inhalation and resuspension dose. If you fail to enter values for the **Gonad, Lung,** and/or **Marrow Inhalation** dose conversion factors, there will be no effect on cloudshine, groundshine, inhalation, or resuspension collective doses, but specific gonad inhalation, etc., doses will not be reported.

When you have added a user-defined radioisotope, the name of that radioisotope appears on the lower part of the **Radioisotope** screen. Using the **Add User Defined Isotope** arrow under that

screen, you add the user-defined radioisotope to your package, and indicate the physical/chemical group and number of curies as before.

IMPORTANT NOTE

Inhalation, resuspension, groundshine, and **cloudshine** doses are calculated for all radioisotopes: both those in the internal library and those that are user-defined. **Ingestion** doses are calculated by RADTRAN 5 only for radioisotopes in the internal radioisotope library.

VEHICLE

If you are making a new input file or adding or deleting a vehicle in an existing file, open the **Vehicle** screen next after the **Radioisotope** screen. If you are editing an existing file without adding or deleting a package, the order in which you open the screens doesn't make any difference.

VEHICLE NAME

Give your vehicle a name in the left-hand column. You can delete what is there and substitute any name that you like. If you wish to analyze more than one vehicle, click the **Add Vehicle** bar and add as many vehicles as you wish. Add packages to vehicles as follows:

1. Click on the vehicle you want to add the package to.
2. Then click on the package you want to add, and enter the number of these packages that you want to put on the vehicle.

You can put different packages on a vehicle. When you click on the vehicle, the number of each of the packages on that vehicle shows up in the **Number of Packages** column. If a package is not on a particular vehicle, the **Number of Packages** column will show a zero.

List all the vehicles that you will want for this run on this screen. You cannot add vehicles on other screens, nor can you delete them from other screens.

NUMBER OF SHIPMENTS

Enter the number of shipments.

VEHICLE SIZE

Enter the maximum dimension of the cargo section of the vehicle, or of the part of the vehicle holding the packages, in meters. This is the "critical dimension" of the vehicle in RADTRAN.

VEHICLE DOSE RATE

Enter the external dose rate, at one meter from the edge of the cargo-carrying part of the vehicle, in units of mrem/hr. Note that the regulations of 10 CFR Part 71 specify that the external dose rate *at two meters* from this edge should not exceed 10 mrem/hour. This is equivalent to 14 mrem/hr at one meter for a "critical dimension" of approximately 5 m. If the actual dose rate is not known, and one assumes that the shipper is abiding by regulations, one may use the regulatory maximum, 14 mrem/hr, as the external dose rate, recognizing that this value is conservative.

RADTRAN has a flag on the **Parameter** screen, REGCHECK, that imposes a regulatory constraint on the shipment (REGCHECK =1) such that RADTRAN will internally adjust the dose rate so that the external dose rate at two meters does not exceed 10 mrem/hr. If you want to lift this regulatory constraint, set REGCHECK = 0.

Remember that RADTRAN models the external dose rate as a source at the center of the package. The distance between the source and the receptor must take this into account.

GAMMA AND NEUTRON FRACTIONS

When you enter a value into either of these cells, RADCAT will automatically adjust the other cell so that the two add up to one.

CREW SIZE

Enter the number of crew members traveling on the vehicle.

CREW DISTANCE

Enter the **Distance** in meters from the crew to the nearest surface of the cargo. This distance is usually between 3 and 7 meters for large trucks.

On a train the dose to the crew on the moving train is not calculated by RADTRAN. "Crew" dose for rail shipments is the dose sustained by yard workers at classification stops along the route.

A barge usually has a crew of 10. Enter the average distance of the crew from the cargo.

CREW SHIELDING FACTOR

Enter a factor between 0 and 1 for crew shielding. This factor is the fraction of ionizing radiation to which the crew is exposed (the inverse of the shielding fraction), so that 1 = no shielding, and 0 = 100% shielding.

CREW VIEW

The **Crew View** is the largest dimension, in meters, of the cargo that faces toward the crew. This is usually the diameter of a cylindrical cask or the diagonal end dimension of a rectangular container or array.

EXCLUSIVE USE

A pull-down menu allows you to indicate whether the vehicle is exclusive use or not.

LINK

If you are making a new input file or adding or deleting a vehicle in an existing file, open the **Link** screen next after the **Vehicle** screen. If you are editing an existing file without adding or deleting a package, the order in which you open the screens doesn't make any difference.

NOTE: The parameter values in this screen can be provided by a routing code or a geographic information system (GIS). The routing code WebTRAGIS is available fro Oak Ridge National Laboratory at http://apps.ntp.doe.gov/tragis/tragis.htm.

LINK NAME

Give each route segment (**Link**) a name in the left-hand column. You can delete what is there and substitute any name that you like. Links do not need to be consecutive. You may divide the entire route into a rural link, which includes all rural segments, a suburban link, which includes all suburban segments, and an urban link, which includes all urban segments. The designation of rural, suburban, or urban is defined by the resident population density along the route (see **Population Density**).

VEHICLE

Available vehicle names are on a pull-down menu in the **Vehicle** column. Note that vehicle names cannot be added or deleted at this screen.

LENGTH

Enter the length of the route segment – the link – in kilometers, as obtained from a routing code like WebTRAGIS or from a GIS system or from a map.

A useful conversion factor is 1 km = 0.6217 mile.

SPEED

Enter the average speed of each vehicle on each link, in km/hr. Based on speed limits, we have used the following, very conservative values in RADTRAN in the past:

Trucks on freeways, primary U. S. highways, or limited-access highways: 88 km/hr (55 mph)
Trucks on two-lane rural roads: 72 km/hr (45 mph)
Trucks on urban or suburban two-lane roads: 40 km/hr (25 mph)
Trucks on city streets: 24 km/hr (15 mph)
Trucks in rush-hour traffic: one-half the non-rush hour speed on the particular road type
Trains on rural route segments: 64 km/hr (40 mph)
Trains on suburban route segments: 40 km/hr
Trains on urban route segments: 24 km/hr

POPULATION DENSITY

Enter the population density in persons/km^2, as obtained from WebTRAGIS , the City/County data book, or some other GIS system or source. This population density is usually provided for a band one-half mile (800 meters) on either side of the route. Rural, suburban, and urban population densities are classified by WebTRAGIS according to the following scheme:

rural: 0 to 139 persons/mi^2 (0 to 55 persons/km^2)
suburban: 139 to 3326 persons/mi^2 (55 to 1300 persons/km^2)
urban: more than 3326 persons/mi^2 (1300 persons/km^2)

The historic RADTRAN classifications are:

rural: 0 to 66 persons/km^2
suburban: 67 to 1670 persons/km^2)
urban: more than 1670 persons/km^2)

National averages are approximately

rural: 6 persons/km^2
suburban: 720 persons/km^2
urban: 3800 persons/km^2

Population density and vehicle speed are important parameters in determining the *off-link incident-free dose* from radioactive materials transportation. Population density is important in determining *accident dose risk.*

VEHICLE DENSITY

Enter the vehicle density – the vehicles that share the route with the radioactive cargo -- in vehicles per hour. National average vehicle densities that have been used in RADTRAN are

Truck
rural: 460 vehicles/hr
suburban: 780 vehicles/hr
urban: 2800 vehicles/hr
During rush hour the vehicle density may be assumed to double.

Rail
rural: 1vehicle/hr
suburban: 5 vehicles/hr
urban: 5 vehicles/hr

More accurate vehicle densities can usually be obtained from state traffic counts.

PERSONS PER VEHICLE (VEHICLE OCCUPANCY)

Enter the average persons per vehicle for the route. For highway transportation, this is usually 1.5 or 2 persons per vehicle. For rail, since most rail transportation is freight, the number is usually 3 (the train crew). If passenger trains share the route, the average vehicle occupancy can be estimated.

Vehicle density and vehicle occupancy are important parameters in determining the *on-link incident-free dose* from transportation of radioactive materials.

ACCIDENT RATE

Enter the accident rate for each route segment in accidents per vehicle-km. Accident rate is usually reported by state and type of road or rail. Useful references for accident rates are

Saricks, C.L. and Tompkins, M.M. 1999. State-Level Accident Rates of Surface Freight Transportation: A Reexamination. ANL/ESD/TM-150. Argonne, Illinois: Argonne National Laboratory.

The Bureau of Transportation Statistics web site: http://www.bts.gov

ZONE

A pull-down menu allows you to designate each link as rural, suburban, or urban. These designations must be applied because they modify certain RADTRAN calculations.

TYPE

A pull-down menu allows you to designate the road type as interstate or U. S. primary, secondary road, or “other,” which includes rail and barge. RADTRAN uses this designation.

FARM FRACTION

A fraction of land on rural route segments can be designated as farmland, and is then used in RADTRAN to calculate ingestion dose in the event of an accident. Farmland fractions should be set to zero on suburban or urban route segments.

STOPS

If you are making a new input file or adding or deleting a vehicle in an existing file, open the **Stop** screen next after the **Link** screen. If you are editing an existing file without adding or deleting a package, the order in which you open the screens doesn't make any difference.

NAME

Give each **Stop** a **Name** in the left-hand column. You can delete what is there and substitute any name that you like. You may aggregate all stops of a particular type (e.g., inspection stops, refueling stops) and just enter the total time for those stops. Different types of populations (e.g., other people at a refueling stop, residents near the stop) may be structured as different stops.

VEHICLE

Available vehicle names are on a pull-down menu in the **Vehicle** column. Note that vehicle names cannot be added or deleted at this screen.

MIN DISTANCE

Enter the shortest distance from the radioactive cargo to the receptor(s) whose dose from incident-free transportation you are calculating. The **Min(imum)** and **Max(imum) Distance** define the area around the radioactive cargo in which there are receptors at that particular stop.

MAX DISTANCE

Enter the longest distance from the radioactive cargo to the receptor(s) whose dose from incident-free transportation you are calculating. The **Min(imum)** and **Max(imum) Distance** define the area around the radioactive cargo in which there are receptors at that particular stop. The **Min(imum)** and **Max(imum) Distance** may be the same or may be different(see **People or People/km^2** below). The **Min(imum) Distance** can never be larger than the **Max(imum) Distance.**

PEOPLE OR PEOPLE/KM^2

This parameter defines the number of radiation receptors at each particular stop. If the **Min(imum)** and **Max(imum) Distance** are the same, enter the total number of people at that distance from the radioactive cargo; e.g., if there are 20 people all at 10 meters from the cargo, then enter 10 m for both **Min(imum) Distance** and **Max(imum) Distance**, and enter 20 for **People Or People/Km^2.** On the other hand, if the **Min(imum)** and **Max(imum) Distance** are different, the receptor population must be entered as a population density: persons/km^2, and this population density must be calculated off-line. For example, if there are 20 people around the cargo in an annular ring with a shortest distance to the cargo of 1 m. and a longest distance of 10 m., the population density in this annular ring may be calculated as follows:

Inner radius = 1 m.
Outer radius = 10 m.
Area of annulus = $\pi^*[(10)^2 - (1)^2] = 99\pi = 311 m^2 = 3.11 \times 10^{-4}$ km^2
Population density in the annulus = $20/(3.11 \times 10^{-4}) = 6.43 \times 10^4$ people/ km^2

Enter 1m for **Min(imum) Distance,** 10 m. for **Max(imum) Distance**, and enter 6.43×10^4 for **People Or People/Km^2**.

RADTRAN reads total population when the **Min(imum)** and **Max(imum) Distance** are the same, and reads population density when the **Min(imum)** and **Max(imum) Distance** are different.

SHIELDING FACTOR

The fraction of ionizing radiation to which the receptors are exposed; that is, the inverse of the amount of shielding, so that 1 = no shielding and 0 = 100% shielding. Enter a number between 0 and 1 for the shielding factor for each stop.

TIME

Enter the total time in hours for each type of stop.

HANDLING

Handling refers to sustaining a potential dose from the cargo packages during storage, loading, and unloading, and similar activities. Doses to handlers may also be calculated using the **Stop** screen and parameters.

If you are making a new input file or adding or deleting a vehicle in an existing file, open the **Handling** screen after the **Vehicle** screen. If you are editing an existing file without adding or deleting a package, the order in which you open the screens doesn't make any difference.

NAME

Give each group of **Handlers** a **Name** in the left-hand column.

VEHICLE

Available vehicle names are on a pull-down menu in the **Vehicle** column. Note that vehicle names cannot be added or deleted at this screen.

NUMBER OF HANDLERS

Enter the number of people in each group of handlers.

DISTANCE

Enter the average distance from the radioactive cargo to the handler group whose dose from incident-free transportation you are calculating.

TIME

Enter the total time in hours that each group of handlers is handling the cargo.

ACCIDENT

The accident analysis requires that you have entered a radionuclide inventory at the **Radioisotopes** screen, and accident rates and population densities at the **Link** screen. RADTRAN won't crash if you have failed to do this, but all your output will be zero.

When the **Accident** screen is opened, seven screens appear:

Probability
Deposition Velocity
Release
Aerosol
Respirable
Isopleth P
Pasquill/Dispersion

PROBABILITY

Probability is the conditional probability of an accident of a particular severity, given that an accident happens. Severity of an accident – how damaging the accident is – is a function of the transportation mode. A pull-down menu at the top of this screen allows selection of the mode (rail, highway, etc.)

PROBABILITY FRACTION AND INDEX

The **Probability Fraction** is the conditional probability of an accident of a particular severity (other discussions of RADTRAN have called it the "severity fraction"). The **Index** is a numbering system for **Probability Fractions** and simply enumerates them. Note that the **Index** begins with zero. The zeroth **Probability Fraction** is usually more than 90%, because it is the fraction of accidents that do not result in any emission or leakage of radioactive material. **Probability Fractions** may be obtained from studies of accidents like the following references:

Sprung, J.L., et al.. 2000. Reexamination of Spent Fuel Shipment Risk Estimates. NUREG/CR-6672. Washington, D.C.: U.S. Nuclear Regulatory Commission. Chapter 7, pp. 7-73 to 7-76.

DOE (U.S. Department of Energy) 2002. Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada. DOE/EIS-0250F. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. Appendix J.

Probability Fractions must add to 1.0. Enter the **Probability Fractions** in the right-hand column.

DEPOSITION VELOCITY

Deposition Velocity depends on the physical behavior of radionuclides that are emitted into the environment as particles. The **Group** column on the left has a pull-down menu of the physical chemical groups entered at the **Radioisotope** screen. Enter a **Deposition Velocity** in meters/sec for each **Group.** Gases have a **Deposition Velocity** = 0. Small particles often have a **Deposition Velocity** = 0.01 m/sec. **Groups** may not be added or deleted at this screen.

RELEASE

Release Fraction, the fraction of each radionuclide that could be released in an accident, depends on the physical behavior of the radionuclides and on the severity of the accident. The

pull-down menu at the top allows selection of the physical/chemical **Group. Groups** may not be added or deleted at this screen. Select a physical/chemical **Group** from the pull-down menu.

The left-hand column shows the **Index** number for each **Probability Fraction.** Enter a **Release Fraction** for each **Index** and each **Group. Indices** may not be added or deleted at this screen.

AEROSOL

The **Aerosol Fraction,** the fraction of each **Release Fraction** that would be aerosolized in an accident, depends on the physical behavior of the radionuclides and on the severity of the accident. The pull-down menu at the top allows selection of the physical/chemical **Group. Groups** may not be added or deleted at this screen. Select a physical/chemical **Group** from the pull-down menu.

The left-hand column shows the **Index** number for each **Probability Fraction.** Enter an **Aerosol Fraction** for each **Index** and each **Group.** In most accidents, only very fine particles are released, so that often the **Aerosol Fraction** = 1. **Indices** may not be added or deleted at this screen.

RESPIRABLE

The **Respirable Fraction,** the fraction of each **Aerosol Fraction** that consists of particles or droplets less than 10 microns in diameter, depends on the physical behavior of the radionuclides and on the severity of the accident. The pull-down menu at the top allows selection of the physical/chemical **Group. Groups** may not be added or deleted at this screen. Select a physical/chemical **Group** from the pull-down menu.

The left-hand column shows the **Index** number for each **Probability Fraction.** Enter a **Respirable Fraction** for each **Index** and each **Group.** The **Respirable Fraction** is usually between 0.05 and 0.1. **Indices** may not be added or deleted at this screen.

PASQUILL/DISPERSION

Open the **Pasquill/Dispersion** screen before you open the **Isopleth P** screen. Choosing **Dispersion** selects a set of **Isopleth Areas**, maximum **Centerline Distances** for each area, and corresponding **Time Integrated Concentrations** (dilution, or Chi/Q, factors) based on U. S. national average meteorology and wind speed. The number of areas may be added to or withdrawn using the bars at the bottom of the screen. **Isopleth Areas**, maximum **Centerline Distances** for each area, and corresponding **Time Integrated Concentrations** may be calculated externally using any Gaussian dispersion program, and can be entered manually into the table on this screen.

Choosing **Pasquill** opens a screen listing the six Pasquill **Stability Classes** in the left-hand **Stability Class** column and allowing the user to enter the **Fraction** of occurrence of each **Stability Class** in the **Fraction** column; these fractions must sum to 1.0. Note that in this option, wind speeds are constant for each **Stability Class,** as shown in the table below:

Stability Class	**Wind Speed (m/sec)**
A	1
B	2
C	3
D	4
E	2.5
F/G	1

ISOPLETH P

Open the **Pasquill/Dispersion** screen before you open the **Isopleth P** screen. **Isopleth P** allows you to enter a different population density for each isopleth area. **Isopleth P** may only be used with the **Dispersion** option on the **Pasquill/Dispersion** screen. Note that isopleth areas may not be added to or withdrawn at this screen.
3333

PARAMETERS

This screen lists values that have historically been used in RADTRAN for a variety of parameters. Any of these values can be overwritten by the user. A list of the functions of these parameters can be found in the RADTRAN 5.0 User's Manual.

SAVING, RUNNING RADTRAN, EXITING

The input file can be saved with either the **Save** or the **Save As** icon. The file may be run in RADTRAN by clicking on the **Run RADTRAN** icon (the computer icon). You will be prompted to save the file before you run it. If the file has already been saved, the prompt will not appear.

When RADTRAN is run, the output appears immediately on the screen, and may be printed and/or saved. It can be saved to any folder on your computer or LAN. Consult the RADTRAN 5.0 User's Manual for help interpreting the output file.

Exit from RADTRAN/RADCAT by clicking on the "x" in the upper right-hand corner