REFERENCE SHEET

CREATING RADTRAN 5 FILES WITH A TEXT EDITOR

Key:

[Brackets] indicate an optional statement
{Braces} indicate a required value
ALL CAPS indicates a keyword that must be entered

TITLE **{alphanumeric title}**
INPUT **{STANDARD or ZERO}**
FORM **{UNIT for population dose or NONUNIT for health effects}**
DIMEN **{# of severity categories} {# of nondispersal accident radii} {# of dispersal areas}**
PARM **{0 no plotting/1 plotting} {1 incident free/2 accident/3 both} {1/2/3/4 level of output} {0 User-supplied time-integrated concentration isopleths and areas/1 Pasquill stability fractions}**
SEVERITY
    NPOP=**{1 rural/2 suburban/3 urban}**
        NMODE=**{transport mode (see mode chart)}**
            {Severity Fraction 1} {Severity Fraction 2} {Severity Fraction 3...}
    [NPOP=...]
RELEASE
    GROUP=**{group name}**
        RFRAC
            {Release Fraction 1} {Release Fraction 2} {Release Fraction 3...}
        AERSOL
            {Aerosol Fraction 1} {Aerosol Fraction 2} {Aerosol Fraction 3...}
        RESP
            {Respirable Fraction 1} {Respirable Fraction 2} {Respirable Fraction 3...}
        LOS
            {Loss of Shielding Fraction 1} {Loss of Shielding Fraction 2...}
        DEPVEL
            Deposition Velocity of Group (m/s)
    [GROUP=...]
    [ISOPLETHP]
        {Population density of isopleth 1} {Population density of isopleth 2...}
    [AREADA]
        {Area of Isopleth 1 (m^2)} {Area of Isopleth 2...}
    [DFLEV]
        {Dilution Factor for Isopleth 1} {Dilution Factor for Isopleth 2...}
    [CLINE]
        {Center-Line Distance for Isopleth 1 (m)} {Center-Line Distance for Isopleth 2...}
    [PSPROB]
        {Pasquill Category A Fraction} {Pasquill Category B Fraction...}
[DEFINE] **{Radionuclide Name}**
    {Half-life (days)} {Photon Energy (MeV/disintegration)} {Cloudshine dose factor (rem-m^3/Ci-second)} {Groundshine dose factor (rem-m^3/μCi-day)} {50-yr committed effective dose equivalent for inhalation (rem/Ci inhaled)} {50-yr committed effective gonad dose for inhalation (rem/Ci inhaled)} {1-yr lung dose for inhalation (rem/Ci inhaled)} {1-yr marrow dose for inhalation (rem/Ci inhaled)}
        {Name for COMIDA Ingestion Data (or NONE)}
[DEFINE] **{Radionuclide Name...}**
PACKAGE **{alphanumeric identifier} {dose rate at 1m (mrem/hr)} {gamma fraction} {neutron fraction} {package dimension (m)}**
    {Radionuclide Name} {Package Inventory (Ci)} {Group Name}

[**{Radionuclide Name} {Package Inventory (Ci)} {Group Name...}**]
END
VEHICLE **{minus sign if shipment is exclusive} {transportation mode number (see mode chart)} {identifier} {dose rate at one meter from vehicle (mrem/hr)} {gamma fraction} {neutron fraction} {vehicle length (m)} {number of shipments} {number of crew members} {distance of crew from package (m)} {crew shielding factor} {crew view dimension (m)} {package identifier} {number of packages per shipment}**
[**{package identifier} {number of packages per shipment...}**]
[FLAGS]
{see flag chart}
[MODSTD]
{see standard values list}
EOF
LINK **{link identifier} {vehicle name} {segment length (km)} {velocity (kph)} {vehicle occupancy} {population density (persons/km^2)} {vehicle density} {accident rate (acc/km)} {R rural/S suburban/U urban} {1 interstate/2 non-interstate/3 other} {farm fraction}**
[LINK] **{link identifier...}**
STOP **{stop identifier} {vehicle name} {population density (annular) or number of persons (radial)} {minimum annular radius} {maximum annular radius (or same as minimum for radial)} {shielding fraction} {stop time (hr)}**
[STOP] **{stop identifier...}**
HANDLING **{handling identifier} {vehicle name} {number of handlers} {average handler distance} {handling time per package (hr)}**
[HANDLING] **{handling identifier...}**
EOF
EOI

Mode	Mode Number	Conveyance Types Associated with Mode
HIGHWAY	1	Any truck; usually a tractor-trailer(also called a "semi" or a combination truck)
RAILWAY	2	One or more railcars in a single train
WATERWAY_A	3	Any vessel; usually barge
WATERWAY_B	4	Any vessel; usually ocean-going ship (>3000 gross tons)
CARGO_AIR	5	Any plane carrying only cargo
PASNGR_AIR	6	Any plane carrying passengers & cargo
HIGHWAY_A	7	Any truck; usually small truck or passenger van
HIGHWAY_B	8	Any truck; usually cargo van/delivery truck as secondary vehicle with tractor-trailer as primary mode
HIGHWAY_C	9	Any truck, usually cargo van/delivery truck as secondary vehicle with rail as primary mode
HIGHWAY_D	10	Any truck; usually cargo van/delivery truck as secondary vehicle with cargo air as primary mode

Figure 1 – Mode Chart
Radtran 5 User's Guide

Flag Name	Flag Description	STANDARD Value
IACC	Setting this flag to 2 directs the code to work through all exposure pathways associated with atmospheric dispersal of package contents during an accident. The alternative value of IACC = 1, denotes non-dispersal and is used to examine particular scenarios such as loss-of-shielding or accidents involving non-dispersible package contents	2
ITRAIN	This flag, used only for rail mode, denotes whether shipment is by general freight (ITRAIN = 1) or by dedicated rail (ITRAIN = 2).	1
IUOPT	This flag is used to select a building shielding option. For the STANDARD value, persons in buildings are exposed at reduced rates and the reduction in dose rate is a function of the shielding factors RR, RS, and RU. Setting the IUOPT flag to 1 is equivalent to full shielding (everyone indoors is fully shielded and receives no dose). Setting the IUOPT flag to 3 is equivalent to no shielding (being indoors provides no protection and is the same as being outdoors).	2
REGCHECK	Setting this flag to 1 causes a series of regulatory checks to be performed. If any circumstances are identified that violate the regulatory requirements, then the appropriate parameter values are reset to the regulatory maximum and the calculation continues. The analyst may set REGCHECK = 0, which bypasses the regulatory-check subroutine.	1

Figure 2 – Flag Chart
Radtran 5 User's Guide

MODSTD STANDARD VALUES LIST
Radtran 5 User's Guide

BDF This is the Building Dose Factor. This factor describes the entrainment of aerosol particles in ventilation systems (i.e., the fraction of particles of an external aerosol that remain in aerosol form after passing through a ventilation system). The BDF is used to modify inhalation doses to persons in urban structures. The STANDARD value of 0.05 represents a conservative average across a series of building types, including residential, office, and industrial structures (Engelmann, 1990). This value is about five times higher than the value for high-rise buildings with air-conditioning systems used by Finley et al., (1980) for New York City, which has been used in RADTRAN in the past.

BRATE This factor represents breathing rate and is used for calculation of inhalation doses. The breathing rate (BRATE = 3.30E-04 m^3/sec) of the Reference Man (70-kg adult male at light work) derived from Shleien 1992; Table 12.6) has been used as the STANDARD value. The value in the cited table has been converted from liters per hour to m^3/sec.

CULVL This factor describes Clean-Up Level, which is the required level to which contaminated surfaces must be cleaned up. The STANDARD value is the EPA guideline of 0.2 μCi/m^2 (EPA, 1977). This value applies to the sum of deposited activity over all radionuclides of a multi-radionuclide material. Although never officially adopted by the EPA or superseded by another standard, this value has become a *de facto* standard (Chanin and Murfin, 1996). This is a controversial issue at present, and analysts who can justify use of more realistic values are urged to do so.

EVACUATION This parameter specifies evacuation time in days following a dispersal accident, where this includes time to respond to the accident and carry out a course of action. The STANDARD value is 24 h (1 day). Mills et al. (1995) analyzed 66 verified hazmat accidents in which evacuations were carried out and found that the mean evacuation time was approximately 1 hour. Even when response time is added, a 24-hour (1-day) value for this variable is conservative. [For non-dispersal accident evacuation, see TIMENDE.]

GECON This parameter specifies the Genetic Effects Conversion Factor. The STANDARD value is 1.0E-04 genetic effects/rem. This value is consistent with the recommendations of BEIR V (NRC/NAS, 1990) and ICRP 60 (ICRP, 1991). Estimates based on the only genetic effects (untoward pregnancy outcome and F_1 mortality) to have been documented in the atomic-bomb survivors have extremely high statistical and model uncertainties. Animal data, which is more reliable, consistently yield lower estimates. As noted in BEIR V, the recommended value is "probably …too high rather than too low" (NRC/NAS, 1990, p. 77).

INTERDICT This parameter specifies the threshold value for interdiction of contaminated land. The STANDARD value is 40, i.e., a value 40 times greater than CULVL, and it was taken from NUREG-0170 (NRC, 1977).

LCFCON This parameter specifies the Latent Cancer Fatality (LCF) Conversion Factors; units are LCFs per rem. The STANDARD values are 5.0E-04 LCF/rem for the general public and 4.0E-04 LCF/rem for workers. They have been adjusted for low-dose and low-dose-rate decrease in effects with a DDRRF (Dose and Dose Rate Reduction Factor) of 2. These values are consistent with the recommendations of BEIR V (NRC/NAS, 1990) and ICRP 60 (ICRP, 1991). The dose-response relationship is assumed to be linear with no threshold in order to agree with current regulations. However, the majority of available data indicate that the actual dose-response relationship at very low doses is likely to be considerably less and, as noted in BEIR V, is not incompatible with zero (NRC/NAS, 1990, p. 181). Thus, cancer risk estimates obtained from RADTRAN 5 will be generally conservative.

LOS The parameter is used to analyze loss-of-shielding accidents. It represents the fractional degradation of package shielding for each severity category in the analysis. Values may be any number between zero and 1.0.

NE This parameter is the neutron emission factor; it may be used to model neutron emissions following a loss-of-shielding accident. For commonly encountered radionuclides that spontaneously emit neutrons (curium-242, curium-244, and californium-242), the NE values are already available in the radionuclide library. All other radionuclides have no assigned NE factor. The NE keyword is applied only when the analyst wishes to assign a new value to an existing radionuclide or to a new material. The analyst must enter NE followed by the radionuclide name in standard format (or exactly as entered under keyword DEFINE) and the emission factor value in neutrons/s-Ci. The analyst must repeat the process (i.e., type NE followed by radionuclide name and NE factor value) for each radionuclide desired.

RADIST This parameter is used to specify an array of Radial Distances, which are used to define annular areas for dose-calculation purposes when the IACC Flag is set to 1.

RPCTHYROID This parameter is used to specify 1-year CEDE (rem per curie) to the thyroid from inhalation of radionuclides of iodine for estimation of early-mortality risk. Radioiodine mainly travels to and irradiates a single organ, the thyroid. In previous releases of RADTRAN, however, the 50-year CEDE was used to approximate the 1-year dose. One-year committed doses to the thyroid have been calculated directly for RADTRAN 5. This new parameter was not included in the internal radionuclide database, since it would have meant adding a new column containing zeros for all radionuclides but the radioiodines. The information has been included under the PRCTHYROID keyword instead. The STANDARD values are 1.27E+06 for iodine-131, 5.77E+06 for iodine-129, and 9.25E+05 for iodine-125.

SURVEY This parameter is used to specify the time (in days) required to survey contaminated land following a dispersal accident. The amount of deposited material removed by radioactive decay is calculated beginning with time of initial deposition. The longer a deposited material remains on the ground, the more is removed by decay and spread by forces such as wind and rain. The actual elapsed time between accident occurrence and completion of a survey is impossible to determine in advance, but is likely to be prolonged because of governmental and regulatory complexities. The STANDARD value is set to an unrealistically brief, but radiologically conservative, 10 days (NRC, 1977).

TIMENDE This parameter specifies the time, in days, required to effect evacuation following a non-dispersal accident. Three values are entered, one for each population-density zone (rural, suburban, and urban, in that order). TIMENDE represents the time required to move potentially exposed members of the public to safe distances beyond the areas specified by the RADIST keyword. The three STANDARD values are 0.67, 0.67, and 0.42 hours (Mills et al., 1995) [for dispersal accident evacuation, see EVACUATION]

UBF This parameter is the Urban Building Fraction; it describes either the fraction of the population that is indoors or the fraction of the area that is occupied by buildings, depending on the type of population model being used. The STANDARD value of 0.52 is for the latter model, and is taken from Finley et al. (1980). The value is most accurate for large cities such as New York and is somewhat conservative for smaller cities.

USWF This parameter is the Urban Sidewalk Fraction; it specifies the fraction of the population that is out of doors or the fraction of the population that occupies sidewalks, depending on the type of population model being used. The STANDARD pre-assigned value of 0.1 is for the latter model, and is taken from Finley et al. (1980). As with the UBF, this value is suitable for large cities and is conservative for smaller cities.

ADJACENT See DISTON

CAMPAIGN This keyword specifies the duration of the shipping campaign in years. The value calculated with CAMPAIGN is the total number of off-link persons exposed. This result may be used to perform external calculations of annual off-link dose. Annual dose values may be compared with total dose in multi-year shipping campaigns and are useful for assessing regulatory compliance with standards based on annual doses. The STANDARD value is 1.0 year, meaning a period of 365.25 consecutive days.

DDRWEF This keyword applies to rail mode only and specifies the Distance Dependent Rail Worker Exposure Factor. This factor is used to calculate the component of rail-worker dose that depends on distance traveled (e.g., exposure related to engine changes, crew shift-changes, etc., while en route). The STANDARD value of 0.0018 inspections/km is taken from Ostmeyer (1986).

DISTOFF This keyword specifies a set of three distances, in meters, used in off-link dose calculations for highway, rail, and barge modes. The three distances are: (1) the minimum perpendicular distance over which the off-link dose calculation will be integrated; (2) the minimum pedestrian-walkway width, for instances in which dose to pedestrians beside the link is calculated (see RPD for discussion of pedestrian density); and (3) the maximum perpendicular distance over which the off-link dose calculation will be integrated. DISTOFF must be followed one or more keywords that specify values for various link types. The STANDARD values, which are supplied for each link type, are from NUREG-0170 (NRC, 1977). The link types and values for each are:
FREEWAY Any limited-access divided highway. [30, 30, 800]
SECONDARY Any non-limited-access highway that is not a city street (27, 30, 800)
STREET Any city street. [5, 8, 800]
RAIL Any rail right-of-way in the U.S. [30, 30, 800]
WATER Any vessel. [200,200,800]

Note that the values are the same for FREEWAY and RAIL. Setting the first two values equal to each other is equivalent to a sidewalk width of zero and means there are no sidewalks or similar close-in areas where unshielded persons (pedestrians, bicyclists, etc.) may reasonably be expected to be found. For STREET, the sidewalk is modeled as being 3 m wide (Finley et al. 1980). The values for WATER conservatively model a narrow navigable waterway (e.g., Houston Ship Channel) and are taken from NUREG-0170 (NRC, 1977). The WATER values are the ones most likely to require modification by the analyst since other bodies of water that might be modeled have ship-to-shore distances that greatly exceed 200 m and even 800 m.

DISTON This keyword specifies a perpendicular distance (i.e., a distance measured along a line at right angles to the line of travel of the RAM shipment) between the RAM shipment and other traffic lanes, in meters. For three link types, DISTON represents the *average* perpendicular distance between the shipment *centerline* and the *centerline* of oncoming traffic lanes(s). In the passing-vehicle case, DISTON represents the distance between the shipment *centerline* and the *centerline* of adjacent passing vehicles (HIGHWAY mode only). DISTON must be followed by a second keyword that specifies the link type. The STANDARD values in parentheses in the following list are taken from Madsen et al. (1986, p. 36-37).
FREEWAY Any limited-access, divided highway [15.0 m];
SECONDARY Any non-limited access highway [3 m];STREET Any city street [3 m];
RAIL Any rail right-of-way [3 m].
An additional parameter for highway mode only is ADJACENT It represents the minimum perpendicular distance between shipment centerline and centerline of adjacent passing vehicles [4 m].

The FREEWAY value is based on the Madsen et al. (1986) model of a minimal Interstate configuration of 4 lanes with an average lane width of 5 m, in the most typical traffic configuration. The latter refers to the RAM shipment being in the outside lane, oncoming traffic in the corresponding outside lane, and passing vehicles in the inner lanes. The SECONDARY and STREET values are smaller because these roadways are modeled as being only 2 lanes wide with an average lane width of 3 m. The RAIL value is based on the minimum clearance between passing trains on double rail segments. The ADJACENT value represents the median value for all Interstate and secondary-road lane widths.

FMINCL This keyword is applied to rail mode only and specifies the minimum number of railcar classifications or inspections per one-way trip. The STANDARD value is 2 since there are always at least two inspections per one-way trip - one at the beginning and one at the end of each trip (Wooden, 1986).

FNOATT This parameter is applied to passenger-air mode only and specifies the Number of Flight Attendants. The STANDARD value is 4 (NRC, 1977).

FREEWAY See DISTOFF and DISTON

MITDDIST This parameter is used to calculate the maximum individual "in-transit" dose to a member of the public; it represents the minimum perpendicular distance, in meters, from the shipment centerline to an individual standing beside the road or railroad while a shipment passes. The STANDARD value is 30.0 m (NRC, 1977).

MITDVEL This parameter is used to calculate the maximum individual "in-transit" dose; it represents the minimum velocity, in km/hr, of a shipment. The STANDARD value is 24.0 km/hr (15 mph) (NRC, 1977).

RAIL See DISTOFF and DISTON

RPD This parameter is the Ratio of Pedestrian Density. It is used to calculate the density of unshielded persons on sidewalks and elsewhere in urban areas when the IUOPT Flag is not equal to 3 by indexing it to the population density of the surrounding area. RPD is also used in the calculation of accident consequences. The STANDARD is 6.0, which is based on empirical data from New York City (Finley, 1980). It means that the pedestrian density is six times the residential population density. This figure is likely to be conservative for most other urban areas, but similar data are seldom collected in other cities.

RR This parameter specifies the Rural Shielding Factor. The STANDARD value is 1.0 (i.e., no shielding). Although even wood-frame construction provides some shielding, the Rural Shielding Factor is set to 1.0 to conservatively account for the fact that rural economies involve a relatively large fraction of outdoor employment (farming, ranching, etc.). RR is used in incident-free dose and in dose-risk calculation for non-dispersal accidents.

RS This parameter specifies the Suburban Shielding Factor. The STANDARD value is 0.87, which represents a residential structure of wood-frame construction (Taylor and Daniel, 1982, p.12). RS is used in incident-free dose and in dose-risk calculations for non-dispersal accidents.

RU This parameter specifies the Urban Shielding Factor. The STANDARD value is 0.018, which represents an urban commercial building constructed of concrete block (Taylor and Daniel, 1982, p.12). RU is used in incident-free dose and in dose-risk calculations for non-dispersal accidents.

SECONDARY See DISTOFF and DISTON

SMALLPKG This parameter specifies the first Package Size Threshold. This parameter is used to determine the handling method that will be used for a package, which, in turn, is used in the calculation of handler dose. If a package is designated as "small" then an empirical algorithm for handling dose is used; if package dimensions exceed the threshold then another method is used. The STANDARD value for SMALLPKG is 0.5 m (Javitz, 1985). Although it is highly unlikely that this value will need to be altered, the analyst has the option to do so.

STREET See DISTOFF and DISTON