HUDU - The Hanford Unified Dose Utility Computer Code

R. I. Scherpelz

February 1991

**Prepared for the U.S. Department of Energy
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**Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
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UTILITY COMPUTER CODE

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SUMMARY

The Hanford Unified Dose Utility (HUDU) computer program was developed to provide rapid initial assessment of radiological emergency situations. The HUDU code uses a straight-line Gaussian atmospheric dispersion model to estimate the transport of radionuclides released from an accident site. For dose points on the plume centerline, it calculates internal doses due to inhalation and external doses due to exposure to the plume. The program incorporates a number of features unique to the Hanford Site (operated by the U.S. Department of Energy), including a library of source terms derived from various facilities' safety analysis reports.

The HUDU code was designed to run on an IBM-PC or compatible personal computer. The user interface was designed for fast and easy operation with minimal user training.

The theoretical basis and mathematical models used in the HUDU computer code are described, as are the computer code itself and the data libraries used. Detailed instructions for operating the code are also included. Appendices to the report contain descriptions of the program modules, listings of HUDU's data library, and descriptions of the verification tests that were run as part of the code development.

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1.0 INTRODUCTION

Effective response to a nuclear facility emergency requires efficient management of data, rapid evaluation and interpretation of potential impacts, and timely development of protective action recommendations. The use of the rapid calculational capability of computers to support these otherwise slow and labor-intensive tasks is essential in accomplishing response objectives. The Hanford Unified Dose Utility (HUDU) program was developed specifically to provide rapid initial assessment of radiological emergency situations on the Hanford site. Consistent with emergency response criteria, the program uses radiation dose factors from publications 26 and 30 of the International Commission on Radiological Protection (ICRP) to calculate inhalation and semi-infinite cloud air submersion doses. A straight-line Gaussian atmospheric dispersion model is used, and the program accesses a library of safety analysis report design-basis accident source terms.

The HUDU computer program was developed as part of the ongoing Emergency Management Support (EMS) System review and development activities. The EMS System, managed by the Pacific Northwest Laboratory(a) for the U.S. Department of Energy, provides the meteorological data and assessment capabilities required during an emergency response at the Hanford facility. The system combines minicomputer and personal computer hardware, sophisticated assessment models, and user-friendly software to provide reliable, fast, and cost-effective support for Hanford emergency response.

This report provides a description of the theoretical basis and mathematical models used in the HUDU computer code (Chapter 2). It also presents a description of the computer code and the data libraries used (Chapter 3). User instructions for operating the code are in Chapter 4. Appendix A contains descriptions of the program modules; Appendix B lists HUDU's data library. Descriptions of the verification tests that were run as part of the code development are presented in Appendix C.

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2.0 DESCRIPTION OF MODELS

This section describes the mathematical models and algorithms used in the HUDU computer code. The mathematical problem in developing HUDU was approached in two major parts: determining the atmospheric transport of radionuclides from the release point to the receptor locations, and estimating doses that would be received by a person exposed to the radionuclides at the receptor location.

2.1 ATMOSPHERIC TRANSPORT

The transport of radionuclides from the release point to a downwind receptor point is calculated using a straight-line Gaussian plume dispersion model. This model was chosen because of its simplicity, wide acceptance, applicability, and its speed of execution.

2.1.1 Basic Gaussian Plume Model

The Gaussian plume model works on the assumption that the terrain is flat and that atmospheric conditions, including wind speed and direction, remain uniform for the duration of the plume emission and transport. The radionuclides in the plume are transported from the release point by the wind, so that plume movement proceeds at the speed of the wind and in a uniform direction. As the plume travels downwind, diffusion mechanisms cause the plume to expand in the vertical and horizontal crosswind directions, continuously decreasing the radionuclide concentrations at the plume centerline.

The basic equation for the atmospheric dispersion of a plume of radioactive material is set in an (x, y, z) coordinate system with x horizontal and parallel to the wind direction, y horizontal but normal to the wind direction, and z vertical. The atmospheric dispersion for a plume released from a height, h_e , is calculated using Equation (2.1):

$$\frac{E}{Q}(x) = \frac{G_z}{2\pi\sigma_y\sigma_z u_h} \quad (2.1)$$

where $E/Q(x)$ = the time-integrated relative air concentration at ground level at a position x , downwind of the release point

σ_y = the crosswind dispersion coefficient

σ_z = the vertical dispersion coefficient

u_h = wind speed at the release height

G_z = term for vertical off-centerline correction, given by Equation (2.2):

$$G_z = 2 \sum_{n=-2}^2 \exp\left(\frac{-(2nH-h_e)^2}{2\sigma_z^2}\right) \quad (2.2)$$

where H = mixing layer depth.

The air concentration is integrated over the entire duration of plume passage to determine the effect of passage of the entire plume. Thus, the calculation assesses the impact from the entire quantity of radioactive material released during an accident rather than only the rate of material release.

The vertical dispersion term, G_z , incorporates the effects of releasing material from an elevated position. It also includes the effects of the depth of the mixing layer, which puts an upper boundary on the lower layer of the atmosphere in which the dispersion can occur.

In some conditions with a low mixing-layer depth, a uniform vertical distribution can be assumed at positions well downwind. In HUDU, this condition is met when the ratio of the mixing layer depth to the vertical dispersion coefficient is less than 0.758. For this case, the relative air concentration at point x is calculated by:

$$\frac{E}{Q}(x) = \frac{1}{\sqrt{(2\pi)} \sigma_y H u_h} \quad (2.3)$$

2.1.2 Diffusion Coefficients and Stability Classes

Since the model involves concentration distributions with a Gaussian shape, standard deviations fully specify the concentration distributions. These standard deviations are the dispersion coefficients in Equations (2.1) and (2.2). Several different sets of dispersion coefficients have been developed for use in Gaussian plume models; HUDU incorporates the commonly used Pasquill-Gifford-Turner (PGT) data set (Gifford 1961, 1976) through a parameterization developed by Martin and Tikvart (1968) and Tadmor and Gur (1969).

The amount of turbulence in the atmosphere is assumed to be related to atmospheric stability classes. Thus, in HUDU, the dispersion coefficients are presented as a function of downwind distance and are listed as a function of atmospheric stability class. The scheme used in conjunction with PGT dispersion coefficients has seven classes:

- A: Extremely unstable
- B: Moderately unstable
- C: Slightly unstable
- D: Neutral
- E: Slightly stable
- F: Moderately stable
- G: Extremely stable

The HUDU code is designed to use one of the stability classes to choose the proper set of dispersion parameters.

2.1.3 Elevated Releases

The calculation of the atmospheric transport of a release from a point significantly elevated above the ground has different features than the

calculation of a ground-level release. For a ground-level release, the wake effect caused by wind eddying around buildings can increase dispersion, but elevated releases are usually above such ground-level turbulence.

For an elevated release, adjustments must also be made for the assumed wind speed. Wind speed is often measured at 10 meters above ground level, but the calculation of plume transport should use the wind speed at the plume centerline, which is at the effective release height. Thus, the calculation must make an adjustment for the vertical wind profile to convert the ground-level wind speed to the speed at the height of the release (Panofsky and Dutton 1984)(a):

$$u_h = \frac{u^*}{0.4} \ln \left(\frac{z}{z_0} - \psi \right) \quad (2.4)$$

where u_h = wind speed at release height (m/sec)

u^* = characteristic wind speed, usually at ground level (m/sec)

z = height above ground (m)

z_0 = surface roughness length (cm)

ψ = dimensionless empirical parameter that varies with atmospheric stability (Golder 1972).

2.1.4 Plume Rise

Effluents released into the atmosphere can be pushed higher into the air at the beginning of its downwind transport by either buoyancy or momentum effects. The effective release height of a plume is therefore expressed as:

$$h_e = h_s + h_r \quad (2.5)$$

where h_s is the actual height of the stack (in m) and h_r is the plume rise due to buoyancy and momentum.

(a)The model used in HUDU for finding the wind speed at an elevated position is the same model used in the computer code GENII (Napier et al. 1988).

The effluent's buoyancy would result from a high temperature of the effluent, such as might occur during a fire. The momentum effects are proportional to the effluent flow rate and would arise if the effluent were forced out of an opening like a stack (e.g., if driven by a fan).

The HUDU code uses the same plume rise models that are incorporated in the computer code GENII. These models are derived from Briggs (1984). Plume rise is directly related to the momentum and buoyancy of the effluent and is inversely related to the wind speed. In addition, the extent of plume rise is affected by atmospheric stability and may be limited by the top of the mixing layer. Evaluation of plume rise requires information on stack dimensions and flow, effluent density and temperature, and ambient air temperature.

The following relationships from Briggs (1984) provide a consistent set of plume rise estimates for all wind and stability conditions.

Two parameters, buoyancy flux and momentum flux, are used in computing plume rise. The buoyancy flux parameter, F_b , is defined as:

$$F_b = g \frac{(\rho_a - \rho_o)}{\rho_a} w_o^2 r_o^2 \quad (2.6)$$

where g = gravitational constant (9.8 m/sec^2)

ρ_o = density of the plume (kg/m^3)

ρ_a = density of air (kg/m^3)

w_o = stack exit velocity (m/sec)

r_o = inside radius of the stack (m).

The buoyancy flux parameter has dimensions of m^4/sec^3 . The momentum flux parameter, F_m , is defined as:

$$F_m = (\rho_o/r_a) (w_o^2 r_o^2) \quad (2.7)$$

It has dimensions of m^4/sec^2 .

The momentum component of plume rise, h_m , is assumed to be limited by atmospheric turbulence, as given by Equation (2.8):

$$h_m = \frac{0.9 [F_m/uu^*]^{1/2}}{0.4 + 1.2 (u/w_o)} \quad (2.8)$$

where u is the stack-height wind speed and u^* is a characteristic wind speed (see Equation [2.4]).

The buoyancy component of plume rise, h_b , is estimated using Equations (2.9), (2.10), and (2.11). During unstable and neutral atmospheric conditions, the buoyancy rise component is given by:

$$h_b = 1.54 [F_b/(uu^*)]^{2/3} h_s^{1/3} \quad (2.9)$$

During stable atmospheric conditions with a release height wind speed of 1 m/sec or more, the buoyancy rise component is given by:

$$h_b = 2.6 [F_b/(us)]^{1/3} \quad (2.10)$$

where s is the stability parameter defined in Equation (2.12), below. In stable atmospheric conditions, if the wind is less than 1 m/sec, the buoyant plume rise component is estimated as:

$$h_b = 5.3 [F_b/s^{3/2}]^{1/4} - 6 r_o \quad (2.11)$$

The stability parameter, in Equations (2.10) and (2.11) is defined as:

$$s = \frac{g}{\theta} \frac{\partial \theta}{\partial z} \quad (2.12)$$

where g = the gravitational constant (9.8 m/sec)

θ = the potential temperature of the air ($^{\circ}K$)

$\partial\theta/\partial z$ = the potential temperature lapse rate ($^{\circ}\text{K}/\text{m}$).

Near sea level, the stability parameter may be approximated as:

$$s = \frac{c}{T} \quad (2.13)$$

where c is a constant that is defined by stability class, and T is the ambient air temperature ($^{\circ}\text{K}$). The values of c for E, F, and G stability classes are 0.049, 0.27, and 0.49 K/sec^2 , respectively.

When Equation (2.10) or (2.11) is used to compute the buoyant component of plume rise, the estimated rise is compared with the rise computed using Equation (2.9). The smaller of the plume rise estimates is then used in computing the final plume rise.

Final plume rise, which is the sum of the momentum and buoyant components, is subject to these constraints: Final plume rise is set to zero if 1) the release height is greater than the mixing layer thickness or 2) the stack exit velocity is equal to zero. Under other conditions, the rise is limited to one-half of the distance between the top of the stack and the top of the mixing layer.

The plume rise component in Equations (2.8), (2.9), (2.10), and (2.11), and the effective release height estimate in Equation (2.5) give the height of the plume after it has become essentially horizontal. These equations should not be used to estimate concentrations near the release point because small changes in effective release height result in large changes in estimated ground-level concentrations near the release point. If concentration estimates are needed for locations within a few hundred meters of a stack, the estimates should be made using more appropriate relationships. In most cases, concentration estimates near an elevated release should be viewed with caution, particularly if the release parameters or atmospheric conditions are not well known.

As the distance from the release point increases, the sensitivity of concentration as a function of release height decreases. In most atmospheric conditions, at distances greater than 1 or 2 kilometers, the concentration estimates for elevated release should not be sensitive to moderate changes in release height.

2.1.5 Building Wake Effect

When a plume is released near a building, the dispersion is affected by the disruption of the winds caused by the building. This effect is called the building wake effect. The building wake effect model used in HUDU was developed by Ramsdell (1988) and it is identical to the model used in the GENII computer code. The basic equation used to calculate atmospheric transport when the release occurs near a building is given by:

$$\frac{E}{Q}(x) = \frac{1}{(F_o + F_p + F_w)} \quad (2.14)$$

where F_o = the flow rate associated with the release

$$F_p = 4\pi \sigma_y \sigma_z u \quad (2.15)$$

$$F_w = [k x^a A^b U^c S^d]^{-1} \quad (2.16)$$

where x = distance from the release point (m)

A = projected building area (m²)

S = atmospheric stability class (1 = A, 2 = B, ...).

$$\left. \begin{array}{l} k = 150 \\ a = -1.2 \\ b = -1.2 \\ c = 0.68 \\ d = 0.5 \end{array} \right\} \quad \text{dimensionless parameters}$$

When a plume is released from a low stack near a building, the building wake effect could occur if the stack height is less than 2.5 times the building height. To account for this effect, the Split-H model was developed for releases in which the actual release height is equal to or greater than the height of the tallest building in the area (NRC 1977). Assuming this condition, a release is considered to be elevated when the ratio of vertical velocity to wind speed is equal to or greater than 5. If this ratio is between 1 and 5, it is assumed that a portion of the release is elevated and the remainder is at ground level. If the ratio is less than 1, the release is considered to be ground-level.

The exact form of the implementation of the model (NRC 1977) is shown in Equation (2.17):

$$E/Q = M(E/Q)_{entr} + (1 - M) (E/Q)_{elev} \quad (2.17)$$

where E/Q = normalized concentration predicted by the Split-H model

M = fraction of time that the plume is entrained in the building wake (see Equation [2.18] below)

$(E/Q)_{entr}$ = normalized concentration in the building wake predicted for a ground-level release

$(E/Q)_{elev}$ = normalized concentration at ground level predicted for an elevated release.

The fraction of time that the plume is entrained in the wake (M) is estimated from the ratio of the effluent vertical velocity (w_0) to the release-height wind speed (u_r), according to:

$$M = \begin{cases} 1 & w_0/u_r < 1.0 \\ 2.58 - 1.58 (w_0/u_r) & 1.0 \leq w_0/u_r < 1.5 \\ 0.3 - 0.06 (w_0/u_r) & 1.5 \leq w_0/u_r < 5.0 \\ 0 & w_0/u_r \geq 5.0 \end{cases} \quad (2.18)$$

The 10-m wind speed is used in the building wake model. However, when the Split-H procedure is used, the release-height wind will be used to

determine the fraction of time that the release is in the wake and will be used to estimate diffusion when the plume escapes the wake.

2.1.6 Other Atmospheric Transport Effects

There are several other modifications to the atmospheric transport model that were considered but were not included in HUDU. Modifications for uneven terrain might have been included to more accurately account for differences in elevation between the release point and different receptor points. Such modifications were not included in HUDU because of the difficulty of acquiring sufficient input data on an emergency basis.

Two mechanisms commonly used to deplete the plume as it traverses the ground, wet and dry deposition, also were excluded. Wet deposition accounts for the radionuclides washed out of the plume by precipitation. Dry deposition accounts for radionuclides that cling to the ground or vegetation as the plume moves along. With both types of deposition mechanisms, ignoring the effects of plume depletion results in a conservative dose assessment for plume exposure pathways, so there is no danger of an underestimate of the evaluated downwind doses. Neither type of depletion was included in HUDU, but the omission will give a conservative estimate of downwind concentrations.

2.2 DOSE ASSESSMENT

Doses are calculated at the selected positions on the plume centerline for two exposure pathways, inhalation of radionuclides in the plume and external exposure to radionuclides in the plume. These pathways were chosen because they produce the highest doses in the time frame immediately after the beginning of a release, and protective actions are based on these calculations.

2.2.1 Radioactive Decay and Ingrowth During Transport

An accurate estimate of the dose delivered downwind must begin with a good estimate of the quantity of radionuclides present at the receptor location. Radionuclides released in the plume experience radioactive decay as the plume moves downwind from the release point, and this decay can result in the production of progeny nuclides. The calculation of radionuclide concentrations at the receptor locations includes the effects of radioactive decay and buildup during plume transit.

The computer code HUDU calculates radioactive decay and buildup using a chain decay processor similar to the routine used in the computer code GENII (Napier et al. 1988). This chain processor uses a recursive application of the Bateman equations (Bateman 1910), which provides a simple means of solving the differential equations describing chain decay. For radionuclide j , the radioactive decay is described by Equation (2.19):

$$Q_j(t) = Q_j(0)e^{-\lambda_j t} \quad (2.19)$$

where $Q_j(t)$ = activity of nuclide j at time t

$Q_j(0)$ = activity of nuclide j at time 0

λ_j = radioactive decay constant

t = radioactive decay time (same as the plume travel time).

The production of radionuclide j from its parent nuclide i , where j is the n th member of the decay chain below i , is given by Equation (2.20):

$$Q_j(t) = Q_i(0) \prod_{k=2}^n (\lambda_k f_k) \sum_{m=1}^n \frac{e^{-\lambda_m t}}{\prod_{\substack{p=1 \\ p \neq m}}^n (\lambda_p - \lambda_m)} \quad (2.20)$$

where Q = activity

λ_k = radioactive decay constant

f_k = fraction of decays of nuclide (k-1) that produce nuclide k

t = plume travel time.

The radionuclide library used in HUDU is derived from the library used in GENII (Napier et al. 1988). This data set was based on the DRALIST data of Kocher (1981). The radionuclides in the library are grouped in decay chains, with up to eight members in each chain, and each member of the chain may have up to two different parent nuclides in the chain.

2.2.2 Dose Commitment from Inhalation

For the inhalation pathway, the committed dose equivalent is calculated for each of four organs: lungs, thyroid, bone marrow, and bone surface. The committed effective dose equivalent is also calculated. In ICRP Publication 26 (ICRP 1977), the committed dose equivalent is defined as the dose equivalent integrated over 50 years following the radionuclide intake. This time period is recommended by the U.S. Environmental Protection Agency in its protective action guides for assessing the potential consequences of an accidental release (EPA 1980).

After the committed dose equivalents to individual organs are calculated in HUDU, they are compared to each other and the highest value is reported. Some released radionuclides tend to concentrate in a single organ, delivering a much higher dose to that organ than to the rest of the body. A typical example of this effect is radioiodine, which quickly moves through the bloodstream to the thyroid after inhalation and gives a relatively high dose to the thyroid. A decision to order protective actions in an emergency must take into account the highest organ dose in addition to the dose to the rest of the body.

The committed dose equivalent to an organ, o , is calculated in HUDU using Equation (2.21):

$$H_o = \sum_i X_i' \dot{B} F_{oi} \quad (2.21)$$

where H_o = committed dose equivalent to organ, o

X_i' = air concentration of nuclide, i, adjusted for radioactive decay and buildup

$\dot{B}$ = breathing rate

F_{oi} = inhalation dose factor to organ, o, from nuclide, i.

The inhalation dose factors were calculated using the INTDF module of the GENII computer code (Napier et al. 1988). These factors were calculated using models compatible with ICRP 26 and ICRP 30 guidance. The dose to each organ accounted for "cross-organ" contributions from the deposition of inhaled radionuclides in all components of the body. The dose factor calculation assumed that the radionuclide intake would occur during a short period of time at the beginning of the 50-year dose commitment time period. The models used in calculating the inhalation dose factors form the theoretical basis for calculating the inhalation doses.

The magnitude of doses to internal organs from inhaled radionuclides depends on the particle size of the inhaled aerosols that carry radionuclides into the respiratory system. These particles must be within a range of sizes between about 0.1 and 10 μm in order to be retained in the respiratory system, where the radionuclides can be absorbed into the bloodstream. The rate of absorption of radionuclides into the bloodstream depends on the size of the particles, so the resulting doses also depend on particle size. The inhalation dose factors used in HUDU assumed that the inhaled particles had a distribution of sizes with an activity mean aerodynamic diameter (AMAD) of 1 μm .

The committed effective dose equivalent is a weighted summation of the committed dose equivalents to individual organs, as shown in Equation (2.22):

$$H_E = \sum_o w_o H_o \quad (2.22)$$

where H_E = committed effective dose equivalent

w_o = weighting factor for organ, o

H_o = committed dose equivalent for organ, o.

The weighting factors were chosen to account for the relative radiosensitivity of each organ. Using this weighting scheme, effective dose equivalent can provide a realistic estimate of the radiological hazard of an exposure to radiation.

The calculation of committed effective dose equivalent in HUDU is identical to the calculation of committed dose equivalent for the other four organs. It also uses Equation (2.21), using the subscript "E" instead of "o". For each radionuclide, a committed effective dose equivalent factor was derived from the radionuclide's individual organ factors produced by the INTDF code in the GENII package, using the following weighting scheme, recommended by ICRP 26:

Gonads	0.25
Breast	0.15
Red marrow	0.12
Lung	0.12
Thyroid	0.03
Bone surface	0.03
Remainder	0.30

The weighting factors for the organs would be expected to vary according to the age and sex of the exposed individual, but the values shown here were chosen by the ICRP to be appropriate for a large population of people. A set of weighting factors typical of the general population is appropriate for an emergency response code, since the potentially exposed population is usually composed of a general mix of people of both sexes with the entire possible range of ages.

The organ called "remainder" was chosen as the average of five organs not included in the first six organs in the above list. For each radionuclide, the committed dose equivalent factors for all organs were

calculated, and the five organs (not including gonads, breast, red marrow, lung, thyroid and bone surface) with the highest values were used for the remainder organ. The four components of the gastro-intestinal tract (stomach, small intestine, upper large intestine, and lower large intestine) were usually included in the remainder. Other organs commonly included were the liver, bladder, kidney, and spleen.

2.2.3 External Dose from Exposure to the Plume

The external dose is calculated using a semi-infinite cloud submersion model. The semi-infinite cloud model has some well-known limitations, such as underestimating doses when the plume is overhead, or overestimating doses for a ground-level but narrow plume. More sophisticated models, such as a finite plume model, are not subject to these limitations, but usually require much longer execution times. Since HUDU uses a simple but fast algorithm for atmospheric dispersion, it is consistent to also use a simple, fast algorithm for calculating external doses.

The calculation of external dose in HUDU is very similar to the calculation of inhalation doses, using Equation (2.23):

$$H_x = \sum_i X_i' F_{xi} \quad (2.23)$$

where H_x = external dose equivalent

X_i' = air concentration of nuclide, i , adjusted for radioactive decay and buildup

F_{xi} = external dose factor from nuclide, i .

The dose factors were determined by considering the dose to individual organs inside the body, then applying a weighting factor. The external dose is, therefore, in the form of effective dose equivalent. It can be compared to the effective dose equivalent value calculated in the internal dose estimation.

3.0 DESCRIPTION OF COMPUTER CODE

The computer code HUDU is written in two languages, FORTRAN and C, for operation on a personal computer. The code uses menus, color displays, and simplified keystroke entry to ensure ease of use.

3.1 HUDU FEATURES

3.1.1 Computer Environment

The HUDU code was written with the Microsoft Fortran and Microsoft C compilers on the MS-DOS operating system. It also uses the C Utility Library, a collection of utilities from Essential Software, Inc., that performs screen handling and collection of data entered by the keyboard.

Written on an IBM-PS/2 personal computer, HUDU will run on any IBM-PC or PC-compatible using MS-DOS. Any 80x86 CPU will handle the code, although an 80286 or faster CPU is recommended for acceptable execution speed. A math coprocessor (80x87) is strongly recommended for acceptable computation speed, although if a coprocessor is not present, the code will run under a coprocessor emulation mode. Code execution requires 640 kilobytes of memory. The code will run from either a flexible disk (720-kB capacity or greater) or a hard disk, but performance will be much better from a hard disk. The menus were written for a color display and color will enhance clarity, but a monochrome screen will work if the color mapping is carefully chosen.

3.1.2 Functional Features

The HUDU code was written to be easy to use in an emergency. In many cases, default values are automatically included for use in a run. The on-screen summary indicates whether data were chosen by default, were derived from a historical record, or were entered by the user. The user may use or replace any default or historical values before performing the calculations.

The code input was designed in a menu-based format for clarity and ease in making rapid decisions on input. Much of a HUDU run is controlled by the HUDU main control menu. This menu allows the user to select code options, select or modify code defaults, and move to sub-menus for data entry. The main control menu presents a summary status of the data that is already available for code execution. The summary status of available data also includes an indicator showing the source of the data.

Input data are always entered through a submenu rather than through the main control menu. Each submenu is tailored for the type of data being entered or option being selected. Several submenus do not accept data entry, but allow the user to select a condition; the user moves a cursor or highlighting bar to the desired choice, then presses a key to accept the selection. For data entry, a choice of units is usually given. The user can again highlight the desired data units, type in the numerical value, and then press the "Return" key to enter the data.

Any default data or any data that had been previously entered may be corrected or updated by, first, selecting the corresponding choice from the main control menu, then going to the submenu to enter the new data. The main control menu will then indicate that this value was entered by the user.

The user may choose any of four possible release conditions:

- open area ground-level release
- open area elevated release
- ground-level release
- elevated release near a building

The selection determines the height of the release and whether plume rise or building wake effect should be considered in the calculation.

After a release condition has been chosen, HUDU has enough data available to perform an atmospheric dispersion calculation, so the main control menu will display a "Go" option in the lower corner. While the Go option is displayed, the user may continue to select items from the main

control menu for additional data entry or option selection. However, when the user selects "Go", the main control menu will disappear and HUDU will perform the atmospheric dispersion calculation. If released radionuclides have also been chosen at the time that Go is selected, HUDU will also calculate doses at the selected downwind locations.

After HUDU has performed the dose calculations, the results of the calculations will be displayed on the computer screen. Either one or two screens will be displayed, depending on the downwind distances selected by the user. The output screens display the calculated doses at downwind distances and display a comparison of the doses to values from EPA Protective Action Guides. After the user views the output screens, HUDU execution ends with a message stating that an output file has been created. This file, which summarizes the input and output, may be printed or renamed and saved on disk. (In the case where no doses were calculated, the results of the atmospheric dispersion calculation will not be displayed on screen, but will be written to the output file.)

3.2 SOURCE CODE DESCRIPTION

A diagram of the structure of the source code modules (excluding the ESI Library routines) is presented in Figure 3.1. Appendix A contains detailed descriptions of each source code module, and the complete source code listing is kept in the files of the HUDU code custodian. A brief summary of each code module follows (the names of routines written in FORTRAN are in upper case letters; lower case names are C routines):

MAIN - The main program unit.

BLOCK DATA - This unit initializes variables and arrays in commons.

logo - This routine makes an introductory logo screen.

DATIME - This routine calls datim to find the current date & time.

datim - This routine finds the current date & time from the system clock.

LIBREAD - This routine reads in nuclide decay and dose factor data from the unformatted file HUDATA.DAT.

FIGURE 3.1. HUDU Program Structure

- MET DEF - This subroutine calls routines to find default values for met. data:
 stability class, wind speed, mixing layer depth, and air temperature, based on the month of the year and hour of the day.
- DFLAYER - This function returns a default mixing layer depth, given the month and stability class.
- DFTEMP - This function returns a default air temperature, given the month and hour.
- DFSTAB - This function returns a default stability class, given the month and time of day.
- DFSPD - This function returns a default wind speed, given the month and time of day.
- INPUT - This subroutine prints the basic input menu, then calls the routine "choost" to allow the user to scroll through the menu and select the line corresponding to an option.
- CHGSTAB - This routine allows the user to change the stability class used in the accident scenario.
- scstab - A routine to handle the screen display and pull in input values for a user-requested change in stability class.
- PGSTAB - This routine returns the Pasquill-Gifford stability class, given the month, hour, wind speed, and cloudiness index.
- witbar - Draws a white bar from col1 to col2 on a selected row, and positions cursor at start of bar.
- blkbar - Draws a black bar from col1 to col2 on a selected row, and positions cursor at start of bar.
- clrbar - Draws a colored bar from col1 to col2 on a selected row, and positions cursor at start of bar.
- barchs - A routine to print two or more inverse video blocks for input. Up and down arrow keys choose the appropriate bar; then, text is entered.
- CHGHRMO - This routine allows the user to change the month and hour of the accident scenario.
- CHGLAYR - This routine allows the user to change the mixing layer depth used in the accident scenario.

CHGTEMP - This routine allows the user to change the air temperature used in the accident scenario.

CHGWND - This routine allows the user to change the wind speed used in the accident scenario.

CHGRANG - This subroutine allows the user to input downwind ranges. Up to 8 ranges and descriptive titles may be entered for dose calculations.

scrang - A routine to help users input new ranges and range titles.

CHNUC - This subroutine displays all the nuclides on the screen and calls scnuc to allow the user to choose nuclides in the release.

scnuc - A routine to display nuclides and let the user choose them and enter released curies.

nextgrp - In the "choose nuclide" screen, a routine that responds to keys input while cursor is on "Next Grp".

prevgrp - In the "choose nuclide" screen, this routine responds to keys input while cursor is on the "Prev Grp" choice.

nucursor - In the "choose nuclide" screen, after the cursor is on a nuclide, the user can enter the amount released or move to a new nuclide.

prcuries - In the "choose nuclide" screen, this routine displays nuclide amounts released with a maximum of six characters.

scqnuc - A routine displayed over the summary of curies released, it colors the screen and lets the user choose the next move.

CHSRELES - This subroutine prints the four choices for release conditions, then allows the user to select one and enter the necessary input.

relchs - A routine to handle the screen display and accept user input for a selection of the scenario release condition.

CHREL2 - This subroutine gathers the input needed for release Type 2.

scr2px - A routine to help users input values needed for release Type 2.

screl2 - A routine to help users input values needed for release Type 2.

CHREL3 - This subroutine gathers the input needed for release Type 3.

screl3 - A routine to help users input values needed for release Type 3.

CHREL4 - This subroutine gathers the input needed for release Type 4.

screl4 - A routine to help users input values needed for release Type 4.

FACLRD - This routine allows the user to select the source term for a specific facility's accident scenario.

<u>scfac1</u>	- A routine to allow the user to choose a facility-specific source term.
<u>ynfac1</u>	- A routine to allow the user to answer yes or no to a facility-specific source term.
<u>choost</u>	- A menu selection routine using inverse video and function keys.
<u>EQQCALC</u>	- This subroutine calculates time-integrated Chi/Q values for each of four release types.
<u>PLMRIZ</u>	- This routine calculates plume rise.
<u>USTAR</u>	- This function computes U^* (used in determining the vertical wind profile) from the wind speed.
<u>INVMOL</u>	- A function to compute the inverse of the Monin-Obukhov length, used in determining the vertical wind profile.
<u>PROFILE</u>	- This function computes wind speed at an arbitrary height.
<u>SIGMA</u>	- σ_y and σ_z values are calculated, given the atmospheric stability, distance from the source, and mixing layer thickness.
<u>RWAKE</u>	- This function estimates normalized concentrations (X/Q) resulting from releases made in building wakes.
<u>DOSECALC</u>	- This subroutine calculates doses incurred at each downwind range.
<u>DECAY</u>	- This routine calculates radioactive decay and building for a given decay time.
<u>BCHAIN</u>	- This routine calculates radioactive decay and building for a given decay time for one decay chain.
<u>OUTPUT</u>	- This routine writes output to the screen and to a log file.
<u>INTRP</u>	- This routine linearly interpolates through the array values X and Y. The function evaluates the distance where a specified dose is exceeded.
<u>curloc</u>	- This routine locates the cursor at a specific position on the screen.
<u>scout1</u>	- This routine enhances the first output screen with color.
<u>scout2</u>	- This routine enhances the second output screen with color.
<u>CHAROOS</u>	- This routine takes a dose value, in mrem, and converts it to a 14-char acter string, including units.
<u>FORM</u>	- This routine takes a dose value, in rem or mrem, and converts it to an 11-character string.

SIGFIG - This routine takes a real number and produces a new number with the desired number of significant figures.

3.3 FEATURES UNIQUE TO HANFORD

While the mathematical models implemented in the computer code HUDU are generally applicable to any location, HUDU incorporates several features that would be particular to Hanford Site emergencies. These features include default atmospheric conditions that are typical of Hanford weather conditions, and source terms derived from safety studies performed at Hanford facilities.

3.3.1 Meteorology

The HUDU code selects default atmospheric conditions based on the time of the year and the time of day of the accident scenario. This scenario time is used to select the following atmospheric conditions: stability class, wind speed, mixing layer depth, and air temperature. These default data were derived from long-term average values for the Hanford meteorological station.

In HUDU Version 1.21, four routines are used to set the default atmospheric conditions: DFSTAB, DFSPD, DFLAYER, and DFTEMP. All four of these FORTRAN routines use values stored in DATA statements to find the default conditions.

3.3.2 Facility Source Terms

The source term for a HUDU calculation includes a list of radionuclides released, the quantity (in curies) of each released nuclide, and a description of the release conditions, particularly the release height. To simplify and speed up the input process for a HUDU run, it is possible to define the source term by selecting a previously determined source term from the data library. These source terms were derived from Safety Analysis Reports (SARs) prepared for each of the Hanford facilities that have a significant potential for accidental releases of radionuclides.

The SAR source term data are stored in a data file read by HUDU. For each facility source term, the following information is included:

- Hanford area
- facility name
- description of accident scenario
- list of released radionuclides and released quantities
- release height.

If an accident scenario for PUREX is selected, and the release height in the scenario is 61 meters, HUDU assumes that the release is from the PUREX stack. Default conditions are used for the PUREX stack's flow rate, stack diameter, and effluent temperature.

For some facilities, more than one accident scenario is included. In all cases, the scenarios are considered to be credible worst-case scenarios, so that selection of an applicable source term should give a conservative estimate of the potential consequences of a realistic accident.

In any situation where a source term is selected, the user may modify the data in order to make the release correspond to a realistic scenario. The quantity of nuclides released could be multiplied by a constant factor, or some nuclides could be added to (or deleted from) the release list. Thus, a worst-case scenario could be modified to make a realistic estimate if additional information were available.

3.4 DATA LIBRARIES

The HUDU code reads one data library, HUDATA.DAT, that contains all the radionuclide decay chain data, dose factors, and facility source terms used by the code. HUDATA.DAT is a FORTRAN unformatted file, produced by a FORTRAN program but unreadable by text editors or word processors. The unformatted file-type was chosen for speed of file reading and for data security. Three regular ASCII files were used to build HUDATA.DAT:

- HRMDLIB.DAT - a library containing radionuclide decay chain data,
- HUDUFACT.DAT - a library containing dose factors,
- FACILITY.DAT - a library containing facility accident scenario source terms.

Although HUDUFACT.DAT is an unformatted file, it can be read if the exact order of variables is known. A new version could also be made with a program that writes data in the same order. The variables, variable types, and order needed to read this file or create a new one are given in Table 3.1. Table 3.2 presents a description of the variables.

TABLE 3.1. Order and Type of Variables Used in HUDATA.DAT

<u>Variable Name</u>	<u>Variable Type</u>	<u>Number of Entries</u>
RMDTITL	Character*80	1
NNUC	Integer*4	1
NCH	Integer*4	1
NOFNUC	Integer*4 Array	NCH (max. 200)
NCHST	Integer*4 Array	NCH (max. 200)
IFR	Integer*4 Array (2-dimension)	2 for each nuclide; NNUC nuclides (max. 300)
DKF	Real*4 Array (2-dimension)	2 for each nuclide; NNUC nuclides (max. 300)
AL	Real*4 Array	NNUC (max. 300)
NCHN	Integer*4 Array	NNUC (max. 300)
NUCNAM	Character*8 Array	NNUC (max. 300)
NUMGRP	Integer*4 Array	5
NUCGRP	Integer*4 Array	NNUC (max. 300)
GRPNAM	Character*80 Array	5
HTITLE	Character*80	1
EXTDF	Real*4 Array	NNUC (max. 300)
DOSINH_1	Real*4 Array (2-dimension)	5 for each nuclide; NNUC nuclides (max. 300)
DOSINH_50	Real*4 Array (2-dimension)	5 for each nuclide; NNUC nuclides (max. 300)

FTITLE	Character*80	1
NUMFAC	Integer*4	1
FACAREA	Character*12 Array	NUMFAC (max. 100)
FACNAME	Character*40 Array	NUMFAC (max. 100)
ACCDES	Character*80 Array (2-dimension)	8 for each facility scenario; NUMFAC scenarios (max. 100)
NUMNUC	Integer*4 Array	NUMFAC (max. 100)
NUCID	Integer*4 Array (2-dimension)	NUMNUC nuclides for each scenario; NUMFAC scenarios (max. 100)
CIRD	Real*4 Array (2-dimension)	NUMNUC nuclides for each scenario; NUMFAC scenarios (max. 100)
RELHT	Real*4 Array	NUMFAC (max. 100)

TABLE 3.2. Description of Variables in HUDATA.DAT File

Variable Name	Description
RMDTITL	Title of Radionuclide Master Data Library
NNUC	Number of radionuclides in data library (max. 300)
NCH	Number of decay chains in data library (max. 200)
NOFNUC	Number of radionuclides in each decay chain (max. 9)
NCHST	Location in the Master Radionuclide List of the first member of each chain
IFR	IFR(1,I) gives the chain member that is the first precursor to radionuclide I. IFR(2,I) is the location of the second precursor
DKF	Fraction of first and second precursor that decays to this radionuclide
AL	Radiological decay constant for each radionuclide (day ⁻¹)
NCHN	Chain number for each radionuclide
NUCNAM	8-character nuclide identifier
NUMGRP	Number of nuclides in each group
NUCGRP	Group ID number for a nuclide

GRPNAM	Title for a group of nuclides in the nuclide Master Data Library
HTITLE	Title of HUDU dose factor library
EXTDF	External dose factor (Sv/yr per Bq/m ³) for each nuclide
DOSINH_1	Inhalation dose factors, 1-yr committed dose equivalent (Sv/Bq): 1 = lungs, 2 = bone surface, 3 = red marrow, 4 = thyroid, 5 = effective dose equivalent (not used in HUDU Version 1.21)
DOSINH_50	Inhalation dose factors, 50-yr committed dose equivalent (Sv/Bq): 1 = lungs, 2 = bone surface, 3 = red marrow, 4 = thyroid, 5 = effective dose equivalent
FTITLE	Title of the Facility Data File
NUMFAC	Number of facility accident scenarios
FACAREA	Name of the area on the Hanford Site containing the facility
FACNAME	Name of the facility, with a short accident scenario description
ACCDES	Description of each facility accident scenario (up to 8 lines of text)
NUMNUC	Number of nuclides in each facility's release list
NUCID	ID# of nuclide in list (corresponds to order read in HUDATA.DAT)
CIRD	Quantity of this nuclide released (Ci)
RELHT	Release height for the accident scenario

4.0 USER INSTRUCTIONS

4.1 CODE OPERATION

This section introduces the HUDU Main Control Menu, the data input menus, and the "GO" function, which begins calculations of atmospheric transport and dose.

4.1.1 Main Control Menu

Program execution can be started from the DOS prompt by typing "HUDU" followed by the <ENTER> key. A logo screen is briefly displayed while data is read in from the disk file, then a Main Control Menu appears. The menu screen contains the date and time of the HUDU run, historical meteorological data, and a summary of the 12 downwind ranges for dose calculation.

Once in the Main Control Menu, the user moves the highlighted bar to each item that needs data entry or change, and selects that option by pressing the <END> or <ENTER> key. Each time a data entry screen is finished, an updated version of the Main Control Menu appears. The highlighting bar can be moved up or down, to allow changes or updates to any previously entered data.

Each time a user selects an item on the Main Control Menu, a data input menu appears. This menu explains the data to be input and describes the choice of units. Once the entry is complete for that screen, control is transferred either to an additional menu or back to the Main Control Menu.

The Main Control Menu displays and tracks the status of all calculational parameters. For each parameter, the Main Control Menu displays its source (e.g., default, historical, user, data file, or data file modified by user), and, in most cases, its value. Parameters may be input, selected, or modified using parameter-specific input screens. When a parameter operation is complete, the Main Control Menu returns to the screen.

Reasonable default values are initially provided for most parameters; however, source term and release conditions are selected and input by the user. Where default values are provided, a user can readily modify them. In general, the <END> key is used to select a menu-provided item or parameter value, the <RETURN> or <ENTER> key is used to enter keyboard input, and the <ESC> key is used to terminate an activity.

4.1.2 Data Input Menus

Descriptions of the different data input menus and procedures for their use are provided on the following pages.

Run Title Input Screen

Entered by selecting the <case title> option in the Main Control Menu.

Type in a title of 54 characters or less, and press <RETURN>. See Figure 4.1.

```
Enter a new title for this run,
  (press <RETURN> to enter):
Demonstration HUDU Run
```

FIGURE 4.1. Run Title Input Screen

Month and Hour Input Screen

Entered from the Main Control Menu (follow the on-screen instructions). See Figure 4.2.

Atmospheric Stability Class Input Screen

Entered from the Main Control Menu.

Use the arrow keys to position the highlighted bar to the appropriate choice, then press <END>. See Figure 4.3.

Enter the Month in which the scenario occurs -
(3-character abbreviation, or integer 1 - 12,
Press <RETURN> to enter):
MAY

Enter the Hour of the day in which the scenario occurs -
(integer 1 - 24, using a 24-hour clock,
Press <RETURN> to enter):

08:00

FIGURE 4.2. Month and Hour Input Screen

The Stability Class can be changed by either:
Entering the desired class directly,
or Describing the cloudiness, then letting HUDU estimate the
class based on the wind speed, month & hour of the day.

Class:

- A - Extremely Unstable
- B - Moderately Unstable
- C - Slightly Unstable
- D - Neutral
- E - Slightly Stable
- F - Moderately Stable
- G - Extremely Stable

Cloud Cover:

- Clear (or a few clouds)
- Partly Cloudy
- Overcast or Mostly Cloudy

Use Arrow Keys to Position Cursor for Selection
Press 'End' or 'Enter', Key to Select
'Esc' to return to Main Menu

FIGURE 4.3. Atmospheric Stability Class Input Screen

Wind Speed Input Screen

Entered from the Main Control Menu.

This screen offers the user three possible units for entering the wind speed. See Figure 4.4.

Enter a new WIND SPEED for the scenario -

Use arrow keys to choose the box corresponding to the desired units,
Then type the speed.
Press <Return> to enter:

4.0 meters/second
miles/hour
knots

FIGURE 4.4. Wind Speed Input Screen

Atmospheric Mixing Layer Input Screen

Entered from the Main Control Menu. See Figure 4.5.

Enter a new MIXING LAYER DEPTH for the scenario -

Use arrow keys to choose the box corresponding to the desired units,
Then type the new depth.
Press <Return> to enter:

_____ meters
miles
feet

FIGURE 4.5. Atmospheric Mixing Layer Input Screen

Ambient Air Temperature Input Screen

Entered from the Main Control Menu. See Figure 4.6.

Enter a new ambient AIR TEMPERATURE for the scenario -

Use arrow keys to choose the box corresponding to the desired units,
Then type the temperature.
Press <Return> to enter:

degrees Celsius
55 degrees Fahrenheit

FIGURE 4.6. Ambient Air Temperature Input Screen

Release Conditions Input Screen

Entered from the Main Control Menu.

Use the arrow keys to highlight the desired condition, then press <END> to make the selection.

Selection of any of the four release conditions will display a secondary screen requesting entry of data describing the release conditions, such as release height, building cross-sectional area for wake effects, or effluent temperatures and flow rates. Default conditions are available if the release occurs from the PUREX stack. See Figure 4.7.

Downwind Range Input Screen

Entered from the Main Control Menu.

These ranges should correspond to significant positions in the scenario, such as site boundaries or at-risk population centers. Ranges may be entered in units of either miles or kilometers, with a descriptive title associated with each. As many as eight distances can be entered. See Figure 4.8.

Safety Analysis Report (SAR) Design Basis Accident (DBA) Scenario Selection Screen

Entered by selecting the "Source Term" option on the Main Control Menu.

One Screen is displayed for each Hanford Area grouping used in the data library. In HUDU Version 1.21, there are four area groupings: 200 East area, 200 West area, waste storage facilities in the 200 areas (called "200 WASTE" in the menu), and facilities in the 300 and 400 areas.

For the first area screen displayed, the arrow keys move a highlighting bar down the list; pressing <END> selects the highlighted choice.

Selection of one of these source terms automatically chooses the appropriate release condition and a radionuclide inventory. At the bottom of the screen are several options in a row showing the other area groupings available. See Figure 4.9.

CHOOSE THE RELEASE CONDITIONS:

- Open Area Ground Level Release
Release Ht < 10 m
No Building Wake Effect
No Plume Rise
- Open Area Elevated Release
Release Ht > 10 m
No Building Wake Effect
Plume Rise Calculated
- Ground Level Release
Could be from a Building Vent or Short Stack
Release Ht < 10 m
Building Wake Effect Calculated
No Plume Rise
- Elevated Release Near a Building
 $0 < \text{Release Ht} < 2.5 \times \text{Bldg Ht}$
Building Wake Effect Calculated
No Plume Rise

Use Arrow Keys to Position Cursor, then 'End' or 'Enter'
to Select Press 'Esc' Key to Return to Main Menu

FIGURE 4.7. Release Conditions Input Screen

Enter DOWNWIND RANGES for Dose Calculations
(ranges do not have to be in order)

Descriptive Title	Downwind Range		
Fence	0.25	miles	(= 0.40 km)
Site Boundary	12.50	miles	(= 20.12 km)
Farm	14.2	miles	km

For each range, "End" key accepts a range already listed.
Otherwise, type in title, followed by "Enter" or => key;
Use arrow keys to choose miles or km, type in number, press
"Enter".

"Escape" key terminates entry.

FIGURE 4.8. Downwind Range Input Screen

Hanford Facility Source Terms	eim / ris	Nov. 26, 1990
	400/300	Area
FFTF Loss of Cooling in IEM Cell	324	Vault Criticality: Filters In Place
FFTF Cover GasSample System Pipe Fail	324	Plutonium Oxide Spill
FFTF Surge & Delay Tank & CAPS Fail	325	Criticality
FFTF Sodium Spill	325	Earthquake
FFTF Earthquake	325	Ion-Exchange Explosion
FFTF Tornado	327	Bldg: PIN BREACH
306-W Criticality	327	Fire in Hot Cell
306-W Sintering Furnance Explosion	327	Hot Cell Criticality
306-E Pu Capsule Breach	327	Cask Drop and Fuel Pin Rupture
308 Criticalty: Massive Glovebox Fail	329	Bldg Criticality
308 Criticalty: Partial Glovebox Fail	331	Bldg Fire
308 Pu Oxide Spill	340	Bldg Solid Waste Fire, No Filters
308 Severe Earthquake	340	Bldg Solid Waste Fire, Filters OK
324 One pin release	340	BUILDING, I-131 Release
324 200 pin release	3730	Bldg: Explosion, No Filters
324 Safeguards Vault&Lab Criticality	3730	Bldg: Explosion, Filters OK
Other Areas: 200 WEST 200 EAST 200 WASTE		
Use Arrow Keys to select Source Term or Area, then press END or ENTER		

FIGURE 4.9. SAR DBA Scenario Selection Screen

Screen 2 for SAR DBA Scenario Selection

Entered after selecting a facility.

This screen presents the user with a more detailed description of the DBA, and it gives the user a chance either to accept this scenario, choose another, or return to the Main Control Menu without choosing a source term. See Figure 4.10.

Released Radionuclide Summary Screen

Entered by choosing the "Radionuclides" option on the Main Control Menu.

If a radionuclide list has already been entered, a summary of the list is presented (in this case the SAR DBA scenario had already been selected), and the user can then perform any of the operations listed at the bottom of the screen. See Figure 4.11. If no radionuclides have been previously

chosen, the user will not see this summary screen, but instead will see Screen 2a as soon as the "Radionuclides" option is entered.

Source term from:	FFTF Surge & Delay Tank & CAPS Fail
Accident Description - FFTF Surge and Delay Tank and CAPS Failure	
The surge and delay tank is ruptured while containing the maximum radioactivity and CAPS fails. Open area ground level release.	
Is this the facility/source term you want?	
YES	
NO - Choose a different source term	
NO - Leave source term selection	
Use Arrow Keys to select your answer, then press END or ENTER	

FIGURE 4.10. Screen 2 for SAR DBA Scenario Selection

SUMMARY OF RADIONUCLIDES IN RELEASE	
Curies Released	
5.400E+00	AR41
7.300E+02	KR83M
7.900E+02	KR85M
1.000E+00	KR85
5.700E+02	KR87
2.000E+03	KR88
5.300E+01	XE131M
1.000E+03	XE133M
2.500E+04	XE133
3.700E+04	XE135
Use Arrows & End to choose Nuclide Grp Display, Modify Q's, or Stop Selection	
1: Group:	Light Elements & Activation Products
2: Group:	Fission Products (mostly)
3: Group:	Heavy Elements & Actinides
	Mult. Q's by Constant Factor
	End Nuclide Selection

FIGURE 4.11. Released Radionuclide Summary Screen

Screen 2a Radionuclide (Group 1) Input

Entered either from the Main Control Menu (if no radionuclides had been chosen), or by choosing "1: Group: ..." from the screen with the Released Radionuclides Summary.

If any radionuclides in this group had already been chosen, the released curies will be displayed next to the nuclide name. In those instances where the quantity of a chosen radionuclide is less than 0.001 curies, the screen will display 0.000 while still using the actual quantity in the calculation.

To change a release quantity or to enter a quantity, the highlighted bar can be moved to the nuclide name with the arrow keys. Then, type in the number of curies released and press <ENTER>. The arrow keys can also move the highlighting bar to select the display for another nuclide group or to end the selection of nuclides. See Figures 4.12, 4.13, and 4.14.

Prev Grp	Ci Released	Group: Light Elements & Activation Products				
H 3	NA24	AR39	MN54	CO60	ZN69M	
BE10	P 32	5.4 AR41	MN56	NI59	ZN69	
C 14	P 33	CA41	FE55	NI63	AS76	
N 13	S 35	CA45	FE59	NI65	SE75	
F 18	CL36	SC46	CO57	CU64	SE79	
NA22	K 40	CR51	CO58	ZN65		

Next Grp

No More Nuclides

Use Arrow Keys to choose Nuclide, type in CURIES released, then ENTER

Arrow and END keys to see other Nuclide Groups or to End Nuclide Selection.

FIGURE 4.12. Screen 2a, Radionuclide (Group 1) Input

4.1.3 "GO" - Begin Calculation

After sufficient data has been entered, the Main Control Menu will display the word "GO" in the lower right hand corner. The user can continue to enter or modify input data after this legend appears. Selecting the Go option begins the calculation of the atmospheric dispersion and downwind doses. If no radionuclides were selected but the "GO" appears, selecting Go will calculate atmospheric dispersion parameters but will not calculate

doses. The code then displays an output screen summarizing calculated doses and states whether or not protective action guides would be exceeded. When a user exits the program, a data file called "HUOU.OUT" is produced, containing a record of the input and the detailed output of the HUOU run. This file may be printed or stored on disk. An example Main Control Menu is shown in Figure 4.15 as it might appear following data input.

Screen 2b Radionuclide Input

For the second nuclide group.

Prev Grp	Ci Released	Group: Fission Products (mostly)				
	BR82 Y 91	PD103	SN121	I 131	CS137	
	BR83 SR92	RH103M	SN123	53.0 XE131M	XE138	
730	KR83M Y 92	RU105	I 125	TE132	CS138	
	BR84 Y 93	RH105	SN125	I 132	CS139	
790	KR85M MO93	RU106	SB125	TE133M	BA139	
1.0	KR85 ZR93	PD107	TE125M	TE133	BA140	
570	KR87 NB93M	PD109	SN126	I133	LA140	
	R887 ZR95	AG110M	S8126M	1000 XE133M	CS136	
2000	KR88 NB95M	AG111	S8126	25000 XE133	BA141	
	R888 NB95	CO109	SB124	TE134	LA141	
	KR89 ZR97	CO113M	SB127	I 134	CE141	
	R889 NB97M	CO115M	TE127M	CS134M	BA142	
	SR89 NB97	CO115	TE127	CS134	LA142	
	R886 NB94	IN115M	TE123M	I 130	CE143	
	SR85 MO99	IN111	TE129M	I 135	PR143	
	SR90 TC99M	IN114M	TE129	XE135M	CE144	
	Y 90 TC99	SN117M	I 129	37000 XE135	PR144M	
	SR91 TC101	SN119M	TE131M	CS135	PR144	
	Y 91M RU103	SN121M	TE131	XE137		
Next Grp		No More Nuclides				
Use arrow keys to choose Nuclide, type in CURIES released, then ENTER						
Arrow and ENO keys to see other Nuclide Groups or to End Nuclide Selection.						

FIGURE 4.13. Screen 2b, Radionuclide Input

4.2 CODE OUTPUT

After calculating doses, HUOU will display either one or two output screens. One screen appears only if the user has selected Downwind Ranges (instead of the 12 default values) for special reporting. Doses calculated at these user-input ranges will be displayed on the first output screen.

Screen 2c Radionuclide Input Screen

For the third nuclide group.

Prev Grp	Ci Released	Group: Heavy Elements & Actinides			
ND147	TB160	BI210	PA231	PA234	PU241
PM147	HO166M	PO210	AC227	PU236	AM241
SM147	W 181	U 232	TH227	PU237	CM246
PM148M	W 185	TH232	FR223	AM242M	CM247
PM148	W 187	RA228	RA223	AM242	CM243
PM149	RE187	AC228	U 237	CM242	PU243
PM151	OS185	TH228	NP237	PU242	AM243
SM151	OS191	RA224	PA233	NP238	NP239
SM153	IR192	PB212	U 233	PU238	PU239
EU152	HG203	BI212	TH229	CM244	CM248
EU154	TH230	U 234	RA225	PU244	CF252
EU155	RA226	U 236	AC225	U 240	
EU156	RN222	U 235	U 238	PU240	
GD153	PB210	TH231	TH234	CM245	

Next Grp No More Nuclides

Use arrow keys to choose Nuclide, type in CURIES released, then ENTER
 Arrow and END keys to see other Nuclide Groups or to End Nuclide Selection

FIGURE 4.14. Screen 2c Radionuclide Input Screen

HUDU MAIN CONTROL MENU			
Demonstration HUDU Run		Wed Jan 9 08:38:30 1991	
Release Month & Hour	: May & 08:00	{BY USER}	
Stability Class	: D - Neutral	{HISTOR.}	
Wind Speed (10 meter elevation)	: 4.0 m/sec	{BY USER}	
Mixing Layer Depth	: 400 meters	{HISTOR.}	
Air Temperature	: 13. deg C	{BY USER}	
Release Conditions	: Open Area Ground Level	{FAC. FILE}	
Effluent Flow Rate	: .00 m ³ /s		
Downwind Ranges	: 12 from .06 to 62. miles	{DEFAULT}	
	: .25 12. 14. mi	{BY USER}	
Source Term	:	{FACILITY FILE}	
	: FFTF Surge & Delay Tank & CAPS Fail		
Radionuclides	:XE135 XE133 KR88 XE133M	{FAC FILE}	
	:KR85M KR83M KR87 XE131M	AR41	
	:KR85		
Use Arrow Keys to Position Cursor for Selection **GO**			
'ENTER' or 'END' Key to Select; 'Esc' key to STOP			

FIGURE 4.15. Sample Main Control Menu

This screen also displays the distance at which 1-rem effective dose equivalent and 5 rem to the highest organ would occur on the plume centerline. An example of this screen is shown in Figure 4.16.

Doses are presented in standard form, no exponents or scientific notation used. In those instances where a dose is calculated to be less than 1 mrem but greater than 0.1 mrem, the output indicates <1 mrem. In those instances where the dose is calculated to be less than 0.1 mrem, the output indicates <0.1 mrem. When the user is finished viewing the first output screen, <Print Screen> may be pressed to generate a hard copy, or any other key can be pressed, and the second output screen (or only output screen if no user-selected ranges were chosen) will be displayed. This screen presents a detailed listing of doses to all organs. A hard copy may be generated as described above, or the user can press any key to exit this screen and end the HUDU run. An example of this screen is shown in Figure 4.17.

Upon completion of the HUDU run, a file called "HUDU.OUT" is produced in the user's default directory. This file contains a copy of the final Main Control Menu and other data that was input by the user. It also contains the calculated atmospheric dispersion parameters and reproductions of the output screens displayed during the HUDU run.

Demonstration HUDU Run			Wed Jan 9 08:38:30 1991		
PROJECTED DOSES AT SELECTED DOWNWIND (Plume Centerline) LOCATIONS					
<u>Location</u>	<u>Downwind Distance (miles)</u>	<u>ETA (hr:min)</u>	<u>Effective Dose Equivalent (Inhal. + Ext.)</u>	<u>Limiting Organ Dose</u>	
Fence	.25	0:02	450 mrem	Ext. WB	450 mrem
Site Boundary	12.00	1:24	< 1 mrem	Ext. WB	< 1 mrem
Farm	14.00	1:35	< 1 mrem	Ext. WB	< 1 mrem
5 Rem to Highest Organ exceeded for External at .1 miles					
1 Rem Effective Dose Equivalent (Ext. + Inh.) exceeded at .2 miles					
Press Any key to continue					

FIGURE 4.16. Downwind Projected Doses Screen with User-Specified Ranges

The user can print this file to keep a hard copy as a record. In DOS, type "print HUDU.OUT", press <ENTER> once, then <ENTER> again in response to the prompt "Name of list device [PRN]:". The file can also be stored on disk by renaming it or copying it to another directory: In DOS, type "rename HUDU.OUT filename.new" <ENTER>. If the output file is not renamed, it will be over written the next time that HUDU is run. A complete HUDU.OUT file is provided in Figure 4.18.

Plume Centerline Distance		ETA (hr:min)	EXTERNAL Air Subm W Body (mrem)	INHALATION (50 Yr Dose Commitment)			Eff Dose Equiv. (mrem)
(km)	(mi)			Lung (mrem)	Red Marrow (mrem)	Thyroid (mrem)	
.10	.06	0:00	5,200	11	< 1 mrem	< 1 mrem	1
.20	.12	0:01	1,500	6	< .1mrem	< .1mrem	< 1 mrem
.40	.25	0:02	450	3	< .1mrem	< .1mrem	< 1 mrem
.81	.50	0:03	140	2	< .1mrem	< .1mrem	< 1 mrem
1.6	1.0	0:07	45	1	< .1mrem	< .1mrem	< 1 mrem
3.2	2.0	0:13	16	< 1 mrem	< .1mrem	< .1mrem	< 1 mrem
4.8	3.0	0:20	8	< 1 mrem	< .1mrem	< .1mrem	< .1mrem
8.0	5.0	0:34	3	< 1 mrem	< .1mrem	< .1mrem	< .1mrem
13	8.0	0:54	1	< 1 mrem	< .1mrem	< .1mrem	< .1mrem
26	16	1:47	< 1 mrem	< .1mrem	0	0	< .1mrem
51	32	3:35	< 1 mrem	< .1mrem	0	0	< .1mrem
100	62	6:58	< .1mrem	< .1mrem	0	0	0
.40	.25	0:02	450	3	< .1mrem	< .1mrem	< 1 mrem
20	12	1:24	< 1 mrem	< .1mrem	< .1mrem	< .1mrem	< .1mrem
23	14	1:35	< 1 mrem	< .1mrem	< .1mrem	0	< .1mrem

Press any key to continue

FIGURE 4.17. Projected Doses Screen Without User-Specified Ranges

PROGRAM HUDU
Version 1.21

Demonstration HUDU Run Wed Jan 9 08:38:30 1991

Release Month & Hour	: May & 08:00	{BY USER}
Stability Class	: D - Neutral	{HISTOR.}
Wind Speed (10 meter elevation)	: 4.0 m/sec	{BY USER}
Mixing Layer Depth	: 400 meters	{HISTOR.}
Air Temperature	: 13. deg C	{BY USER}
Release Conditions	: Open Area Ground Level	{FAC. FILE}
Effluent Flow Rate	: .00 m ³ /s	
Downwind Ranges	: 12 from .06 to 62. miles	{DEFAULT}
	: .25 12. 14. mi	{BY USER}
Source Term	:	{FACILITY FILE}
	: FFTF Surge & Delay Tank & CAPS Fail	
Radionuclides	: XE135 XE133 KR88 XE133M {FAC FILE}	
	: KR85M KR83M KR87 XE131M AR41	
	: KR85	

=====

PROJECTED DOSES AT SELECTED DOWNWIND (Plume Centerline) LOCATIONS

Location	Downwind Distance (miles)	ETA (hr:min)	Effective Dose Equivalent (Inhal. + Ext.)	Limiting Organ Dose	
Fence	.25	0:02	450 mrem	Ext. WB	450mrem
Site Boundary	12.00	1:20	1 mrem	Ext. WB	1
Farm	14.00	1:34	< 1 mrem	Ext. WB	< 1mrem

5 Rem to Highest Organ exceeded for External at .1 miles
1 Rem Effective Dose Equivalent (Ext. + Inh.) exceeded at .2 miles

FIGURE 4.18. Sample HUDU.OUT File

SUMMARY OF RADIONUCLIDES IN RELEASE					
<u>Curies Released</u>		<u>Curies Released</u>		<u>Curies Released</u>	
5.400E+00	AR41	7.300E+02	KR83M	7.900E+02	KR85M
5.700E+02	KR87	2.000E+03	KR88	5.300E+01	XE131M
2.500E+04	XE133	3.700E+04	XE135	1.000E+00	KR85
				1.000E+03	XE133M
=====					
CALCULATED AIR CONCENTRATIONS					
	<u>Downwind Distance</u> <u>(km)</u>	<u>(mi)</u>	<u>sigmay</u> <u>(m)</u>	<u>sigmaz</u> <u>(m)</u>	<u>X/Q</u> <u>(sec/m^3)</u>
1	.10	.06	9.5	4.6	1.82E-03
2	.20	.12	17.7	8.7	5.18E-04
3	.40	.25	33.1	15.5	1.56E-04
4	.81	.50	61.9	26.7	4.82E-05
5	1.60	1.00	115.7	43.9	1.57E-05
6	3.20	2.00	216.5	68.3	5.38E-06
7	4.80	3.00	312.1	87.3	2.92E-06
8	8.00	5.00	495.1	117.5	1.37E-06
9	13.00	8.00	757.1	153.3	6.85E-07
10	26.00	16.00	1415.7	224.9	2.51E-07
11	51.00	32.00	2647.5	327.1	1.01E-07
12	100.00	62.00	4833.8	466.8	5.17E-08
13	.40	.25	33.1	15.5	1.55E-04
14	19.00	12.00	1091.8	192.0	3.80E-04
15	23.00	14.00	1254.9	209.0	3.04E-07

FIGURE 4.18. Sample HUDU.OUT File (cont'd.)

PROGRAM HUDU Version 1.21							
Demonstration HUDU Run				Wed Jan 9 08:38:30 1991			
SUMMARY OF CALCULATED DOSES							
Plume		ETA (hr:min)	EXTERNAL	INHALATION (50 Yr Dose Commitment)			
Centerline Distance (km)	(mi)		Air Subm W Body (mrem)	Lung (mrem)	Red Marrow (mrem)	Thyroid (mrem)	Eff Dose Equiv. (mrem)
.10	.06	0:00	5,200	11	< 1 mrem	< 1 mrem	1
.20	.12	0:01	1,500	6	< .1mrem	< .1mrem	< 1 mrem
.40	.25	0:02	450	3	< .1mrem	< .1mrem	< 1 mrem
.81	.50	0:03	140	2	< .1mrem	< .1mrem	< 1 mrem
1.	1.0	0:07	45	1	< .1mrem	< .1mrem	< 1 mrem
3.2	2.0	0:13	16	< 1 mrem	< .1mrem	< .1mrem	< 1 mrem
4.8	3.0	0:20	8	< 1 mrem	< .1mrem	< .1mrem	< .1mrem
8.0	5.0	0:34	3	< 1 mrem	< .1mrem	< .1mrem	< .1mrem
13	8.0	0:54	1	< 1 mrem	< .1mrem	< .1mrem	< .1mrem
26	16	1:47	< 1 mrem	< .1mrem	0	0	< .1mrem
51	32	3:35	< 1 mrem	< .1mrem	0	0	< .1mrem
100	62	6:58	< .1mrem	< .1mrem	0	0	0
.40	.25	0:02	450	3	< .1mrem	< .1mrem	< 1 mrem
19	12	1:20	1	< 1 mrem	< .1mrem	< .1mrem	< .1mrem
23	14	1:34	< 1 mrem	< .1mrem	< .1mrem	0	< .1mrem

FIGURE 4.18. Sample HUDU.OUT File (cont'd.)

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APPENDIX A

DESCRIPTION OF HUDU MODELS

```

C=====C
C
C  MODULE NAME:
C    MAIN
C
C  ABSTRACT:
C    Hanford Unified Dose Utility (HUDU) -- Version 1.21
C    Developed for use in the UDAC EMS Facility
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C
C  CREATION DATE:
C    August 30, 1990
C
C  PROGRAMMING LANGUAGE:
C    Fortran 77, C
C
C  COMPILER VENDOR AND VERSION NUMBER:
C    Microsoft
C      Fortran: Version 4.10
C      C      : Version 5.1
C
C  COMPUTER:
C    IBM PS/2 Model 50 or higher
C    or IBM-PC or AT compatibles.
C
C  OPERATING SYSTEM:
C    MS-DOS V. 3.3 or higher
C
C  CPU REQUIREMENTS:

```

c	80286 or 80386 is desirable (8088 or 8086 will work)	c
c	80x87 math coprocessor recommended but not required	c
c		c
c	MEMORY REQUIREMENTS:	c
c	640k Memory Necessary	c
c		c
c	DISK SPACE:	c
c	Floppy or Hard Drive with at least 720 kbytes capacity	c
c		c
c	MONITOR:	c
c	Color preferred but not required	c
c		c
c	PRINTER/PLOTTER:	c
c	No requirements	c
c		c
c	KEYBOARD:	c
c	No requirements	c
c		c
c	I/O:	c
c	Input via operator input on the screen	c
c	Output via the screen and through	c
c	variables in arguments and commons	c
c		c
c	CONSTANTS:	c
c	None (See list in Block Data routine)	c
c		c
c	LOCAL VARIABLES:	c
c	None	c
c		c
c	PARAMETER PASSING:	c
c	Input Values:	c
c	None	c
c	Values Returned as ARGUMENTS:	c
c	None	c
c		c

c	SUBORDINATE ROUTINES CALLED:	c
c	blockdata logo datetime libread	c
c	met_def input eoqcalc dosecalc	c
c	output	c
c		c
c	MODULE ALGORITHM:	c
c	This routine manages the HUDU system. It fills the screen	c
c	with logo information, gets the date and time, puts out the	c
c	title, reads in the library files, sets up default values.	c
c	Then it writes out the rest of the input lines and gets	c
c	input from the operator. Next the calculations are	c
c	performed: atmospheric distribution of a release and	c
c	radiation dose calculations. Finally the results are	c
c	output to the screen and a data file.	c
c		c
c	ERROR HANDLING:	c
c	None.	c

```

C-----C
C
C  MODULE NAME:
C    BLOCKDATA
C
C  ABSTRACT:
C    Contains compile-time data for the code.
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C
C  CREATION DATE:
C    March 1, 1989
C
C  I/O:
C    Input through variables in commons
C    Output through variables in commons
C
C  CONSTANTS:
C    None
C
C  LOCAL VARIABLES:
C    None
C
C  DATA STRUCTURES:
C    Common /general/
C    TITLE      Chr*78    Title message for display screen
C    INPLIN(25)  Chr*78    Input lines for main menu display
C    MONTH      Integer   Current month
C    IHOURL      Integer   Current hour
C    IFMAYGO     Logical   Flags if sufficient data has been

```

c			entered to perform the atmospheric	c
c			transport calculation	c
c	Common	/meteo/		c
c	JSTAB	Integer	Stability class	c
c	WINDSPD	Real*4	Wind speed (m/sec)	c
c	LAYER	Integer	Mixing layer thickness (m)	c
c	AIRTEMP	Real*4	Air Temperature (C)	c
c	INDEXC	Integer	Cloudiness index	c
c	DEFSTAB	Logical	Flags default stability	c
c	DEFWSPD	Logical	Flags default wind speed	c
c	DEFLAYER	Logical	Flags default mixing layer thickness	c
c	DEFTEMP	Logical	Flags default effluent temperature	c
c	DEFHRMO	Logical	Flags default hour and month	c
c	STABNAM(7)	Chr*25	Names of the seven stability classes:	c
c			A: Extremely, B: Moderately Unstable,	c
c			C: Slightly Unstable, D: Neutral,	c
c			E: Slightly, F: Moderately Stable,	c
c			G: Extremely Stable	c
c	Common	/release/		c
c	SHGHT	Real*4	Stack height of release (m)	c
c	SFLOW	Real*4	Stack flow of release (m^3/sec)	c
c	SRAD	Real*4	Stack radius of release (m)	c
c	ETEMP	Real*4	Effluent temperature of release (C)	c
c	BDAREA	Real*4	Building Area of release (m^2)	c
c	BHT	Real*4	Building height of release (m)	c
c	ITREL	Integer	Release number value (1 to 4)	c
c			1 - Open Area Ground Level, 2 - Open	c
c			Area Elevated, 3 - Ground Level,	c
c			4 - Effective release height (m)	c
c	OHT	Real*4	Open Area Elevated Height (m)	c
c	ERHT	Real*4	Effective Release height (m)	c
c	PRISE	Real*4	Height the plume rises (m)	c
c	Common	/downwind/		c
c	NRANGE	Integer	Number of downwind ranges for dose	c
c			calculation (≤ 20)	c

c	RANGE(20)	Real*4	Downwind distance, meters	c
c	EQQ(20)	Real*4	Time-integrated relative air	c
c			concentration at each range (sec/m ³)	c
c	RGTITL(20)	Chr*25	Title for each downwind range	c
c	ETA(20)	Real*4	Estimated time of plume arrival;	c
c			actually the plume transit time to	c
c			each downwind range (sec)	c
c	Common	/doses/		c
c	BRATE	Real*4	Breathing rate, (l/min)	c
c	EXTDOS(20)	Real*4	External dose, semi-infinite	c
c			cloud submersion (mrem)	c
c			index: 1 to number downwind ranges	c
c	DOSLUNG(2,20)	Real*4	Inhalation dose to lung (mrem)	c
c			1st index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1 to number downwind ranges	c
c	DOSBONE(2,20)	Real*4	Inhalation dose to bone (mrem)	c
c			1st index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1 to number downwind ranges	c
c	DOSTHY(2,20)	Real*4	Inhalation dose to thyroid (mrem)	c
c			1st index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1 to number downwind ranges	c
c	DOSEDE(2,20)	Real*4	Effective dose equivalent (mrem)	c
c			inhalation (mrem)	c
c			1st index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1 to number downwind ranges	c
c	WHICHBONE	Chr*8	contains name of the bone part	c
c			(red marrow or bone surface)	c
c			with higher dose	c
c	Common	/nuclide/		c
c	NNUC:	Integer	Number of radionuclides in the master	c
c			library 'RMDLIB', 1 <= NUC => 300	c
c	NCH	Integer	Number of decay chains in the master	c
c			library 'RMDLIB', 1 <= NCH => 200.	c
c	NOFNUC(200)	Integer	Number of radionuclides in each	c

c			decay chain. 1 <= NOFNUC(I) => 9.	c
c			When NOFNUC(I) = 1, No daughters.	c
c	NCHST(200)	Integer	Location in the master radionuclide	c
c			list of the 1st member of each chain.	c
c			1 <= NCHST(I) => 300.	c
c	IFR(2,300)	Integer	IFR(1,I) gives the chain member that	c
c			is the 1st precursor to radionuclide I.	c
c			IFR(2,I) is location of 2nd precursor.	c
c			IFR(1,I) < IFR(2,I) < IMEM(I)	c
c	DKF(2,300)	Real*4	Fraction of 1st and 2nd precursor	c
c			that decays to this radionuclide.	c
c	AL(300)	Real*4	Radiological decay constant for each	c
c			radionuclide day ** -1.	c
c	NCHN(300)	Integer	Chain number for each radionuclide.	c
c	NUCNAM(300)	Chr*8	8-character nuclide identifier:	c
c			First 2 Chars: Element name for each	c
c			radionuclide in the Master	c
c			Radionuclide Data library.	c
c			Chars. 3-8: Atomic weight symbol for	c
c			each radionuclide in the Master	c
c			Radionuclide Data library.	c
c			Isomeric states are indicated by the	c
c			letter 'M' after the atomic weight.	c
c			Daughter contributions are indicated by	c
c			'+D' after the atomic weight	c
c			and 'M' if present.	c
c	RMDTITL	Chr*80	80-character title of Radionuclide	c
c			Master Data Library.	c
c	HTITLE	Chr*80	80-character title of HUDU	c
c			Dose Factor Library.	c
c	EXTDF(300)	Real*4	External dose factor (Sv/yr per Bq/m ³)	c
c			for each nuclide. Value of -1 means	c
c			that a nuclide in the 'RMDLIB' library	c
c			was not found in the Dose Factor librar	c
c	DOSINH(2,5,300)	Real*4	Inhalation dose factors (Sv/Bq).	c

c			First index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1=Lungs, 2=Bone Surf,	c
c			3=Red Marrow, 4=Thyroid,	c
c			5=Effective Dose Equivalent	c
c			3rd Index: nuclide	c
c	GRPNAM(5)	Chr*80	Title for a group of nuclides in the	c
c			Radionuclide Master Data Library	c
c	NUCGRP(300)	Integer	Group ID# for this nuclide	c
c	NUMGRP(5)	Integer	Number of nuclides in this group	c
c	Q0(300)	Real*4	Curies of this nuclide released	c
c	IFQMOO	Logical	Whether user has modified a set of q0	c
c			values from a source term file	c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	None			c
c	Values Returned as ARGUMENTS:			c
c	None			c
c	Values Returned in COMMONS:			c
c	Name	Via		c
c	inplin	/General/		c
c	ifmaygo	/General/		c
c	indexc	/Meteo/		c
c	defstab	/Meteo/		c
c	defwspd	/Meteo/		c
c	deflayer	/Meteo/		c
c	deftemp	/Meteo/		c
c	defhrmo	/Meteo/		c
c	stabnam	/Meteo/		c
c	itrel	/Release/		c
c	shght	/Release/		c
c	sflow	/Release/		c
c	srad	/Release/		c
c	etemp	/Release/		c
c	prise	/Release/		c

c	oht	/Release/	c
c	bdarea	/Release/	c
c	bht	/Release/	c
c	nrange	/Downwind/	c
c	range	/Downwind/	c
c	eoq	/Downwind/	c
c	rgtitl	/Downwind/	c
c	ifqmod	/Nuclide/	c
c	extdf	/Nuclide/	c
c	brate	/Doses/	c
c	extdos	/Doses/	c
c	doslung	/Doses/	c
c	dosbone	/Doses/	c
c	dosthy	/Doses/	c
c	dosed	/Doses/	c
c			c
c	SUBORDINATE ROUTINES CALLED:		c
c	None		c
c			c
c	MODULE ALGORITHM:		c
c	Initial key variables for system in commons.		c
c			c
c	ERROR HANDLING:		c
c	None		c

```

/*****/
/* */
/*  MODULE NAME: */
/*    LOGO */
/* */
/*  ABSTRACT: */
/*    This routine makes an introductory logo screen */
/* */
/*  AUTHOR: */
/*    R. I. Scherpelz */
/*    Pacific Northwest Laboratory */
/*    P.O. Box 999 */
/*    Richland, WA 99352 */
/*    509-375-2454 */
/*    S. D. Miller */
/*    509-375-3843 */
/* */
/*  CREATION DATE: */
/*    February 21, 1990 */
/* */
/*  I/O: */
/*    No input */
/*    Output written to screen */
/* */
/*  CONSTANTS: */
/*    None */
/* */
/*  LOCAL VARIABLES: */
/*    Name      Type      Description */
/*    ICOL      Integer   Column number for cursor */
/*    IROW      Integer   Row number for cursor */
/* */
/*  MODULE CALLED FROM: */
/*    MAIN */
/* */

```

```

/*  PARAMETER PASSING:                                */
/*    Input Values:                                    */
/*    None                                             */
/*  Values Returned:                                  */
/*    None                                             */
/*                                                     */
/*  SUBORDINATE ROUTINES CALLED:                       */
/*    None                                             */
/*                                                     */
/*  MODULE ALGORITHM:                                  */
/*    Routine simply writes messages to the screen.  */
/*                                                     */
/*  ERROR HANDLING:                                    */
/*    None                                             */
/*                                                     */
/*  ESI C Utilities routines called:                  */
/*    colrcprt  curlocat  colrprts  setscmod          */

```

```

C=====C
C
C  MODULE NAME:
C    DATIME
C
C  ABSTRACT:
C    This routine returns the current date & time in a
C    27 character-long variable
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C
C  CREATION DATE:
C    February 12, 1988
C
C  I/O:
C    No Input
C    Output through variables in arguments
C
C  CONSTANTS:
C    None
C
C  LOCAL VARIABLES:
C
C    Name          Type          Description
C    IHR           Integer       Hour (1 to 24)
C    MONTH         Integer       Month (1 to 12)
C    DAYTIME       Chr*27        String containing the date and time
C    IM            Integer       Do loop index or month
C    DAT           Chr*21        Current date
C    TIM           Chr*21        Current time
C    MONNAM(12)    Chr*3         Abbreviated month names

```

c		c	
c	MODULE CALLED FROM:	c	
c	MAIN	c	
c		c	
c	PARAMETER PASSING:	c	
c	Input Values:	c	.
c	None	c	.
c	Values Returned as ARGUMENTS:	c	.
c	daytime month ihr	c	.
c		c	
c	SUBORDINATE ROUTINES CALLED:	c	
c	datim	c	
c		c	
c	MODULE ALGORITHM:	c	
c	Routine simply returns date and time.	c	
c		c	
c	ERROR HANDLING:	c	
c	None	c	


```

/*****
/*
/*  MODULE NAME:
/*    DATIM
/*
/*  ABSTRACT:
/*    This routine finds the current date & time
/*    from the system clock.
/*
/*  AUTHOR:
/*    R. I. Scherpelz
/*    Pacific Northwest Laboratory
/*    P.O. Box 999
/*    Richland, WA 99352
/*    509-375-2454
/*
/*  CREATION DATE:
/*    February 21, 1990
/*
/*  I/O:
/*    No Input
/*    Output passed to calling module
/*
/*  CONSTANTS:
/*    None
/*
/*  LOCAL VARIABLES:
/*
/*    Name          Type          Description
/*    I_            Integer      Return code (ignored)
/*    DAT[11]       Character     Current date
/*    TIM[11]       Character     Current time
/*
/*  MODULE CALLED FROM:
/*    DATIME
/*

```

```

/*  PARAMETER PASSING:                                */
/*    Input Values:                                    */
/*    None                                             */
/*  Values Returned:                                  */
/*    dat      tim                                    */
/*                                                    */
/*  SUBORDINATE ROUTINES CALLED:                       */
/*    None                                             */
/*                                                    */
/*  MODULE ALGORITHM:                                  */
/*    Routine returns the current date and time.      */
/*                                                    */
/*  ERROR HANDLING:                                    */
/*    None                                             */
/*                                                    */
/*  ESI C Utilities routines called:                  */
/*    sysdate    systime                              */

```

```

C=====C
C
C      MODULE NAME:
C      LIBREAD
C
C      ABSTRACT:
C      This routine reads in nuclide decay and dose factor data
C      from the unformatted file HUDATA.DAT This data was
C      derived from: the decay library HRMDLIB.DAT, dose factor
C      library HUDUFACT.DAT, facility library file FACILITY.DAT.
C
C      AUTHOR:
C      R. I. Scherpelz
C      Pacific Northwest Laboratory
C      P.O. Box 999
C      Richland, WA 99352
C      509-375-2454
C
C      CREATION DATE:
C      February 15, 1990
C
C      I/O:
C      Input through variables in commons and through files:
C      File HUDATA.DAT, Purpose:
C      Contains radionuclide decay chains, dose factors,
C      and facility accident scenario source terms.
C      Output through variables in commons
C
C      CONSTANTS:
C      None
C
C      LOCAL VARIABLES:
C      Name          Type          Description
C      I_            Integer      Implid do index
C      J_            Integer      Implid do index

```

```

C=====C
C
C      MODULE NAME:
C      MAIN
C
C      ABSTRACT:
C      Hanford Unified Dose Utility (HUDU) -- Version 1.21
C      Developed for use in the UDAC EMS Facility
C
C      AUTHOR:
C      R. I. Scherpelz
C      Pacific Northwest Laboratory
C      P.O. Box 999
C      Richland, WA 99352
C      509-375-2454
C
C      CREATION DATE:
C      August 30, 1990
C
C      PROGRAMMING LANGUAGE:
C      Fortran 77, C
C
C      COMPILER VENDOR AND VERSION NUMBER:
C      Microsoft
C      Fortran: Version 4.10
C      C      : Version 5.1
C
C      COMPUTER:
C      IBM PS/2 Model 50 or higher
C      or IBM-PC or AT compatibles.
C
C      OPERATING SYSTEM:
C      MS-DOS V. 3.3 or higher
C
C      CPU REQUIREMENTS:

```

c	80286 or 80386 is desirable (8088 or 8086 will work)	c
c	80x87 math coprocessor recommended but not required	c
c		c
c	MEMORY REQUIREMENTS:	c
c	640k Memory Necessary	c
c		c
c	DISK SPACE:	c
c	Floppy or Hard Drive with at least 720 kbytes capacity	c
c		c
c	MONITOR:	c
c	Color preferred but not required	c
c		c
c	PRINTER/PLOTTER:	c
c	No requirements	c
c		c
c	KEYBOARD:	c
c	No requirements	c
c		c
c	I/O:	c
c	Input via operator input on the screen	c
c	Output via the screen and through	c
c	variables in arguments and commons	c
c		c
c	CONSTANTS:	c
c	None (See list in Block Data routine)	c
c		c
c	LOCAL VARIABLES:	c
c	None	c
c		c
c	PARAMETER PASSING:	c
c	Input Values:	c
c	None	c
c	Values Returned as ARGUMENTS:	c
c	None	c
c		c

c	SUBORDINATE ROUTINES CALLED:	c
c	blockdata logo datetime libread	c
c	met_def input eoqcalc dosecalc	c
c	output	c
c		c
c	MODULE ALGORITHM:	c
c	This routine manages the HUDU system. It fills the screen	c
c	with logo information, gets the date and time, puts out the	c
c	title, reads in the library files, sets up default values.	c
c	Then it writes out the rest of the input lines and gets	c
c	input from the operator. Next the calculations are	c
c	performed: atmospheric distribution of a release and	c
c	radiation dose calculations. Finally the results are	c
c	output to the screen and a data file.	c
c		c
c	ERROR HANDLING:	c
c	None.	c

```

C=====C
C
C  MODULE NAME:
C    BLOCKDATA
C
C  ABSTRACT:
C    Contains compile-time data for the code.
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C
C  CREATION DATE:
C    March 1, 1989
C
C  I/O:
C    Input through variables in commons
C    Output through variables in commons
C
C  CONSTANTS:
C    None
C
C  LOCAL VARIABLES:
C    None
C
C  DATA STRUCTURES:
C    Common  /general/
C    TITLE      Chr*78    Title message for display screen
C    INPLIN(25)  Chr*78    Input lines for main menu display
C    MONTH       Integer   Current month
C    I HOUR      Integer   Current hour
C    IFMAYGO     Logical    Flags if sufficient data has been

```

c			entered to perform the atmospheric	c
c			transport calculation	c
c	Common	/meteo/		c
c	JSTAB	Integer	Stability class	c
c	WINDSPD	Real*4	Wind speed (m/sec)	c
c	LAYER	Integer	Mixing layer thickness (m)	c
c	AIRTEMP	Real*4	Air Temperature (C)	c
c	INDEXC	Integer	Cloudiness index	c
c	DEFSTAB	Logical	Flags default stability	c
c	DEFWSPD	Logical	Flags default wind speed	c
c	DEFLAYER	Logical	Flags default mixing layer thickness	c
c	DEFTEMP	Logical	Flags default effluent temperature	c
c	DEFHRMO	Logical	Flags default hour and month	c
c	STABNAM(7)	Chr*25	Names of the seven stability classes:	c
c			A: Extremely, B: Moderately Unstable,	c
c			C: Slightly Unstable, D: Neutral,	c
c			E: Slightly, F: Moderately Stable,	c
c			G: Extremely Stable	c
c	Common	/release/		c
c	SHGHT	Real*4	Stack height of release (m)	c
c	SFLOW	Real*4	Stack flow of release (m ³ /sec)	c
c	SRAD	Real*4	Stack radius of release (m)	c
c	ETEMP	Real*4	Effluent temperature of release (C)	c
c	BDAREA	Real*4	Building Area of release (m ²)	c
c	BHT	Real*4	Building height of release (m)	c
c	ITREL	Integer	Release number value (1 to 4)	c
c			1 - Open Area Ground Level, 2 - Open	c
c			Area Elevated, 3 - Ground Level,	c
c			4 - Effective release height (m)	c
c	OHT	Real*4	Open Area Elevated Height (m)	c
c	ERHT	Real*4	Effective Release height (m)	c
c	PRISE	Real*4	Hight the plume rises (m)	c
c	Common	/downwind/		c
c	NRANGE	Integer	Number of downwind ranges for dose	c
c			calculation (< = 20)	c

c	RANGE(20)	Real*4	Downwind distance, meters	c
c	EQQ(20)	Real*4	Time-integrated relative air	c
c			concentration at each range (sec/m ³)	c
c	RGTITL(20)	Chr*25	Title for each downwind range	c
c	ETA(20)	Real*4	Estimated time of plume arrival;	c
c			actually the plume transit time to	c
c			each downwind range (sec)	c
c	Common	/doses/		c
c	BRATE	Real*4	Breathing rate, (l/min)	c
c	EXTDOS(20)	Real*4	External dose, semi-infinite	c
c			cloud submersion (mrem)	c
c			index: 1 to number downwind ranges	c
c	DOSLUNG(2,20)	Real*4	Inhalation dose to lung (mrem)	c
c			1st index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1 to number downwind ranges	c
c	DOSBONE(2,20)	Real*4	Inhalation dose to bone (mrem)	c
c			1st index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1 to number downwind ranges	c
c	DOSTHY(2,20)	Real*4	Inhalation dose to thyroid (mrem)	c
c			1st index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1 to number downwind ranges	c
c	DOSEDE(2,20)	Real*4	Effective dose equivalent (mrem)	c
c			inhalation (mrem)	c
c			1st index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1 to number downwind ranges	c
c	WHICHBONE	Chr*8	contains name of the bone part	c
c			(red marrow or bone surface)	c
c			with higher dose	c
c	Common	/nuclide/		c
c	NNUC:	Integer	Number of radionuclides in the master	c
c			library 'RMDLIB', 1 <= NUC => 300	c
c	NCH	Integer	Number of decay chains in the master	c
c			library 'RMDLIB', 1 <= NCH => 200.	c
c	NOFNUC(200)	Integer	Number of radionuclides in each	c

c			decay chain. 1 <= NOFNUC(I) => 9.	c
c			When NOFNUC(I) = 1, No daughters.	c
c	NCHST(200)	Integer	Location in the master radionuclide	c
c			list of the 1st member of each chain.	c
c			1 <= NCHST(I) => 300.	c
c	IFR(2,300)	Integer	IFR(1,I) gives the chain member that	c
c			is the 1st precursor to radionuclide I.	c
c			IFR(2,I) is location of 2nd precursor.	c
c			IFR(1,I) < IFR(2,I) < IMEM(I)	c
c	DKF(2,300)	Real*4	Fraction of 1st and 2nd precursor	c
c			that decays to this radionuclide.	c
c	AL(300)	Real*4	Radiological decay constant for each	c
c			radionuclide day ** -1.	c
c	NCHN(300)	Integer	Chain number for each radionuclide.	c
c	NUCNAM(300)	Chr*8	8-character nuclide identifier:	c
c			First 2 Chars: Element name for each	c
c			radionuclide in the Master	c
c			Radionuclide Data library.	c
c			Chars. 3-8: Atomic weight symbol for	c
c			each radionuclide in the Master	c
c			Radionuclide Data library.	c
c			Isomeric states are indicated by the	c
c			letter 'M' after the atomic weight.	c
c			Daughter contributions are indicated by	c
c			'+D' after the atomic weight	c
c			and 'M' if present.	c
c	RMDTITL	Chr*80	80-character title of Radionuclide	c
c			Master Data Library.	c
c	HTITLE	Chr*80	80-character title of HUDU	c
c			Dose Factor Library.	c
c	EXTDF(300)	Real*4	External dose factor (Sv/yr per Bq/m^3)	c
c			for each nuclide. Value of -1 means	c
c			that a nuclide in the 'RMDLIB' library	c
c			was not found in the Dose Factor librar	c
c	DOSINH(2,5,300)	Real*4	Inhalation dose factors (Sv/Bq).	c

c			First index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1=Lungs, 2=Bone Surf,	c
c			3=Red Marrow, 4=Thyroid,	c
c			5=Effective Dose Equivalent	c
c			3rd Index: nuclide	c
c	GRPNAM(5)	Chr*80	Title for a group of nuclides in the	c
c			Radionuclide Master Data Library	c
c	NUCGRP(300)	Integer	Group ID# for this nuclide	c
c	NUMGRP(5)	Integer	Number of nuclides in this group	c
c	Q0(300)	Real*4	Curies of this nuclide released	c
c	IFQMOD	Logical	Whether user has modified a set of q0	c
c			values from a source term file	c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	None			c
c	Values Returned as ARGUMENTS:			c
c	None			c
c	Values Returned in COMMONS:			c
c	Name	Via		c
c	inplin	/General/		c
c	ifmaygo	/General/		c
c	indexc	/Meteo/		c
c	defstab	/Meteo/		c
c	defwspd	/Meteo/		c
c	deflayer	/Meteo/		c
c	deftemp	/Meteo/		c
c	defhrmo	/Meteo/		c
c	stabnam	/Meteo/		c
c	itrel	/Release/		c
c	shght	/Release/		c
c	sflow	/Release/		c
c	srad	/Release/		c
c	etemp	/Release/		c
c	prise	/Release/		c

c	oht	/Release/	c
c	bdarea	/Release/	c
c	bht	/Release/	c
c	nrange	/Downwind/	c
c	range	/Downwind/	c
c	eoq	/Downwind/	c
c	rgtitl	/Downwind/	c
c	ifqmod	/Nuclide/	c
c	extdf	/Nuclide/	c
c	brate	/Doses/	c
c	extdos	/Doses/	c
c	doslung	/Doses/	c
c	dosbone	/Doses/	c
c	dosthy	/Doses/	c
c	dosed	/Doses/	c
c			c
c	SUBORDINATE ROUTINES CALLED:		c
c	None		c
c			c
c	MODULE ALGORITHM:		c
c	Initial key variables for system in commons.		c
c			c
c	ERROR HANDLING:		c
c	None		c

```

/*****/
/* */
/*  MODULE NAME: */
/*    LOGO */
/* */
/*  ABSTRACT: */
/*    This routine makes an introductory logo screen */
/* */
/*  AUTHOR: */
/*    R. I. Scherpelz */
/*    Pacific Northwest Laboratory */
/*    P.O. Box 999 */
/*    Richland, WA 99352 */
/*    509-375-2454 */
/*    S. D. Miller */
/*    509-375-3843 */
/* */
/*  CREATION DATE: */
/*    February 21, 1990 */
/* */
/*  I/O: */
/*    No input */
/*    Output written to screen */
/* */
/*  CONSTANTS: */
/*    None */
/* */
/*  LOCAL VARIABLES: */
/*    Name          Type          Description */
/*    ICOL           Integer      Column number for cursor */
/*    IROW           Integer      Row number for cursor */
/* */
/*  MODULE CALLED FROM: */
/*    MAIN */
/* */

```

```

/*  PARAMETER PASSING:                                */
/*    Input Values:                                    */
/*    None                                             */
/*  Values Returned:                                   */
/*    None                                             */
/*                                                     */
/*  SUBORDINATE ROUTINES CALLED:                       */
/*    None                                             */
/*                                                     */
/*  MODULE ALGORITHM:                                  */
/*    Routine simply writes messages to the screen.   */
/*                                                     */
/*  ERROR HANDLING:                                    */
/*    None                                             */
/*                                                     */
/*  ESI C Utilities routines called:                  */
/*    colrcprt  curlocat  colrprts  setscmod          */

```

```

C-----C
C
C  MODULE NAME:
C    DATIME
C
C  ABSTRACT:
C    This routine returns the current date & time in a
C    27 character-long variable
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C
C  CREATION DATE:
C    February 12, 1988
C
C  I/O:
C    No Input
C    Output through variables in arguments
C
C  CONSTANTS:
C    None
C
C  LOCAL VARIABLES:
C
C    Name          Type          Description
C    IHR           Integer       Hour (1 to 24)
C    MONTH         Integer       Month (1 to 12)
C    DAYTIME       Chr*27       String containing the date and time
C    IM            Integer       Do loop index or month
C    DAT           Chr*21       Current date
C    TIM           Chr*21       Current time
C    MONNAM(12)    Chr*3        Abbreviated month names

```

c		c
c	MODULE CALLED FROM:	c
c	MAIN	c
c		c
c	PARAMETER PASSING:	c
c	Input Values:	c
c	None	c
c	Values Returned as ARGUMENTS:	c
c	daytime month ihr	c
c		c
c	SUBORDINATE ROUTINES CALLED:	c
c	datim	c
c		c
c	MODULE ALGORITHM:	c
c	Routine simply returns date and time.	c
c		c
c	ERROR HANDLING:	c
c	None	c


```

/*****/
/* */
/*  MODULE NAME: */
/*    DATIM */
/* */
/*  ABSTRACT: */
/*    This routine finds the current date & time */
/*    from the system clock. */
/* */
/*  AUTHOR: */
/*    R. I. Scherpelz */
/*    Pacific Northwest Laboratory */
/*    P.O. Box 999 */
/*    Richland, WA 99352 */
/*    509-375-2454 */
/* */
/*  CREATION DATE: */
/*    February 21, 1990 */
/* */
/*  I/O: */
/*    No Input */
/*    Output passed to calling module */
/* */
/*  CONSTANTS: */
/*    None */
/* */
/*  LOCAL VARIABLES: */
/*    Name          Type          Description */
/*    I_            Integer      Return code (ignored) */
/*    DAT[11]       Character     Current date */
/*    TIM[11]       Character     Current time */
/* */
/*  MODULE CALLED FROM: */
/*    DATIME */
/* */

```

```

/*  PARAMETER PASSING:                                */
/*    Input Values:                                    */
/*    None                                             */
/*  Values Returned:                                    */
/*    dat      tim                                    */
/*                                                     */
/*  SUBORDINATE ROUTINES CALLED:                        */
/*    None                                             */
/*                                                     */
/*  MODULE ALGORITHM:                                    */
/*    Routine returns the current date and time.      */
/*                                                     */
/*  ERROR HANDLING:                                    */
/*    None                                             */
/*                                                     */
/*  ESI C Utilities routines called:                  */
/*    sysdate    systime                              */

```

```

C=====C
C
C  MODULE NAME:
C    LIBREAD
C
C  ABSTRACT:
C    This routine reads in nuclide decay and dose factor data
C    from the unformatted file HUDATA.DAT  This data was
C    derived from: the decay library HRMDLIB.DAT, dose factor
C    library HUDUFACT.DAT, facility library file FACILITY.DAT.
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C
C  CREATION DATE:
C    February 15, 1990
C
C  I/O:
C    Input through variables in commons and through files:
C    File HUDATA.DAT, Purpose:
C    Contains radionuclide decay chains, dose factors,
C    and facility accident scenario source terms.
C    Output through variables in commons
C
C  CONSTANTS:
C    None
C
C  LOCAL VARIABLES:
C
C    Name          Type          Description
C    I_            Integer       Implied do index
C    J_            Integer       Implied do index

```

c	IF	Integer	Implied do index	c
c	IL	Integer	Implied do index	c
c	IN	Integer	Implied do index	c
c	IO	Integer	Implied do index	c
c				c
c	DATA STRUCTURES:			c
c	Common /facility/			c
c	FTITLE	Chr*80	Title of facility data file	c
c	NUMFAC	Integer	Number of facilities (< 101)	c
c	FACNAME(100)	Chr*40	Name of the facility	c
c			(with a short accident description)	c
c	FACAREA(100)	Chr*12	Name of the Hanford area containing	c
c			the facility	c
c	ACCDES(8,100)	Chr*80	Up to 8 lines of text describing	c
c			the accident scenario	c
c	NUMNUC(100)	Integer	Number of nuclides in each facility's	c
c			release list (<201)	c
c	NUCID(200,100)	Integer	Id number of nuclide in list	c
c			(corresponds to order read from HRMDLIB)	c
c	CIRD(200,100)	Real*4	Radioactivity released of nuclide (Ci)	c
c	RELHT(100)	Real*4	Release height of scenario (m)	c
c	Common /nuclide/			c
c	NNUC:	Integer	Number of radionuclides in the master	c
c			library 'RMDLIB', 1 <= NUC => 300	c
c	NCH	Integer	Number of decay chains in the master	c
c			library 'RMDLIB', 1 <= NCH => 200.	c
c	NOFNUC(200)	Integer	Number of radionuclides in each	c
c			decay chain. 1 <= NOFNUC(I) => 9.	c
c			When NOFNUC(I) = 1, No daughters.	c
c	NCHST(200)	Integer	Location in the master radionuclide	c
c			list of the 1st member of each chain.	c
c			1 <= NCHST(I) => 300.	c
c	IFR(2,300)	Integer	IFR(1,I) gives the chain member that	c
c			is the 1st precursor to radionuclide I.	c
c			IFR(2,I) is location of 2nd precursor.	c

c			IFR(1,I) < IFR(2,I) < IMEM(I)	c
c	DKF(2,300)	Real*4	Fraction of 1st and 2nd precursor	c
c			that decays to this radionuclide.	c
c	AL(300)	Real*4	Radiological decay constant for each	c
c			radionuclide day ** -1.	c
c	NCHN(300)	Integer	Chain number for each radionuclide.	c
c	NUCNAM(300)	Chr*8	8-character nuclide identifier:	c
c			First 2 Chars: Element name for each	c
c			radionuclide in the Master	c
c			Radionuclide Data library.	c
c			Chars. 3-8: Atomic weight symbol for	c
c			each radionuclide in the Master	c
c			Radionuclide Data library.	c
c			Isomeric states are indicated by the	c
c			letter 'M' after the atomic weight.	c
c			Daughter contributions are indicated by	c
c			'+D' after the atomic weight	c
c			and 'M' if present.	c
c	RMDTITL	Chr*80	80-character title of Radionuclide	c
c			Master Data Library.	c
c	HTITLE	Chr*80	80-character title of HUDU	c
c			Dose Factor Library.	c
c	EXTDF(300)	Real*4	External dose factor (Sv/yr per Bq/m ³)	c
c			for each nuclide. Value of -1 means	c
c			that a nuclide in the 'RMDLIB' library	c
c			was not found in the Dose Factor librar	c
c	DOSINH(2,5,300)	Real*4	Inhalation dose factors (Sv/Bq).	c
c			First index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1=Lungs, 2=Bone Surf,	c
c			3=Red Marrow, 4=Thyroid,	c
c			5=Effective Dose Equivalent	c
c			3rd Index: nuclide	c
c	GRPNAM(5)	Chr*80	Title for a group of nuclides in the	c
c			Radionuclide Master Data Library	c
c	NUCGRP(300)	Integer	Group ID# for this nuclide	c

c	NUMGRP(5)	Integer	Number of nuclides in this group	c
c	Q0(300)	Real*4	Curies of this nuclide released	c
c	IFQMOD	Logical	Whether user has modified a set of q0	c
c			values from a source term file	c
c				c
c	MODULE CALLED FROM:			c
c	MAIN			c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	None			c
c	Values Returned as ARGUMENTS:			c
c	None			c
c	Values Returned in COMMONS:			c
c	Name	Via		c
c	nnuc	/Nuclide/		c
c	nch	/Nuclide/		c
c	nofnuc	/Nuclide/		c
c	nchst	/Nuclide/		c
c	ifr	/Nuclide/		c
c	dkf	/Nuclide/		c
c	al	/Nuclide/		c
c	nchn	/Nuclide/		c
c	nucnam	/Nuclide/		c
c	grpnam	/Nuclide/		c
c	nucgrp	/Nuclide/		c
c	numbrp	/Nuclide/		c
c	rmdtitl	/Nuclide/		c
c	htitile	/Nuclide/		c
c	extdf	/Nuclide/		c
c	dosinh	/Nuclide/		c
c	qo	/Nuclide/		c
c	ifqmod	/Nuclide/		c
c	accdes	/Facilty/		c
c	facarea	/Facilty/		c

c	ftitle	/Facilty/	c
c	numfac	/Facilty/	c
c	numnuc	/Facilty/	c
c	nucid	/Facilty/	c
c	cird	/Facilty/	c
c	relht	/Facilty/	c
c	facnam	/Facilty/	c
c			c
c	SUBORDINATE ROUTINES CALLED:		c
c	None		c
c			c
c	MODULE ALGORITHM:		c
c	Opens, reads, and closes the data file.		c
c			c
c	ERROR HANDLING:		c
c	None		c

```

C=====C
C
C      MODULE NAME:
C      MET_DEF
C
C      ABSTRACT:
C      Calculates default values for meterological data.
C
C      AUTHOR:
C      R. I. Scherpelz
C      Pacific Northwest Laboratory
C      P.O. Box 999
C      Richland, WA 99352
C      509-375-2454
C
C      CREATION DATE:
C      February 27, 1989
C
C      I/O:
C      Input through variables in commons
C      Output through variables in commons
C
C      CONSTANTS:
C      Name          Type          Description
C      MONNAM(12)    Chr*3         Names of the months of the year
C
C      LOCAL VARIABLES:
C      None
C
C      DATA STRUCTURES:
C      Common /general/
C      TITLE          Chr*78       Title message for display screen
C      INPLIN(25)     Chr*78       Input lines for main menu display
C      MONTH          Integer      Current month
C      I HOUR         Integer      Current hour

```


c	IFMAYGO	Logical	Flags if sufficient data has been	c
c			entered to perform the atmospheric	c
c			transport calculation	c
c	Common	/meteo/		c
c	JSTAB	Integer	Stability class	c
c	WINDSPD	Real*4	Wind speed (m/sec)	c
c	LAYER	Integer	Mixing layer thickness (m)	c
c	AIRTEMP	Real*4	Air Temperature (C)	c
c	INDEXC	Integer	Cloudiness index	c
c	DEFSTAB	Logical	Flags default stability	c
c	DEFWSPD	Logical	Flags default wind speed	c
c	DEFLAYER	Logical	Flags default mixing layer thickness	c
c	DEFTEMP	Logical	Flags default effluent temperature	c
c	DEFHRMO	Logical	Flags default hour and month	c
c	STABNAM(7)	Chr*25	Names of the seven stability classes:	c
c			A: Extremely, B: Moderately Unstable,	c
c			C: Slightly Unstable, D: Neutral,	c
c			E: Slightly, F: Moderately Stable,	c
c			G: Extremely Stable	c
c				c
c	MODULE CALLED FROM:			c
c	MAIN INPUT			c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	None			c
c	Values Returned as ARGUMENTS:			c
c	None			c
c	Values Returned in COMMONS:			c
c	Name	Via		c
c	inplin	/General/		c
c	jstab	/Meteo/		c
c	windspd	/Meteo/		c
c	layer	/Meteo/		c
c	airtemp	/Meteo/		c

c		c
c	SUBORDINATE ROUTINES CALLED:	c
c	dflayer dfspd dfstab dftemp	c
c	pgstab	c
c		c
c	MODULE ALGORITHM:	c
c	Routine calls subroutines to calculate default atmospheric	c
c	conditions, if the logical flag for each condition is set	c
c	to .true., including: stability class, wind speed,	c
c	mixing layer depth, and air temperatures based on the	c
c	month of the year and hour of the day. Values are used	c
c	to fill strings written in the input menu screen.	c
c		c
c	ERROR HANDLING:	c
c	None	c

```

=====C
C
C
C   MODULE NAME:
C   DFLAYER
C
C
C   ABSTRACT:
C       Calculates default mixing layer depth given the
C       month & stability
C
C
C   AUTHOR:
C       J. V. Ramsdell
C       Pacific Northwest Laboratory
C       P.O. Box 999
C       Richland, WA 99352
C       509-376-8626
C
C
C   CREATION DATE:
C       February 6, 1988
C
C
C   I/O:
C       Input through variables in arguments
C       Output through variables in arguments
C
C
C   CONSTANTS:
C
C       Name          Type          Description
C       MONTH          Integer      Month of year
C       IST             Integer      Stability
C       MLAYER(4,7)    Real*4       Defalult mixing layer depths (m)
C                                   Index #1: 1=Winter, 2=Spring,
C                                   3=Summer, 4=Autumn
C                                   Index #2: Stability classes
C
C
C   LOCAL VARIABLES:
C
C       Name          Type          Description
C       DFLAYER        Integer      Default mixing layer depth (m)

```

c	IM	Integer	One more than the current month	c
c	IS	Integer	Season (1 = Winter, 3 = Summer .e.g.)	c
c				c
c	MODULE CALLED FROM:			c
c	MET_DEF			c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	month	ist		c
c	Values Returned as ARGUMENTS:			c
c	dflayer			c
c				c
c	SUBORDINATE ROUTINES CALLED:			c
c	None			c
c				c
c	ABSTRACT:			c
c	The default depths are determined from climatological data			c
c	by month and stability, which are defined in a data			c
c	statement. The routine converts the month of the year to			c
c	the correct season of the year. The season and stability			c
c	are used to extract the mixing layer depth.			c
c				c
c	ERROR HANDLING:			c
c	None			c

```

C=====C
C
C  MODULE NAME:
C    DFSPD
C
C  ABSTRACT:
C    Calculates default wind speed
C    given the month & time of day
C
C  AUTHOR:
C    J. V. Ramsdell
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-376-8626
C    R. I. Scherpelz
C    509-375-2454
C
C  CREATION DATE:
C    July 5, 1989
C
C  I/O:
C    Input through variables in arguments
C    Output through variables in arguments
C
C  CONSTANTS:
C
C    Name          Type          Description
C    MONTH         Integer       Month of year
C    HOUR          Integer       Hour of the day
C    IST           Integer       Stability
C    SPD(12,12)    Real*4        Default wind speeds (mi/hr)
C                                     Index #1: Month of year
C                                     Index #2: Every other hour of the day
C    HT            Real*4        Height for profile calculation (m)
C    ZO            Real*4        Surface roughness length (m)

```

c				c
c	LOCAL VARIABLES:			c
c	Name	Type	Description	c
c	IH	Integer	Every other hour of the day	c
c	IM	Integer	Month of year	c
c	TSPD	Real*4	Wind speed from table (m/s)	c
c	DFSPD	Real*4	Default wind speed (m/s)	c
c				c
c	MODULE CALLED FROM:			c
c	MET_DEF			c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	month	hour	ist	c
c	Values Returned as ARGUMENTS:			c
c	dfspd			c
c				c
c	SUBORDINATE ROUTINES CALLED:			c
c	Profile			c
c				c
c	ABSTRACT:			c
c	The default wind speeds are determined from climatological			c
c	data by month and hour, which are defined in a data			c
c	statement. The routine divides the hour of day into two			c
c	adjusted for midnight and calculates the wind speed from			c
c	the table based on the month and hour. This speed is then			c
c	adjusted to the speed at a height of 10 M by calling the			c
c	'PROFILE' calculation subroutine.			c
c				c
c	ERROR HANDLING:			c
c	None			c

```

C=====C
C
C      MODULE NAME:
C      DFSTAB
C
C      ABSTRACT:
C      Calculates default stability class
C      given the month and time of day
C
C      AUTHOR:
C      J. V. Ramsdell
C      Pacific Northwest Laboratory
C      P.O. Box 999
C      Richland, WA 99352
C      509-376-8626
C      R. I. Scherpelz
C      509-375-2454
C
C      CREATION DATE:
C      July 5, 1989
C
C      I/O:
C      Input through variables in arguments
C      Output through variables in arguments
C
C      CONSTANTS:
C      Name          Type          Description
C      MONTH          Integer      Month of year
C      HOUR            Integer      Hour of the day
C      STAB(12,12)     Integer      Default stability classes
C                                  Index #1: Month of year
C                                  Index #2: Every other hour of the day
C
C      LOCAL VARIABLES:
C      Name          Type          Description

```

c	IH	Integer	Every other hour of the day	c
c	IM	Integer	Month of year	c
c	DFSTAB	Real*4	Default stability class	c
c				c
c	MODULE CALLED FROM:			c
c	MET_DEF			c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	month	hour		c
c	Values Returned as ARGUMENTS:			c
c	dfstab			c
c				c
c	SUBORDINATE ROUTINES CALLED:			c
c	None			c
c				c
c	ABSTRACT:			c
c	The default stability classes are determined from			c
c	climatological data by month and hour, which are			c
c	defined in a data statement. The routine divides the			c
c	hour of day into two adjusted for midnight and calculates a			c
c	stability class from the table based on the month and hour.			c
c				c
c	ERROR HANDLING:			c
c	None			c


```

C-----C
C
C  MODULE NAME:
C    DFTEMP
C
C  ABSTRACT:
C    Calculates default air temperature
C    given the month and time of day
C
C  AUTHOR:
C    J. V. Ramsdell
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-376-8626
C    R. I. Scherpelz
C    509-375-2454
C
C  CREATION DATE:
C    July 5, 1989
C
C  I/O:
C    Input through variables in arguments
C    Output through variables in arguments
C
C  CONSTANTS:
C
C    Name          Type          Description
C    MONTH         Integer       Month of year
C    HOUR          Integer       Hour of the day
C    ATEMP(12,12)  Real*4        Default air temperatures (F)
C                                     Index #1: Month of year
C                                     Index #2: Every other hour of the day
C
C  LOCAL VARIABLES:
C
C    Name          Type          Description

```

c	IH	Integer	Every other hour of the day	c
c	IM	Integer	Month of year	c
c	FTEMP	Real*4	Default air temperature (F)	c
c	DFTMP	Real*4	Default air temperature (C)	c
c				c
c	MODULE CALLED FROM:			c
c	MET_DEF			c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	month	hour		c
c	Values Returned as ARGUMENTS:			c
c	dftemp			c
c				c
c	SUBORDINATE ROUTINES CALLED:			c
c	None			c
c				c
c	ABSTRACT:			c
c	The default air temperatures are determined from			c
c	climatological data by month and hour, which are			c
c	defined in a data statement. The routine divides the			c
c	hour of day into two adjusted for midnight and calculates			c
c	an air temperature from the table based on the month and			c
c	hour. The temperature is then converted into degrees C.			c
c				c
c	ERROR HANDLING:			c
c	None			c

```

C=====C
C
C  MODULE NAME:
C    PGSTAB
C
C  ABSTRACT:
C    Calculates default Pasquill-Gifford stability class
C    given the month, time, wind speed, and cloudiness index.
C
C  AUTHOR:
C    J. V. Ramsdell
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-376-8626
C    R. I. Scherpelz
C    509-375-2454
C
C  CREATION DATE:
C    April 12, 1988
C
C  I/O:
C    Input through variables in arguments
C    Output through variables in arguments
C
C  CONSTANTS:
C
C    Name          Type          Description
C    MONTH         Integer       Month of year
C    HOUR           Integer       Hour of the day
C    SPD            Real*4        Wind speed (m/sec)
C    CINDX          Real*4        Cloudiness index
C    SR(12)         Integer       Two hours after sunrise for month
C                                Index: Month of year
C    SS(12)         Integer       Two hours before sunset for month
C                                Index: Month of year

```

c	STAB(5,4)	Integer	Pasquill-Gifford stability classes	c	
c			Index #1: Net radiation coming in	c	
c			Index #2: Wind speed factors	c	
c				c	
c	LOCAL VARIABLES:			c	
c	Name	Type	Description	c	
c	ISPD	Integer	Wind speed index	c	
c	NETRAD	Integer	Radiation coming in factor	c	
c	IM	Integer	Month of year	c	
c	PGSTAB	Integer	Default Pasquill-Gifford stability	c	
c			class from wind speed & net radiation.	c	
c				c	
c	MODULE CALLED FROM:			c	
c	MET_DEF	CHGSTAB		c	
c				c	
c	PARAMETER PASSING:			c	
c	Input Values:			c	
c	month	hour	spd	cindex	c
c	Values Returned as ARGUMENTS:			c	
c	pgstab			c	
c				c	
c	SUBORDINATE ROUTINES CALLED:			c	
c	None			c	
c				c	
c	ABSTRACT:			c	
c	The default Pasquill-Gifford stability classes are			c	
c	determined from climatological data by month, hour, wind			c	
c	speed, and the cloudiness index. Two hours after sunrise			c	
c	and before sunset are defined in data statements. The			c	
c	Pasquill-Gifford stability classes are defined in another			c	
c	data statement. The routine first determines the wind			c	
c	speed index based on the wind speed entered. It then			c	
c	determines if it is midday, just before sunrise or sunset,			c	
c	or at night. The radiation factor is calculated based on			c	
c	this and cloudiness index. The default Pasquill-Gifford			c	

c stability classes is then calculated.

c

c

c

c ERROR HANDLING:

c

c None

c

·
·
·
·

·
·
·
·

```

=====
c
c
c  MODULE NAME:
c    INPUT
c
c  ABSTRACT:
c    Displays the basic input menu, then calls the routine
c    "CHOOST" to allow the user to scroll through the menu
c    and select the line corresponding to an option.
c
c  AUTHOR:
c    R. I. Scherpelz
c    Pacific Northwest Laboratory
c    P.O. Box 999
c    Richland, WA 99352
c    509-375-2454
c
c  CREATION DATE:
c    June 9, 1988
c
c  I/O:
c    Input through variables in commons
c    Output to CRT screen and through variables in commons
c
c  CONSTANTS:
c
c    Name          Type          Description
c    LINLEN        Integer       Number of characters in a line on CRT
c
c  LOCAL VARIABLES:
c
c    Name          Type          Description
c    ITREL         Integer       ID for type of release (1 to 4)
c    IL            Integer       Index: CRT line number
c    ISELECT       Integer       Option chosen by user (1 to NSELECT)
c    NLINE         Integer       Number of lines on the CRT
c    NSELECT       Integer       Number of options to select from menu

```

```

c
c DATA STRUCTURES:
c   Common /general/
c   TITLE      Chr*78   Title message for display screen
c   INPLIN(25)  Chr*78   Input lines for main menu display
c   MONTH      Integer  Current month
c   IHOURL      Integer  Current hour
c   IFMAYGO     Logical  Flags if sufficient data has been
c                       entered to perform the atmospheric
c                       transport calculation
c   Common /downwind/
c   NRANGE      Integer  Number of downwind ranges for dose
c                       calculation (< = 20)
c   RANGE(20)   Real*4   Downwind distance, meters
c   EQQ(20)     Real*4   Time-integrated relative air
c                       concentration at each range (sec/m^3)
c   RGTITL(20)  Chr*25   Title for each downwind range
c   ETA(20)     Real*4   Estimated time of plume arrival;
c                       actually the plume transit time to
c                       each downwind range (sec)
c
c MODULE CALLED FROM:
c   MAIN
c
c PARAMETER PASSING:
c   Input Values:
c   None
c   Values Returned as ARGUMENTS:
c   None
c   Values Returned in COMMONS:
c   Name      Via
c   inplin    /General/
c   ifmaygo    /General/
c
c SUBORDINATE ROUTINES CALLED:

```

c	met_def	chgstab	witbar	blkbar	c
c	chghrmo	chglayr	chgtemp	chgwnd	c
c	chgrang	chnuc	chsreles	facldr	c
c	choost				c
c					c
c	MODULE ALGORITHM:				c
c	Routine prints the INPLIN array of text lines to CRT, then				c
c	calls "choost", where the user chooses and option. 'Choost'				c
c	returns the id number of the option chosen. Depending on				c
c	the option chosen, INPUT calls the appropriate subroutine.				c
c					c
c	ERROR HANDLING:				c
c	Depressing the "Escape" key allows the user to leave the				c
c	routine with no selection and exit the program.				c
c					c
c	OTHER ROUTINES CALLED:				c
c	Clrit				c


```

C=====C
C
C  MODULE NAME:
C    CHGSTAB
C
C  ABSTRACT:
C    This routine allows the user to change the stability
C    class used in the accident scenerio.
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C
C  CREATION DATE:
C    June 29, 1989
C
C  I/O:
C    Input from keyboard and from variables in common
C    Output to screen and through variables in common
C
C  CONSTANTS:
C    None
C
C  LOCAL VARIABLES:
C    None
C
C  DATA STRUCTURES:
C    Common  /general/
C    TITLE      Chr*78    Title message for display screen
C    INPLIN(25)  Chr*78    Input lines for main menu display
C    MONTH      Integer    Current month
C    IHOUR       Integer    Current hour

```

c	IFMAYGO	Logical	Flags if sufficient data has been	c
c			entered to perform the atmospheric	c
c			transport calculation	c
c	Common	/meteo/		c
c	JSTAB	Integer	Stability class	c
c	WINDSPD	Real*4	Wind speed (m/sec)	c
c	LAYER	Integer	Mixing layer thickness (m)	c
c	AIRTEMP	Real*4	Air Temperature (C)	c
c	INDEXC	Integer	Cloudiness index	c
c	DEFSTAB	Logical	Flags default stability	c
c	DEFWSPD	Logical	Flags default wind speed	c
c	DEFLAYER	Logical	Flags default mixing layer thickness	c
c	DEFTEMP	Logical	Flags default effluent temperature	c
c	DEFHRMO	Logical	Flags default hour and month	c
c	STABNAM(7)	Chr*25	Names of the seven stability classes:	c
c			A: Extremely, B: Moderately Unstable,	c
c			C: Slightly Unstable, D: Neutral,	c
c			E: Slightly, F: Moderately Stable,	c
c			G: Extremely Stable	c
c				c
c	MODULE CALLED FROM:			c
c	INPUT			c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	None			c
c	Values Returned as ARGUMENTS:			c
c	None			c
c	Values Returned in COMMONS:			c
c	Name	Via		c
c	defstab	/Meteo/		c
c	jstab	/Meteo/		c
c	indexc	/Meteo/		c
c	inplin	/General/		c
c				c

c	SUBORDINATE ROUTINES CALLED:	c
c	scstab pgstab	c
c		c
c	MODULE ALGORITHM:	c
c	Displays message to the user, then calls 'scstab' to get	c
c	input from the user. If input is a cloudiness index,	c
c	then code calls 'pgstab' to determine stability class.	c
c		c
c	ERROR HANDLING:	c
c	None	c
c		c
c	OTHER ROUTINES CALLED:	c
c	Clrit	c

```

/*****/
/* */
/*  MODULE NAME: */
/*    SCSTAB */
/* */
/*  ABSTRACT: */
/*    Handles the screen display and pulls in input values for a */
/*    user-requested change in stability class. */
/* */
/*  AUTHOR: */
/*    R. I. Scherpelz */
/*    Pacific Northwest Laboratory */
/*    P.O. Box 999 */
/*    Richland, WA 99352 */
/*    509-375-2454 */
/* */
/*  CREATION DATE: */
/*    June 30, 1989 */
/* */
/*  I/O: */
/*    User input from keyboard and arguments passed */
/*    Output written to screen and through arguments passed */
/* */
/*  CONSTANTS: */
/*    Name          Type          Description */
/*    SROW1         Integer      Row number for top line */
/*                                of stability classes */
/*    SROW2         Integer      Row number for bottom line */
/*                                of stability classes */
/*    SCOLINV        Integer      column number for stability */
/*                                class (in inverse video) */
/*    SCOL1         Integer      Left column for stability */
/*                                class descriptions */
/*    SCOL2         Integer      Right column for stability */
/*                                class descriptions

```

```

/*      CROW1      Integer  Row number for top line      */
/*                                     of cloudiness index */
/*      CROW2      Integer  Row number for bottom line   */
/*                                     of cloudiness index */
/*      CCOL1      Integer  Left column for cloudiness index */
/*      CCOL2      Integer  Right column for cloudiness index */
/*
/*
/*      LOCAL VARIABLES:
/*
/*      Name      Type      Description
/*      FKEY      Integer   ASCII value returned by keystroke
/*      IKEY      Integer   scan code returned by keystroke
/*      ROW       Integer   current vertical position of cursor
/*      JSTAB     Integer   stability class (1 to 7)
/*      INDEXC    Integer   cloudiness index (1 to 3)
/*
/*      MODULE CALLED FROM:
/*      CHGSTAB
/*
/*      PARAMETER PASSING:
/*      Input Values:
/*      jstab
/*      Values Returned:
/*      jstab      indexc
/*
/*      OTHER ROUTINES CALLED:
/*      clrnt
/*
/*      SUBORDINATE ROUTINES CALLED:
/*      None
/*
/*      MODULE ALGORITHM:
/*      Information already printed at top of screen is painted
/*      green and instructions are printed in red at the bottom.
/*      The cursor is positioned over the current stability class
/*      (inverse video for the 1-character letter, blue for the

```

```

/*      text description).  User input is accepted - up or down      */
/*      arrow moves to new position, End or Enter accepets a        */
/*      selection, Esc key leaves 'scstab' with no change in        */
/*      stability class.  If a cloudiness index is selected,        */
/*      the stability class is set to 0; if a stability class        */
/*      is selected, the cloudiness index is set to 0.                */
/*                                                                    */
/*  ERROR HANDLING:                                                  */
/*      Only appropriate keystrokes are accepted.  Others cause      */
/*      no action in the code.  User may leave the screen by        */
/*      pressing Escape key, causing no action.                      */
/*                                                                    */
/*  ESI C Utilities routines called:                                */
/*      colrcprt  curlocat  getkey  paint                            */

```

```

C=====C
C
C      MODULE NAME:
C      CHGRANG
C
C      ABSTRACT:
C      Allow the user to input up to 8 downwind ranges and
C      descriptive titles for dose calculations
C
C      AUTHOR:
C      R. I. Scherpelz
C      Pacific Northwest Laboratory
C      P.O. Box 999
C      Richland, WA 99352
C      509-375-2454
C
C      CREATION DATE:
C      July 5, 1988
C
C      I/O:
C      Input from keyboard and variables in commons
C      Output to the screen and through variables in commons
C
C      CONSTANTS:
C      None
C
C      LOCAL VARIABLES:
C      Name          Type          Description
C      RTITL         Chr*200      Titles for downwind ranges
C      IL            Integer      Input line for range (15 or 16)
C      X(8)          Real*4       Entered range (in km or miles)
C      IR            Integer      Index: Chosen ranges (13 to 20)
C      JR            Integer      Index: Previous ranges (1 to 8)
C      KR            Integer      Index: Ranges (nrange to ir+1)
C      IW            Integer      Width of string

```

c	FMT	Chr*25	Format for writing range into inplin	c
c	XJR	Real*4	Temperature range value	c
c	IC1	Integer	First position in string	c
c	IC2	Integer	Last position in string	c
c	XRNG	Real*4	Temp. range value (km)	c
c				c
c	DATA STRUCTURES:			c
c	Common /general/			c
c	TITLE	Chr*78	Title message for display screen	c
c	INPLIN(25)	Chr*78	Input lines for main menu display	c
c	MONTH	Integer	Current month	c
c	IHOUR	Integer	Current hour	c
c	IFMAYGO	Logical	Flags if sufficient data has been	c
c			entered to perform the atmospheric	c
c			transport calculation	c
c	Common /downwind/			c
c	NRANGE	Integer	Number of downwind ranges for dose	c
c			calculation (< = 20)	c
c	RANGE(20)	Real*4	Downwind distance, meters	c
c	EQQ(20)	Real*4	Time-integrated relative air	c
c			concentration at each range (sec/m ³)	c
c	RGTITL(20)	Chr*25	Title for each downwind range	c
c	ETA(20)	Real*4	Estimated time of plume arrival;	c
c			actually the plume transit time to	c
c			each downwind range (sec)	c
c				c
c	MODULE CALLED FROM:			c
c	INPUT			c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	None			c
c	Values Returned as ARGUMENTS:			c
c	None			c

c	Values Returned in COMMONS:	c
c	Name Via	c
c	nrange /Downwind/	c
c	range /Downwind/	c
c	rgtitl /Downwind/	c
c	inplin /General/	c
c		c
c	SUBORDINATE ROUTINES CALLED:	c
c	scrang	c
c		c
c	MODULE ALGORITHM:	c
c	Routine prints a message plus any ranges and range titles	c
c	that were previously entered by the user. Instructions	c
c	are printed on-screen. The subroutine 'scrang' is called	c
c	to get user input. Input values are checked, sorted,	c
c	and converted, then loaded into the RANGE and RGTITL	c
c	arrays and the INPLIN array is updated.	c
c		c
c	ERROR HANDLING:	c
c	Pressing 'Escape' key returns control to INPUT.	c

```

/*****/
/* */
/*  MODULE NAME: */
/*    SCRANG */
/* */
/*  ABSTRACT: */
/*    Helps users input new ranges and */
/*    up 8 downwind range titles. */
/* */
/*  AUTHOR: */
/*    R. I. Scherpelz */
/*    Pacific Northwest Laboratory */
/*    P.O. Box 999 */
/*    Richland, WA 99352 */
/*    509-375-2454 */
/* */
/*  CREATION DATE: */
/*    July 5, 1988 */
/* */
/*  I/O: */
/*    User input from keyboard and through arguments passed */
/*    Output written to screen and through arguments passed */
/* */
/*  CONSTANTS: */
/*      Name          Type          Description */
/*      CNVRT          Floating  Converts miles to km (1.609344) */
/*      LOVAL          Floating  Minimum downwind range (miles) */
/*      HIVAL          Floating  Maximum downwind range (miles) */
/* */
/*  LOCAL VARIABLES: */
/*      Name          Type          Description */
/*      IBKG          Integer    Background color */
/*      IFORE          Integer    Foreground color */
/*      FKEY          Integer    (not used) */
/*      KEY           Integer    ASCII Code of keystroke

```

```

/*      IKEY          Integer   Scan code of keystroke          */
/*      NROW          Integer   Row number                      */
/*      NCH1          Integer   Column number                  */
/*      IRCH          Integer   Index: column number in string */
/*      ANSR[25]      Character String entered by user         */
/*      ICH           Integer   Index: position in string      */
/*      DEFUNITS[5]   Character Default units                  */
/*      LCHOIC        Integer   Flag: which units              */
/*      IROW          Integer   Row number for cursor          */
/*      RTITL[200]    Character String contained in range titles */
/*      XIN(8)        Floating  Range values entered by user   */
/*                                                              */
/*  MODULE CALLED FROM:                                         */
/*      CHGRANG                                                */
/*                                                              */
/*  PARAMETER PASSING:                                         */
/*      Input Values:                                         */
/*      rtitl      xin                                         */
/*  Values Returned:                                         */
/*      rtitl      xin                                         */
/*                                                              */
/*  SUBORDINATE ROUTINES CALLED:                               */
/*      None                                                  */
/*                                                              */
/*  MODULE ALGORITHM:                                         */
/*      Anything already on screen is nicely colored, then the user */
/*      steps through the 8 downwind range positions. Text is */
/*      entered for each, then arrow keys can be used to select */
/*      units of either miles or km, then the user types in the */
/*      value. The 'Esc' key terminates the process. Entered */
/*      values are checked to be within bounds - an error message */
/*      is given if out-of-bounds and the user gets to enter a */
/*      new value. If all 8 rows are filled or the 'Esc' key is */
/*      pushed, the code returns to 'chgrang'.                */
/*                                                              */

```

```

/*  ERROR HANDLING:                                     */
/*    Only appropriate keystrokes are accepted:  others cause */
/*    no action in the code.  User-entered numbers are checked */
/*    to be within range and legal numerical entries - if not, */
/*    an error message is displayed and the operator is given */
/*    another chance to retry entering data.                 */
/*                                                         */
/*  ESI C Utilities routines called:                       */
/*    colrprta  colrprtf  colrprts  curlocat                */
/*    getkey    paint    rdchatr   wrtch                    */

```

```

C=====C
C
C  MODULE NAME:
C    CHGHRMO
C
C  ABSTRACT:
C    Allow the user to change the month and hour of the
C    accident scenerio
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C
C  CREATION DATE:
C    March 30, 1988
C
C  I/O:
C    Input from the keyboard and from variables in commons
C    Output through variables in commons
C
C  CONSTANTS:
C    None
C
C  LOCAL VARIABLES:
C
C      Name          Type          Description
C  MONNAM(3,12)  Chr*3      Names of months (3 variations of each)
C  IM            Integer      Month returned by user (1 to 12)
C  IHR           Integer      Hour returned by user (0 to 23)
C  ANSR          Chr*3        Three character answer entered by user
C  IFORM         Integer      Index: which form of month name
C
C  DATA STRUCTURES:

```

c	Common	/general/		c
c	TITLE	Chr*78	Title message for display screen	c
c	INPLIN(25)	Chr*78	Input lines for main menu display	c
c	MONTH	Integer	Current month	c
c	IHOUR	Integer	Current hour	c
c	IFMAYGO	Logical	Flags if sufficient data has been	c
c			entered to perform the atmospheric	c
c			transport calculation	c
c	Common	/meteo/		c
c	JSTAB	Integer	Stability class	c
c	WINDSPD	Real*4	Wind speed (m/sec)	c
c	LAYER	Integer	Mixing layer thickness (m)	c
c	AIRTEMP	Real*4	Air Temperature (C)	c
c	INDEXC	Integer	Cloudiness index	c
c	DEFSTAB	Logical	Flags default stability	c
c	DEFWSPD	Logical	Flags default wind speed	c
c	DEFLAYER	Logical	Flags default mixing layer thickness	c
c	DEFTEMP	Logical	Flags default effluent temperature	c
c	DEFHRMO	Logical	Flags default hour and month	c
c	STABNAM(7)	Chr*25	Names of the seven stability classes:	c
c			A: Extremely, B: Moderately Unstable,	c
c			C: Slightly Unstable, D: Neutral,	c
c			E: Slightly, F: Moderately Stable,	c
c			G: Extremely Stable	c
c				c
c	MODULE CALLED FROM:			c
c	INPUT			c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	None			c
c	Values Returned as ARGUMENTS:			c
c	None			c
c	Values Returned in COMMONS:			c
c	Name	Via		c

```

c      defhrmo    /Meteo/                                c
c      month      /General/                              c
c      ihour      /General/                              c
c                                                        c
c      SUBORDINATE ROUTINES CALLED:                      c
c      witbar      blkbar                                c
c                                                        c
c      MODULE ALGORITHM:                                  c
c      Routine asks user for month - reads user input, checks to c
c      see if it's an integer, if not it reads the character c
c      input and checks list of allowable month names - if not c
c      identified, or if value not in range 1-12, prints error c
c      message and asks for new input. Then requests hour of day, c
c      reads entry, and checks to see if it's within range. c
c      If ok, then returns.                               c
c                                                        c
c      ERROR HANDLING:                                    c
c      User input is checked to see if it is in allowable range, c
c      if not: user gets new chance to try it. ERR parameter used c
c      in READ statements to minimize chance of bad user entry. c
c                                                        c
c      OTHER ROUTINES CALLED:                             c
c      clrit                                              c

```

```

C=====C
C
C
C  MODULE NAME:
C    CHGLAYR
C
C
C  ABSTRACT:
C    Allow the user to change the mixing layer depth used in
C    the accident scenerio
C
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C
C
C  CREATION DATE:
C    July 4, 1989
C
C
C  I/O:
C    Input from keyboard
C    Output to screen and through variables in commons
C
C
C  CONSTANTS:
C
C    Name          Type          Description
C    NLINES        Integer       Number of lines to highlight
C    NCH1          Integer       Column number for first
C                                highlighted character
C    LINE1         Integer       Vertical position on screen of bar
C    NCHAR         Integer       Number of characters in highlighted bar
C
C
C  LOCAL VARIABLES:
C
C    Name          Type          Description
C    JLAYR         Integer       Mixing layer (m)
C    FLAYER        Real*4        Mixing layer (feet, miles, or meters)

```


c	LCHOIC	Integer	Integer indicating type of units	c
c			0= Escape, 1= Meters, 2= Miles, 3= Feet	c
c				c
c	DATA STRUCTURES:			c
c	Common /general/			c
c	TITLE	Chr*78	Title message for display screen	c
c	INPLIN(25)	Chr*78	Input lines for main menu display	c
c	MONTH	Integer	Current month	c
c	IHOUR	Integer	Current hour	c
c	IFMAYGO	Logical	Flags if sufficient data has been	c
c			entered to perform the atmospheric	c
c			transport calculation	c
c	Common /meteo/			c
c	JSTAB	Integer	Stability class	c
c	WINDSPD	Real*4	Wind speed (m/sec)	c
c	LAYER	Integer	Mixing layer thickness (m)	c
c	AIRTEMP	Real*4	Air Temperature (C)	c
c	INDEXC	Integer	Cloudiness index	c
c	DEFSTAB	Logical	Flags default stability	c
c	DEFWSPD	Logical	Flags default wind speed	c
c	DEFLAYER	Logical	Flags default mixing layer thickness	c
c	DEFTEMP	Logical	Flags default effluent temperature	c
c	DEFHRMO	Logical	Flags default hour and month	c
c	STABNAM(7)	Chr*25	Names of the seven stability classes:	c
c			A: Extremely, B: Moderately Unstable,	c
c			C: Slightly Unstable, D: Neutral,	c
c			E: Slightly, F: Moderately Stable,	c
c			G: Extremely Stable	c
c				c
c	MODULE CALLED FROM:			c
c	INPUT			c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	None			c

c	Values Returned as ARGUMENTS:	c
c	None	c
c	Values Returned in COMMONS:	c
c	Name Via	c
c	delayer /Meteo/	c
c	layer /Meteo/	c
c	inplin /General/	c
c		c
c	SUBORDINATE ROUTINES CALLED:	c
c	blkbar barchs clrbar	c
c		c
c	MODULE ALGORITHM:	c
c	Routine prints its message to the user, then call 'barchs'	c
c	to present user with 3 bars, one for each unit - 'barchs'	c
c	returns value and integer showing which unit. Routine	c
c	converts value to meters, then checks for being in-bounds	c
c	error message if out-of-bounds. Otherwise return.	c
c		c
c	ERROR HANDLING:	c
c	User input is checked to see if it is in allowable range,	c
c	if not: user gets new chance to try it.	c
c		c
c	OTHER ROUTINES CALLED:	c
c	clrit	c

```

C=====C
C
C  MODULE NAME:
C    CHGTEMP
C
C  ABSTRACT:
C    Allow the user to change the air temperature used in the
C    accident scenerio.
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C
C  CREATION DATE:
C    July 4, 1989
C
C  I/O:
C    Input from the keyboard and variables in common
C    Output to screen and through variables in common
C
C  CONSTANTS:
C    none
C
C  LOCAL VARIABLES:
C
C      Name          Type          Description
C  NLINES            Integer       Number of lines to highlight
C  NCH1              Integer       First character position to highlight
C  LINE1             Integer       Top line to highlight
C  NCHAR             Integer       Number of characters to highlight
C  TAIR              Real*4        Air temperature (degrees C)
C  LCHOIC            Integer       Flag user's choice:
C                                0= escape, 1= degrees C, 2= degrees F

```

c				c
c	DATA STRUCTURES:			c
c	Common /general/			c
c	TITLE	Chr*78	Title message for display screen	c
c	INPLIN(25)	Chr*78	Input lines for main menu display	c
c	MONTH	Integer	Current month	c
c	IHOUR	Integer	Current hour	c
c	IFMAYGO	Logical	Flags if sufficient data has been	c
c			entered to perform the atmospheric	c
c			transport calculation	c
c	Common /meteo/			c
c	JSTAB	Integer	Stability class	c
c	WINDSPD	Real*4	Wind speed (m/sec)	c
c	LAYER	Integer	Mixing layer thickness (m)	c
c	AIRTEMP	Real*4	Air Temperature (C)	c
c	INDEXC	Integer	Cloudiness index	c
c	DEFSTAB	Logical	Flags default stability	c
c	DEFWSPD	Logical	Flags default wind speed	c
c	DEFLAYER	Logical	Flags default mixing layer thickness	c
c	DEFTEMP	Logical	Flags default effluent temperature	c
c	DEFHRMO	Logical	Flags default hour and month	c
c	STABNAM(7)	Chr*25	Names of the seven stability classes:	c
c			A: Extremely, B: Moderately Unstable,	c
c			C: Slightly Unstable, D: Neutral,	c
c			E: Slightly, F: Moderately Stable,	c
c			G: Extremely Stable	c
c				c
c	MODULE CALLED FROM:			c
c	INPUT			c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	None			c
c	Values Returned as ARGUMENTS:			c
c	None			c

c	Values Returned in COMMONS:	c
c	Name Via	c
c	deftemp /Meteo/	c
c	airtemp /Meteo/	c
c	inplin /General/	c
c		c
c	SUBORDINATE ROUTINES CALLED:	c
c	blkbar barchs clrbar	c
c		c
c	MODULE ALGORITHM:	c
c	Routine prints message to user, then calls 'CLRBAR' to	c
c	highlight; prints instructions, then 'CLBAR' to highlight	c
c	again. Routine 'BARCHS' is called to get input:	c
c	'BARCHS' returns WSPEED (value of wind speed) and LCHOIC to	c
c	indicate units. If LCHOIC=0 then exit with no change in	c
c	temp, otherwise use LCHOIC to indicate units and convert	c
c	to m/sec. Check to see if value is in-bounds - if not,	c
c	print error message and allow user to re-enter.	c
c	If correct, update variables DEFTEMP, AIRTEMP, and INPLIN.	c
c		c
c	ERROR HANDLING:	c
c	The input value is checked against bounds to see if it's	c
c	reasonable - if not, user can re-enter. User can escape	c
c	the routine by pressing the Escape key, with no changes made.	c
c		c
c	OTHER ROUTINES CALLED:	c
c	clrit	c

```

C=====C
C
C  MODULE NAME:
C    CHGWND
C
C  ABSTRACT:
C    Allow the user to change the wind speed used in the
C    accident scenerio.
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C
C  CREATION DATE:
C    July 4, 1989
C
C  I/O:
C    Input from variables in common
C    Output to screen and through variables in common
C
C  CONSTANTS:
C    None
C
C  LOCAL VARIABLES:
C
C    Name          Type          Description
C    NLINES        Integer       Number of lines to highlight
C    NCH1           Integer       First chracter position to highlight
C    LINE1          Integer       Top line to highlight
C    NCHAR          Integer       Number of characters to highlight
C    WSPEED         Real*4        Wind speed entered by the user
C    LCHOIC         Integer       Flag for user's choice,
C                                0= escape, 1= m/sec, 2= mph, 3= knots

```

c				c
c	DATA STRUCTURES:			c
c	Common /general/			c
c	TITLE	Chr*78	Title message for display screen	c
c	INPLIN(25)	Chr*78	Input lines for main menu display	c
c	MONTH	Integer	Current month	c
c	IHOUR	Integer	Current hour	c
c	IFMAYGO	Logical	Flags if sufficient data has been	c
c			entered to perform the atmospheric	c
c			transport calculation	c
c	Common /meteo/			c
c	JSTAB	Integer	Stability class	c
c	WINDSPD	Real*4	Wind speed (m/sec)	c
c	LAYER	Integer	Mixing layer thickness (m)	c
c	AIRTEMP	Real*4	Air Temperature (C)	c
c	INDEXC	Integer	Cloudiness index	c
c	DEFSTAB	Logical	Flags default stability	c
c	DEFWSPD	Logical	Flags default wind speed	c
c	DEFLAYER	Logical	Flags default mixing layer thickness	c
c	DEFTEMP	Logical	Flags default effluent temperature	c
c	DEFHRMO	Logical	Flags default hour and month	c
c	STABNAM(7)	Chr*25	Names of the seven stability classes:	c
c			A: Extremely, B: Moderately Unstable,	c
c			C: Slightly Unstable, D: Neutral,	c
c			E: Slightly, F: Moderately Stable,	c
c			G: Extremely Stable	c
c				c
c	MODULE CALLED FROM:			c
c	INPUT			c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	None			c
c	Values Returned as ARGUMENTS:			c
c	None			c

c	Values Returned in COMMONS:	c
c	Name Via	c
c	defwspd /Meteo/	c
c	windspd /Meteo/	c
c	inplin /General/	c
c		c
c	SUBORDINATE ROUTINES CALLED:	c
c	blkbar barchs clrbar	c
c		c
c	MODULE ALGORITHM:	c
c	Routine prints message to the user, then calls 'CLRBAR'	c
c	to highlight; prints instructions, then calls 'CLRBAR'	c
c	to highlight again. Routine 'BARCHS' is called to get	c
c	input: 'BARCHS' returns tair (value of air temp) and	c
c	LCHOIC to indicate units. If LCHOIC=0 then exit with no	c
c	change in temp; otherwise use LCHOIC to indicate units	c
c	and convert to degrees C. Check to see if value is in	c
c	bounds - if not, print error message and allow user to	c
c	re-enter. If correct, update variables DEFWSPD	c
c	and WINDSPD and INPLIN.	c
c		c
c	ERROR HANDLING:	c
c	The input value is checked against bounds to see if it's	c
c	reasonable - if not, user can re-enter. User can escape	c
c	the routine by pressing the Esc key, with no changes made.	c
c		c
c	OTHER ROUTINES CALLED:	c
c	clrit	c


```

/*****/
/* */
/*  MODULE NAME: */
/*    BARCHS */
/* */
/*  ABSTRACT: */
/*    Print two or more inverse video blocks for input. */
/*    Up & down arrow keys choose the appropriate bar, */
/*    then text is input. */
/* */
/*  AUTHOR: */
/*    R. I. Scherpelz */
/*    Pacific Northwest Laboratory */
/*    P.O. Box 999 */
/*    Richland, WA 99352 */
/*    509-375-2454 */
/* */
/*  CREATION DATE: */
/*    July 4, 1989 */
/* */
/*  I/O: */
/*    Input by keyboard and arguments passed */
/*    Output written to screen and arguments passed */
/* */
/*  CONSTANTS: */
/*    Name          Type          Description */
/*    LINE1         Integer       Top row highlighted on screen */
/*    NCH1           Integer       Column number of start of bar */
/*    NCHAR          Integer       Number of characters in bar */
/*    NLINES         Integer       Number of lines highlighted */
/*    NUMLIN         Integer       Bottom line of interest */
/*    LINLEN         Integer       Column number of end of bar */
/* */
/*  LOCAL VARIABLES: */
/*    Name          Type          Description */

```

```

/*      IKEY      Integer   Scan key of returned keystroke      */
/*      KEY       Integer   ASCII code of keystroke             */
/*      ICH       Integer   Index which character               */
/*      ANSR[10]   Character Characters entered by user         */
/*      LCHOIC     Integer   Which choice is selected           */
/*      XIN        Floating Value entered by user               */
/*                                                           */
/*  MODULE CALLED FROM:                                         */
/*      CHGLAYR    CHGTEMP    CHGWND                             */
/*                                                           */
/*  PARAMETER PASSING:                                         */
/*      Input Values:                                           */
/*      line1      nch1      nchar      nlines                  */
/*  Values Returned:                                           */
/*      lchoic     xin                                              */
/*                                                           */
/*  SUBORDINATE ROUTINES CALLED:                                 */
/*      None                                                    */
/*                                                           */
/*  MODULE ALGORITHM:                                          */
/*      Routine writes messages to screen and reads keystrokes. */
/*                                                           */
/*  ERROR HANDLING:                                           */
/*      When reading keystrokes, only keystrokes that are      */
/*      applicable to code are read, all others are ignored.   */
/*      Backspace is permitted; Escape key exits out of       */
/*      routine with no result.                                  */
/*                                                           */
/*  ESI C Utilities routines called:                           */
/*      curlocat   getkey   paint   wrtch                       */

```

```

/*****/
/* */
/*  MODULE NAME: */
/*    WITBAR */
/* */
/*  ABSTRACT: */
/*    Draws a white bar from column col1 to col2 on row */
/*    and positions cursor at start of bar */
/* */
/*  AUTHOR: */
/*    R. I. Scherpelz */
/*    Pacific Northwest Laboratory */
/*    P.O. Box 999 */
/*    Richland, WA 99352 */
/*    509-375-2454 */
/* */
/*  CREATION DATE: */
/*    July 4, 1989 */
/* */
/*  I/O: */
/*    Input by arguments passed */
/*    Output written to screen */
/* */
/*  CONSTANTS: */
/*    Name          Type          Description */
/*    ROW           Integer      Line of text to highlight */
/*    COL1          Integer      Start column number for highlighted bar*/
/*    COL2          Integer      Column number of end of highlighted bar*/
/* */
/*  MODULE CALLED FROM: */
/*    INPUT      CHGHRMO */
/* */
/*  PARAMETER PASSING: */
/*    Input Values: */
/*    row        col1        col2 */

```

```

/* Values Returned: */
/*     None */
/* */
/* SUBORDINATE ROUTINES CALLED: */
/*     None */
/* */
/* MODULE ALGORITHM: */
/*     Colors part of the screen specifed as a white bar */
/*     and positions cursor at start of bar. */
/* */
/* ERROR HANDLING: */
/*     None */
/* */
/* ESI C Utilities routines called: */
/*     curlocat    paint */

```

```

/*****/
/* */
/* MODULE NAME: */
/*   BLKBAR */
/* */
/* ABSTRACT: */
/*   Draws a black bar from column col1 to col2 on row */
/*   and positions cursor at start of bar. */
/*   (particularly good for erasing a white or colored bar) */
/* */
/* AUTHOR: */
/*   R. I. Scherpelz */
/*   Pacific Northwest Laboratory */
/*   P.O. Box 999 */
/*   Richland, WA 99352 */
/*   509-375-2454 */
/* */
/* CREATION DATE: */
/*   July 4, 1989 */
/* */
/* I/O: */
/*   Input by arguments passed */
/*   Output written to screen */
/* */
/* CONSTANTS: */
/*   Name           Type           Description */
/*   ROW            Integer        Line of text to highlight */
/*   COL1           Integer        Start column number for highlighted bar*/
/*   COL2           Integer        Column number of end of highlighted bar*/
/* */
/* MODULE CALLED FROM: */
/*   INPUT          CHGRHRMO        CHGLAYR */
/*   CHGTEMP        CHGWND */
/* */
/* PARAMETER PASSING: */

```

```

/*      Input Values:                                     */
/*      row      col1      col2                           */
/*      Values Returned:                                  */
/*      None                                              */
/*                                                         */
/*      SUBORDINATE ROUTINES CALLED:                      */
/*      None                                              */
/*                                                         */
/*      MODULE ALGORITHM:                                 */
/*      Colors part of the screen specifed as a black bar */
/*      and positions cursor at start of bar.             */
/*                                                         */
/*      ERROR HANDLING:                                   */
/*      None                                              */
/*                                                         */
/*      ESI C Utilities routines called:                 */
/*      curlocat    paint                                */

```

```

/*****
/*
/* MODULE NAME:
/* CLRBAR
/*
/* ABSTRACT:
/*   Draws a colored bar from column col1 to col2 on row,
/*   and positions cursor at start of bar.
/*
/* AUTHOR:
/*   R. I. Scherpelz
/*   Pacific Northwest Laboratory
/*   P.O. Box 999
/*   Richland, WA 99352
/*   509-375-2454
/*
/* CREATION DATE:
/*   July 4, 1989
/*
/* I/O:
/*   Input by arguments passed
/*   Output written to screen
/*
/* MODULE ALGORITHM:
/*   Routine colors part of the screen and positions cursor.
/*
/* ERROR HANDLING:
/*   None
/*
/* CONSTANTS:
/*   Name           Type           Description
/*   ROW            Integer        Line of text to highlight
/*   COL1           Integer        Start column number for highlighted bar
/*   COL2           Integer        Column number of end of highlighted bar
/*   FRGND          Integer        Foreground color of bar

```

```

/*      BKGND          Integer   Background color of bar      */
/*                                                              */
/*  MODULE CALLED FROM:                                          */
/*      CHGLAYR      CHGTEMP      CHGWND                      */
/*                                                              */
/*  PARAMETER PASSING:                                          */
/*      Input Values:                                          */
/*      row          col1          col2                      */
/*      frgnd        bkgnd                                              */
/*  Values Returned:                                          */
/*      None                                                  */
/*                                                              */
/*  SUBORDINATE ROUTINES CALLED:                                */
/*      None                                                  */
/*                                                              */
/*  MODULE ALGORITHM:                                          */
/*      Colors part of the screen specifed with the foreground and */
/*      background colors and positions cursor at start of bar.  */
/*                                                              */
/*  ERROR HANDLING:                                          */
/*      None                                                  */
/*                                                              */
/*  ESI C Utilities routines called:                          */
/*      curlocat      paint                                          */

```



```

C=====C
C
C  MODULE NAME:
C    CHNUC
C
C  ABSTRACT:
C    Displays all the nuclides on the screen and calls 'scnuc'
C    to allow user to choose nuclides in the release.
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C
C  CREATION DATE:
C    June 14, 1988
C
C  I/O:
C    Input from variables in common
C    Output to screen and through variables in common
C
C  CONSTANTS:
C    None
C
C  LOCAL VARIABLES:
C
C    Name          Type          Description
C    GTITL         Chr*50       Title of nuclide group displayed
C    NQNUC         Integer      Number of nuclides w/ > 0 Ci released
C    QTOT          Real*4       Total number of curies released
C    QPRINT(300)   Real*4       Curies released to display on-screen
C    QNUC(300)     Real*4       Curies released - temp. updatable array
C    QMULT         Real*4       User-entered Multiplier for Ci released
C    ELTAW(300)    Chr*7        Nuclide names

```

c	NMPRINT(300)	Chr*8	Nuclide names to display on-screen	c
c	ICH	Integer	Index: which character	c
c	JCH	Integer	Index: which position in string	c
c	IN	Integer	Index: which nuclide	c
c	JN	Integer	Index: which nuclide	c
c	KN	Integer	Index: which nuclide	c
c	NN	Integer	Index: which nuclide	c
c	INUCO(3)	Integer	First nuclide of each group	c
c	INUCF(3)	Integer	Last nuclide of each group	c
c	NCOL	Integer	Number of columns for nuclides display	c
c	INUC	Integer	Which nuclide	c
c	JNUC	Integer	Which nuclide	c
c	IGRP	Integer	Which group to display	c
c	IGRPO	Integer	Which nuclide group displayed	c
c	NGNUC	Integer	Number of nuclides in group to display	c
c	NQMOD	Integer	Flag: enter a Q multiplier?	c
c				c
c	DATA STRUCTURES:			c
c	Common /nuclide/			c
c	NNUC:	Integer	Number of radionuclides in the master	c
c			library 'RMDLIB', 1 <= NUC => 300	c
c	NCH	Integer	Number of decay chains in the master	c
c			library 'RMDLIB', 1 <= NCH => 200.	c
c	NOFNUC(200)	Integer	Number of radionuclides in each	c
c			decay chain. 1 <= NOFNUC(I) => 9.	c
c			When NOFNUC(I) = 1, No daughters.	c
c	NCHST(200)	Integer	Location in the master radionuclide	c
c			list of the 1st member of each chain.	c
c			1 <= NCHST(I) => 300.	c
c	IFR(2,300)	Integer	IFR(1,I) gives the chain member that	c
c			is the 1st precursor to radionuclide I.	c
c			IFR(2,I) is location of 2nd precursor.	c
c			IFR(1,I) < IFR(2,I) < IMEM(I)	c
c	DKF(2,300)	Real*4	Fraction of 1st and 2nd precursor	c
c			that decays to this radionuclide.	c

c	AL(300)	Real*4	Radiological decay constant for each	c
c			radionuclide day ** -1.	c
c	NCHN(300)	Integer	Chain number for each radionuclide.	c
c	NUCNAM(300)	Chr*8	8-character nuclide identifier:	c
c			First 2 Chars: Element name for each	c
c			radionuclide in the Master	c
c			Radionuclide Data library.	c
c			Chars. 3-8: Atomic weight symbol for	c
c			each radionuclide in the Master	c
c			Radionuclide Data library.	c
c			Isomeric states are indicated by the	c
c			letter 'M' after the atomic weight.	c
c			Daughter contributions are indicated by	c
c			'D' after the atomic weight	c
c			and 'M' if present.	c
c	RMDTITL	Chr*80	80-character title of Radionuclide	c
c			Master Data Library.	c
c	HTITLE	Chr*80	80-character title of HUDU	c
c			Dose Factor Library.	c
c	EXTDF(300)	Real*4	External dose factor (Sv/yr per Bq/m ³)	c
c			for each nuclide. Value of -1 means	c
c			that a nuclide in the 'RMDLIB' library	c
c			was not found in the Dose Factor librar	c
c	DOSINH(2,5,300)	Real*4	Inhalation dose factors (Sv/Bq).	c
c			First index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1=Lungs, 2=Bone Surf,	c
c			3=Red Marrow, 4=Thyroid,	c
c			5=Effective Dose Equivalent	c
c			3rd Index: nuclide	c
c	GRPNAM(5)	Chr*80	Title for a group of nuclides in the	c
c			Radionuclide Master Data Library	c
c	NUCGRP(300)	Integer	Group ID# for this nuclide	c
c	NUMGRP(5)	Integer	Number of nuclides in this group	c
c	Q0(300)	Real*4	Curies of this nuclide released	c
c	IFQMOD	Logical	Whether user has modified a set of q0	c

```

c                                     values from a source term file      c
c      Common  /general/                                                    c
c      TITLE      Chr*78      Title message for display screen            c
c      INPLIN(25)  Chr*78      Input lines for main menu display          c
c      MONTH       Integer     Current month                              c
c      I HOUR      Integer     Current hour                                c
c      IFMAYGO     Logical     Flags if sufficient data has been          c
c                                     entered to perform the atmospheric    c
c                                     transport calculation                 c
c                                                                 c
c      MODULE CALLED FROM:                                                  c
c      INPUT                                              c
c                                                                 c
c      PARAMETER PASSING:                                                  c
c      Input Values:                                              c
c      None                                              c
c      Values Returned as ARGUMENTS:                                     c
c      None                                              c
c      Values Returned in COMMONS:                                       c
c      Name          Via                                              c
c      q0            /Nuclide/                                         c
c      inplin        /General/                                         c
c                                                                 c
c      SUBORDINATE ROUTINES CALLED:                                       c
c      scnuc          scqnuc                                           c
c                                                                 c
c      MODULE ALGORITHM:                                                  c
c      Routine presets variables, checks to see if non-negligible        c
c      amounts of nuclides were released; if not, it presents a          c
c      screen with all the nuclides in first group; otherwise it         c
c      presents a screen with a summary of nuclides released             c
c      (as already chosen). Also, don't bother with a summary            c
c      page if there are > 72 nuclides. After presenting summary         c
c      and choice screens, act on user input.                            c
c                                                                 c

```

c ERROR HANDLING:
c None

c
c

```

/*****/
/* */
/* MODULE NAME: */
/* SCNUC */
/* */
/* ABSTRACT: */
/* Display nuclides and let the user choose them */
/* and enter released Ci */
/* */
/* AUTHOR: */
/* R. I. Scherpelz */
/* Pacific Northwest Laboratory */
/* P.O. Box 999 */
/* Richland, WA 99352 */
/* 509-375-2454 */
/* */
/* CREATION DATE: */
/* June 10, 1988 */
/* */
/* I/O: */
/* Input from user and variables in arguments */
/* Output to screen and through variables in arguments */
/* */
/* CONSTANTS: */
/* Name Type Description */
/* ELTAW[300][7] Character Nuclide names */
/* */
/* LOCAL VARIABLES: */
/* Name Type Description */
/* QNUC[300] Floating Curies released for each nuclide */
/* IGRP Integer Next nuclide group to display */
/* igrp=0 => end nuclide choosing */
/* NQMOD Integer Was a qnuc value changed? */
/* 0= no, 1= yes */
/* GTITL[50] Character Title of nuclide group displayed */

```

```

/*      NGNUC          Integer      Number of nuclides w/ > 0 Ci released */
/*      IROW           Integer      Row number for cursor                  */
/*      ICOL           Integer      Column number for cursor              */
/*      INUC           Integer      Nuclide ID number                    */
/*      IKEY           Integer      Scan code returned by keystroke       */
/*      KEY            Integer      ASCII code returned by keystroke     */
/*      NGRP           Integer      Nuclide group displayed              */
/*      IQMOD          Integer      Flags if a qnuc value changed.        */
/*      JCOL           Integer      (icol + 6) / 13                      */
/*      ICH            Integer      Index: blanks answer space           */
/*      NNUC           Integer      Nuclide ID number                    */
/*      NROWO          Integer      Top row with nuclides                */
/*      NROWF          Integer      Bottom row with nuclides             */
/*      NROWF72        Integer      Bottom row with nuclides             */
/*                                in column 72                          */
/*      NROWS          Integer      Number of rows with nuclides         */
/*                                                                */
/*      MODULE CALLED FROM:                                          */
/*      CHNUC                                                  */
/*                                                                */
/*      PARAMETER PASSING:                                          */
/*      Input Values:                                          */
/*      igrp          ngnuc          eltaw                      */
/*      gtitl         qnuc          nqmod                      */
/*      Values Returned:                                          */
/*      qnuc          igrp          nqmod                      */
/*                                                                */
/*      SUBORDINATE ROUTINES CALLED:                                */
/*      nextgrp      prevgrp      nucursr      prcuries          */
/*                                                                */
/*                                                                */
/*      MODULE ALGORITHM:                                          */
/*      Print stuff on screen including red instructions at the      */
/*      bottom. Find the row & column for each nuclide. Then      */
/*      write in the nuclide names. If any nuclides have been      */

```

```

/*      already chosen, enter Ci released. The user can now move      */
/*      the cursor around between the groups to make his selection.    */
/*      After the selection is made, the system processes it.          */
/*                                                                    */
/*  ERROR HANDLING:                                                    */
/*      When reading keystrokes, only keystrokes that are             */
/*      applicable to code are read, all others are ignored.          */
/*      Backspace is permitted; Escape key exits out of              */
/*      routine with no result.                                        */
/*                                                                    */
/*  ESI C Utilities routines called:                                    */
/*      colrcprt   colrprtf   colrprts                                 */
/*      curlocat   getkey     paint                                   */

```



```

/*****/
/* */
/* MODULE NAME: */
/* SCQNUC */
/* */
/* ABSTRACT: */
/* Display over the summary of Ci released in colors. */
/* User then chooses the next move. */
/* */
/* AUTHOR: */
/* R. I. Scherpelz */
/* Pacific Northwest Laboratory */
/* P.O. Box 999 */
/* Richland, WA 99352 */
/* 509-375-2454 */
/* */
/* CREATION DATE: */
/* July 21, 1989 */
/* */
/* I/O: */
/* Input from user and variables in arguments */
/* Output to screen and through variables in arguments */
/* */
/* LOCAL VARIABLES: */
/* Name Type Description */
/* GRPNAM[5][80] Character Names of groups displayed */
/* NCOL Integer Number of columns to display */
/* IGRP Integer Which group to display */
/* IGP Integer Which group to display */
/* IKEY Integer Scan code returned by keystroke */
/* KEY Integer ASCII code returned by keystroke */
/* IROW Integer Row number for cursor */
/* */
/* MODULE CALLED FROM: */
/* CHNUC */

```

```

/* */
/*  PARAMETER PASSING: */
/*    Input Values: */
/*      ncol      grpnam      igrp */
/*  Values Returned: */
/*      igrp */
/* */
/*  SUBORDINATE ROUTINES CALLED: */
/*      None */
/* */
/*  MODULE ALGORITHM: */
/*      Display headings and nuclide names and instructions. */
/*      The user can select Nuclide group display, Modify Q's, */
/*      or Stop. He can then move the cursor around to select */
/*      the item requiring processing. After a valid selection */
/*      is made that item is processed. */
/* */
/*  ERROR HANDLING: */
/*      When reading keystrokes, only keystrokes that are */
/*      applicable to code are read, all others are ignored. */
/*      Backspace is permitted; Escape key exits out of */
/*      routine with no result. */
/* */
/*  ESI C Utilities routines called: */
/*      curlocat  colrprtf  colrppts */
/*      getkey    paint */

```

```

/*****/
/*                                          */
/*  MODULE NAME:                          */
/*    NEXTGRP                            */
/*                                          */
/*  ABSTRACT:                            */
/*    Responds to keys input while cursor is on "Next Grp" */
/*    in nuclide screen                  */
/*                                          */
/*  AUTHOR:                              */
/*    R. I. Scherpelz                    */
/*    Pacific Northwest Laboratory        */
/*    P.O. Box 999                      */
/*    Richland, WA 99352                */
/*    509-375-2454                      */
/*                                          */
/*  CREATION DATE:                       */
/*    May 5, 1988                       */
/*                                          */
/*  I/O:                                 */
/*    Input from user and variables in arguments          */
/*    Output to screen and through variables in arguments */
/*                                          */
/*  LOCAL VARIABLES:                    */
/*    Name           Type           Description            */
/*    IROW           Integer        Row number for cursor */
/*    ICOL           Integer        Column number for cursor */
/*    NGRP           Integer        ID number for new nuclide group */
/*    NROWF          Integer        Bottom row with nuclides */
/*    IKEY           Integer        Scan code returned by keystroke */
/*    KEY            Integer        ASCII code returned by keystroke */
/*                                          */
/*  MODULE CALLED FROM:                  */
/*    SCNUC                              */
/*                                          */

```

```

/*  PARAMETER PASSING:                                */
/*    Input Values:                                    */
/*    nrowf                                            */
/*  Values Returned:                                    */
/*    irow      icol      ngrp                        */
/*                                                    */
/*  SUBORDINATE ROUTINES CALLED:                        */
/*    None                                            */
/*                                                    */
/*  MODULE ALGORITHM:                                  */
/*    The user, with the next Nuclide group display  */
/*    selected, can then move the cursor around to select */
/*    the item requiring processing. After a valid selection */
/*    is made that item is processed.                */
/*                                                    */
/*  ERROR HANDLING:                                    */
/*    When reading keystrokes, only keystrokes that are */
/*    applicable to code are read, all others are ignored. */
/*    Backspace is permitted; Escape key exits out of */
/*    routine with no result.                        */
/*                                                    */
/*  ESI C Utilities routines called:                  */
/*    curlocat  paint                                */

```

```

/*****/
/* */
/*  MODULE NAME: */
/*    PREVGRP */
/* */
/*  ABSTRACT: */
/*    Responds to keys input while cursor is on "Prev Grp" */
/*    in nuclide screen */
/* */
/*  AUTHOR: */
/*    R. I. Scherpelz */
/*    Pacific Northwest Laboratory */
/*    P.O. Box 999 */
/*    Richland, WA 99352 */
/*    509-375-2454 */
/* */
/*  CREATION DATE: */
/*    May 5, 1988 */
/* */
/*  I/O: */
/*    Input from user and variables in arguments */
/*    Output to screen and through variables in arguments */
/* */
/*  LOCAL VARIABLES: */
/*    Name          Type          Description */
/*    IROW          Integer       Row number for cursor */
/*    ICOL          Integer       Column number for cursor */
/*    NGRP          Integer       ID number for new nuclide group */
/*    NROWO         Integer       Top row with nuclides */
/*    IKEY          Integer       Scan code returned by keystroke */
/*    KEY           Integer       ASCII code returned by keystroke */
/* */
/*  MODULE CALLED FROM: */
/*    SCNUC */
/* */

```

```

/*  PARAMETER PASSING:                                */
/*    Input Values:                                    */
/*    nrow0                                            */
/*  Values Returned:                                    */
/*    irow      icol      ngrp                        */
/*                                                    */
/*  SUBORDINATE ROUTINES CALLED:                        */
/*    None                                            */
/*                                                    */
/*  MODULE ALGORITHM:                                    */
/*    The user, with the previous Nuclide group display */
/*    selected, can then move the cursor around to select */
/*    the item requiring processing. After a valid selection */
/*    is made that item is processed.                */
/*                                                    */
/*  ERROR HANDLING:                                    */
/*    When reading keystrokes, only keystrokes that are */
/*    applicable to code are read, all others are ignored. */
/*    Backspace is permitted; Escape key exits out of */
/*    routine with no result.                        */
/*                                                    */
/*  ESI C Utilities routines called:                    */
/*    curlocat    paint                                */

```

```

/*****/
/* */
/* MODULE NAME: */
/*   NUCRSR */
/* */
/* ABSTRACT: */
/*   The cursor has landed on a nuclide, the user can */
/*   enter Ci amount or move to a new nuclide. */
/* */
/* AUTHOR: */
/*   R. I. Scherpelz */
/*   Pacific Northwest Laboratory */
/*   P.O. Box 999 */
/*   Richland, WA 99352 */
/*   509-375-2454 */
/* */
/* CREATION DATE: */
/*   June 10, 1988 */
/* */
/* I/O: */
/*   Input from user and variables in arguments */
/*   Output to screen and through variables in arguments */
/* */
/* CONSTANTS: */
/*   Name          Type          Description */
/*   ELTAW[126][7] Character Nuclide names */
/* */
/* LOCAL VARIABLES: */
/*   Name          Type          Description */
/*   IROW          Integer      Row number for cursor */
/*   ICOL          Integer      Column number for cursor */
/*   ICH           Integer      Index: blanks answer space */
/*   INUC          Integer      Nuclide ID number */
/*   IQMOD         Integer      =1 => qnuc0 was modified */
/*   QNUCO         Floating     Ci released of nuclide selected */

```

```

/*      NNUC          Integer    Nuclide ID number          */
/*      NROW0         Integer    Top row with nuclides      */
/*      NROWF         Integer    Bottom row with nuclides in column 72 */
/*      NROWF72       Integer    Bottom row with nuclides   */
/*      IKEY          Integer    Scan code returned by keystroke */
/*      KEY           Integer    ASCII code returned by keystroke */
/*      NEWROW        Integer    New row for cursor to move to   */
/*      NEWCOL        Integer    New column for cursor          */
/*      ANSR[13]      Character  Space to enter Ci released    */
/*      IFASCII       Integer    Flags if ASCII character entered */
/*                                                              */
/*  MODULE CALLED FROM:                                          */
/*      SCNUC                                                  */
/*                                                              */
/*  PARAMETER PASSING:                                          */
/*      Input Values:                                          */
/*          nrow0      nrowf      nrow72      eltaw          */
/*          nnuc       key        ikey                                     */
/*      Values Returned:                                          */
/*          irow       icol       qnuc       iqmod          */
/*                                                              */
/*  SUBORDINATE ROUTINES CALLED:                                */
/*      prcuries                                              */
/*                                                              */
/*  MODULE ALGORITHM:                                          */
/*      Highlight the nuclide and interpret the keystroke.    */
/*      Accept a new value and process when correctly entered. */
/*      Or accept any keystroke that will move the cursor to  */
/*      another item requiring processing.                      */
/*                                                              */
/*  ERROR HANDLING:                                          */
/*      When reading keystrokes, only keystrokes that are     */
/*      applicable to code are read, all others are ignored.  */
/*      Only characters that are part of a number are entered  */
/*      when the numerical value is read in.                  */

```



```
/*      Backspace is permitted; Escape key exits out of      */
/*      routine with no result.                                */
/*                                                                 */
/*      ESI C Utilities routines called:                        */
/*      curlocat   paint       getkey       wrtch              */
/*                                                                 */
```

```

/*****/
/* */
/*  MODULE NAME: */
/*    PROCURIES */
/* */
/*  ABSTRACT: */
/*    Display Ci amounts in only 6 characters. */
/* */
/*  AUTHOR: */
/*    R. I. Scherpelz */
/*    Pacific Northwest Laboratory */
/*    P.O. Box 999 */
/*    Richland, WA 99352 */
/*    509-375-2454 */
/* */
/*  CREATION DATE: */
/*    May 5, 1988 */
/* */
/*  I/O: */
/*    Input from variables in arguments */
/*    Output to screen */
/* */
/*  LOCAL VARIABLES: */
/*    Name          Type          Description */
/*    QN            Floating    Ci quantity */
/*    QNMEGA        Floating    Mega Ci quantity */
/* */
/*  MODULE CALLED FROM: */
/*    SCNUC          NUCRSR */
/* */
/*  PARAMETER PASSING: */
/*    Input Values: */
/*    qn */
/*  Values Returned: */
/*    None */

```

```

/* */
/* SUBORDINATE ROUTINES CALLED: */
/*     None */
/* */
/* MODULE ALGORITHM: */
/*     Evaluate the size of the input Ci. If the number is too */
/*     large then convert to mega Ci's. Use a format using only */
/*     six characters depending on the number's size. */
/* */
/* ERROR HANDLING: */
/*     None */
/* */
/* ESI C Utilities routines called: */
/*     None */

```

```

C=====C
C
C  MODULE NAME:
C    CHSRELES
C
C  ABSTRACT:
C    Print the 4 choices for release conditions, then allow
C    the user to select one and enter the necessary variables
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C
C  CREATION DATE:
C    July 3, 1989
C
C  I/O:
C    User input from keyboard
C    Output written to screen and through arguments passed
C
C  CONSTANTS:
C    None
C
C  LOCAL VARIABLES:
C
C    Name          Type          Description
C    IFPUREX       Logical       Flags if Purex is selected
C    MODPURX        Logical       Flags if default or modified
C                                Purex is selected
C    ITRNEW         Integer       Flag user's choice: 0= escape,
C                                1= Open Area Ground Level
C                                2= Open Area Elevated, 3= Ground Level,
C                                4= Elevated Release Near a Building

```

c	ITREL	Integer	User's choice 0= escape,	c
c			1= Open Area Ground Level	c
c			2= Open Area Elevated, 3= Ground Level,	c
c			4= Elevated Release Near a Building	c
c	SHTOLD	Real*4	Stack Height of release (m)	c
c	SFOLD	Real*4	Stack Flow of release (m/sec)	c
c	SRADOLD	Real*4	Stack Radius of release (m)	c
c	ETEMPOLD	Real*4	Effluent temperature of release (C)	c
c	BDAROLD	Real*4	Building area of release (m ²)	c
c	BHTOLD	Real*4	Building height of release (m)	c
c	JTREL	Integer	Final user's choice 0= escape,	c
c			1= Open Area Ground Level	c
c			2= Open Area Elevated, 3= Ground Level,	c
c			4= Elevated Release Near a Building	c
c				c
c	DATA STRUCTURES:			c
c	Common /general/			c
c	TITLE	Chr*78	Title message for display screen	c
c	INPLIN(25)	Chr*78	Input lines for main menu display	c
c	MONTH	Integer	Current month	c
c	IHOUR	Integer	Current hour	c
c	IFMAYGO	Logical	Flags if sufficient data has been	c
c			entered to perform the atmospheric	c
c			transport calculation	c
c	Common /release/			c
c	SHGHT	Real*4	Stack height of release (m)	c
c	SFLOW	Real*4	Stack flow of release (m ³ /sec)	c
c	SRAD	Real*4	Stack radius of release (m)	c
c	ETEMP	Real*4	Effluent temperature of release (C)	c
c	BDAREA	Real*4	Building Area of release (m ²)	c
c	BHT	Real*4	Building height of release (m)	c
c	ITREL	Integer	Release number value (1 to 4)	c
c			1 - Open Area Ground Level, 2 - Open	c
c			Area Elevated, 3 - Ground Level,	c
c			4 - Effective release height (m)	c

```

c      OHT          Real*4    Open Area Elevated Height (m)      c
c      ERHT         Real*4    Effective Release height (m)       c
c      PRISE        Real*4    Hight the plume rises (m)          c
c                                                                c
c      MODULE CALLED FROM:                                       c
c          INPUT                                                  c
c                                                                c
c      PARAMETER PASSING:                                       c
c          Input Values:                                         c
c          None                                                  c
c      Values Returned as ARGUMENTS:                             c
c          jtre1                                                 c
c                                                                c
c      SUBORDINATE ROUTINES CALLED:                             c
c          chrel2      chrel3      chrel4      relchs             c
c                                                                c
c                                                                c
c      MODULE ALGORITHM:                                         c
c          Routine displays the release choices. The operator can c
c          use the arrow keys to move from choice to choice.     c
c          The enter key is used to select the choice. If the stack c
c          height is negative, the flow is negative, building     c
c          and height out of bounds, the release type is either   c
c          adjusted or the choice is rejected. The operator's     c
c          choice is returned, unless the Escape key is hit,     c
c          which returns no selection.                             c
c                                                                c
c      ERROR HANDLING:                                           c
c          When reading keystrokes, only keystrokes that are     c
c          applicable to code are read, all others are ignored.   c
c          Backspace is permitted; Escape key exits              c
c          out of routine with no result.                         c

```

```

C=====C
C
C  MODULE NAME:
C    CHREL2
C
C  ABSTRACT:
C    This routine gathers the input needed for release
C    type 2: Open area elevated release
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C
C  CREATION DATE:
C    June 30, 1989
C
C  I/O:
C    User input from keyboard
C    Output written to screen and through arguments passed
C
C  LOCAL VARIABLES:
C
C    Name          Type          Description
C    IFPUREX       Logical       Flags if Purex is selected
C    MODPURX        Logical       Flags if default or modified
C                                Purex is selected
C    SHGHT          Real*4        Stack height of release (m)
C    SFLOW          Real*4        Stack flow of release (m/sec)
C    SRAD           Real*4        Radius of stack with release (m)
C    ETEMP          Real*4        Effluent temperature of release (C)
C    ISPURX         Integer       Answer to is it the Purex
C                                stack (Yes, No, Escape)
C

```

c	MODULE CALLED FROM:	c
c	CHSRELES	c
c		c
c	PARAMETER PASSING:	c
c	Input Values:	c
c	None	c
c	Values Returned as ARGUMENTS:	c
c	shght sflow srad etemp	c
c	ifpurex modpurx	c
c		c
c	SUBORDINATE ROUTINES CALLED:	c
c	scr2px screl2	c
c		c
c	MODULE ALGORITHM:	c
c	A menu listing several questions about the release	c
c	appears on the screen. The cursor moves from question	c
c	to question as they are answered, usually with number	c
c	entries. If the escape key is pressed, exit with no	c
c	entry. If the user states that the release comes from	c
c	the Purex stack, the input values are compared to	c
c	Purex default values to determine whether values are	c
c	default Purex or modified Purex.	c
c		c
c	ERROR HANDLING:	c
c	When reading keystrokes, only keystrokes that are	c
c	applicable to code are read. All others are ignored.	c
c	Backspace is permitted; Escape key exits	c
c	out of routine with no result.	c


```

/*****/
/* */
/*  MODULE NAME: */
/*    SCREL2 */
/* */
/*  ABSTRACT: */
/*    A routine to help users input values for release */
/*    type 2: Open area elevated release */
/* */
/*  AUTHOR: */
/*    R. I. Scherpelz */
/*    Pacific Northwest Laboratory */
/*    P.O. Box 999 */
/*    Richland, WA 99352 */
/*    509-375-2454 */
/* */
/*  CREATION DATE: */
/*    July 4, 1989 */
/* */
/*  I/O: */
/*    User input from keyboard */
/*    Output written to screen and through arguments passed */
/* */
/*  CONSTANTS: */
/*    Name          Type          Description */
/*    CNVRT[4]      Floating      Conversion values for each question */
/*    LOVAL[4]       Floating      Low values for each answer */
/*    HIVAL[4]       Floating      High values for each answer */
/* */
/*  LOCAL VARIABLES: */
/*    Name          Type          Description */
/*    SHGHT          Floating      Stack Height of release */
/*    SFLOW           Floating      Effluent flow of release */
/*    SRAD            Floating      Stack Radius of release */
/*    ETEMP           Floating      Effluent temperature of release */

```

```

/*  ANSR[10]      Character Operator entry for answer      */
/*  DEFUNITS[10]  Character Default units                  */
/*  IROW          Integer  Index row or question being answered */
/*  ROW[4]        Integer  Screen row for each question      */
/*  KEY           Integer  ASCII code returned by keystroke  */
/*  IKEY          Integer  Scan code returned by keystroke   */
/*  FKEY          Integer  ASCII code returned by keystroke  */
/*  LCHOIC        Integer  Which choice is selected: 0= Escape */
/*                  1= shght, 2=sflow, 3=srad, 4=etemp      */
/*  ICH           Integer  Index -- blanks out answer space */
/*                  (10 characters)                         */
/*  NCH1          Integer  Cursor position for answers       */
/*                  (20 or 45 usually)                      */
/*  IFORE         Integer  Foreground color                  */
/*  IBKG          Integer  Background color                  */
/*  XIN[4]        Floating Values for four answers          */
/*                                                         */
/*  MODULE CALLED FROM:                                     */
/*      CHREL2                                              */
/*                                                         */
/*  PARAMETER PASSING:                                     */
/*      Input Values:                                       */
/*      shght      sflow      srاد      etemp              */
/*  Values Returned:                                       */
/*      shght      sflow      srاد      etemp              */
/*                                                         */
/*  SUBORDINATE ROUTINES CALLED:                           */
/*      None                                                */
/*                                                         */
/*  MODULE ALGORITHM:                                       */
/*      A menu listing several questions about the release */
/*      appears on the screen. The cursor moves from question */
/*      to question as they are answered, usually with number */
/*      entries. If the escape key is pressed, exit with no */
/*      entry. Handles 1-Stack height, 2-Effluent flow,      */

```

```

/*      3-Stack Radius, 4-Temperature      */
/*                                          */
/*  ERROR HANDLING:                      */
/*      When reading keystrokes, only keystrokes that are      */
/*      applicable to code are read, all others are ignored.    */
/*      Backspace is permitted; Escape key exits                */
/*      out of routine with no result.                          */
/*                                          */
/*  ESI C Utilities routines called:      */
/*      curlocat   getkey   paint   colrprt f      */
/*      wrtch      rdchatr  colorcprt  colrprts      */

```

```

/*****/
/* */
/*  MODULE NAME: */
/*    SCR2PX */
/* */
/*  ABSTRACT: */
/*    Routine helps users input values needed to determine */
/*    whether the release came from the Purex stack or not */
/* */
/*  AUTHOR: */
/*    R. I. Scherpelz */
/*    Pacific Northwest Laboratory */
/*    P.O. Box 999 */
/*    Richland, WA 99352 */
/*    509-375-2454 */
/* */
/*  CREATION DATE: */
/*    June 30, 1989 */
/* */
/*  I/O: */
/*    User input from keyboard */
/*    Output written to screen and through arguments passed */
/* */
/*  CONSTANTS: */
/*    None */
/* */
/*  LOCAL VARIABLES: */
/*    Name          Type          Description */
/*    IKEY          Integer       Scan code returned by keystroke */
/*    FKEY          Integer       ASCII code returned by keystroke */
/*    ISPURX        Integer       Flags if Purex selected */
/* */
/*  MODULE CALLED FROM: */
/*    CHREL2 */
/* */

```

```

/*  PARAMETER PASSING:                                     */
/*    Input Values:                                       */
/*    None                                              */
/*  Values Returned:                                     */
/*    ispurx                                           */
/*                                                     */
/*  SUBORDINATE ROUTINES CALLED:                         */
/*    None                                              */
/*                                                     */
/*  MODULE ALGORITHM:                                    */
/*    Put some color on the screen and get a key input from the */
/*    operator, who can select 'yes' or 'no' to the Purex      */
/*    question. Yes or no is filled in if selected along with  */
/*    any instructions needed. If the escape key is pressed,   */
/*    exit with no entry.                                     */
/*                                                     */
/*  ERROR HANDLING:                                       */
/*    When reading keystrokes, only keystrokes that are      */
/*    applicable to code are read, all others are ignored.    */
/*    Backspace is permitted; Escape key exits               */
/*    out of routine with no result.                         */
/*                                                     */
/*                                                     */
/*  ESI C Utilities routines called:                     */
/*    curlocat  getkey  paint  coloreol                 */
/*    colorcprt                                     */

```

```

C=====C
C
C
C  MODULE NAME:
C    CHREL3
C
C
C  SUBORDINATE ROUTINES CALLED:
C
C
C  ABSTRACT:
C    This routine gathers the input needed for release
C    type 3: Ground level release
C
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C
C
C  CREATION DATE:
C    March 24, 1988
C
C
C  I/O:
C    User input from keyboard
C    Output written to screen and through arguments passed
C
C
C  LOCAL VARIABLES:
C
C    Name          Type          Description
C    SFLOW          Real*4      Effluent flow rate of release (m^3/sec)
C    BOAREA          Real*4      Building cross-sectional
C                                area of release (m^2)
C
C
C  MODULE CALLED FROM:
C    CHSRELES
C
C
C  PARAMETER PASSING:

```

c	Input Values:	c
c	None	c
c	Values Returned as ARGUMENTS:	c
c	sflow bdarea	c
c	screl3	c
c		c
c	MODULE ALGORITHM:	c
c	A menu listing several questions about the release	c
c	appears on the screen. SCREL3 is then called to	c
c	accept user input.	c
c		c
c	ERROR HANDLING:	c
c	None.	c

```

/*****/
/* */
/*  MODULE NAME: */
/*    SCREL3 */
/* */
/*  ABSTRACT: */
/*    A routine to help users input values for release */
/*    type 3: Ground level release */
/* */
/*  AUTHOR: */
/*    R. I. Scherpelz */
/*    Pacific Northwest Laboratory */
/*    P.O. Box 999 */
/*    Richland, WA 99352 */
/*    509-375-2454 */
/* */
/*  CREATION DATE: */
/*    July 4, 1989 */
/* */
/*  I/O: */
/*    User input from keyboard */
/*    Output written to screen and through arguments passed */
/* */
/*  CONSTANTS: */
/*    Name          Type          Description */
/*    CNVRT[4]      Floating      Conversion values for each question */
/*    LOVAL[4]       Floating      Low values for each answer */
/*    HIVAL[4]       Floating      High values for each answer */
/* */
/*  LOCAL VARIABLES: */
/*    Name          Type          Description */
/*    SFLOW          Floating      Stack flow rate of release (m^3/sec) */
/*    BDAREA          Floating      Building cross-sectional */
/*                                Area of release (m^2) */
/*    ANSR[10]        Character    Operator entry for answer */

```



```

/*  DEFUNITS[10]  Character Default units  */
/*  IROW          Integer  Row number for cursor  */
/*  ROW[4]        Integer  Screen row for each question  */
/*  KEY           Integer  ASCII code returned by keystroke  */
/*  IKEY          Integer  Scan code returned by keystroke  */
/*  FKEY          Integer  ASCII code returned by keystroke  */
/*  LCHOIC        Integer  Which choice is selected: 0= Escape  */
/*                  1= sflow, 2= bdarea  */
/*  ICH           Integer  Index -- blanks out answer space  */
/*                  (10 characters)  */
/*  NCH1          Integer  Cursor position for answers  */
/*                  (20 or 45 usually)  */
/*  IFORE         Integer  Foreground color  */
/*  IBKG          Integer  Background color  */
/*  XIN[4]        Floating  Values for two answers  */
/*                  (same as sflow and bdarea)  */
/*  */
/*  MODULE CALLED FROM:  */
/*  CHREL3  */
/*  */
/*  PARAMETER PASSING:  */
/*  Input Values:  */
/*  sflow      bdarea  */
/*  Values Returned:  */
/*  sflow      bdarea  */
/*  */
/*  SUBORDINATE ROUTINES CALLED:  */
/*  None  */
/*  */
/*  MODULE ALGORITHM:  */
/*  A menu asking the operator if the release came from the  */
/*  Purex stack appears on the screen. If yes is answered  */
/*  ISPURX is set to 1, if no it is set to 0. If the escape  */
/*  key is pressed, exit with no entry. (ISPUREX = 2)  */
/*  */

```

```

/*  ERROR HANDLING:                                     */
/*      When reading keystrokes, only keystrokes that are */
/*      applicable to code are read, all others are ignored. */
/*      Backspace is permitted; Escape key exits          */
/*      out of routine with no result.                    */
/*                                                         */
/*  ESI C Utilities routines called:                      */
/*      curlocat   getkey   paint   colrprtf              */
/*      wrtch      rdchatr  colorcprt  colrprts          */

```

```

C=====C
C
C  MODULE NAME:
C    CHREL4
C
C  ABSTRACT:
C    This routine gathers the input needed for release
C    type 4: Elevated Release Near a building
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C
C  CREATION DATE:
C    March 29, 1988
C
C  I/O:
C    User input from keyboard
C    Output written to screen and through arguments passed
C
C  LOCAL VARIABLES:
C
C    Name          Type          Description
C    SFLOW          Real*4      Effluent flow rate of release (m^3/sec)
C    BDAREA          Real*4      Building cross-sectional
C                                Area of release (m^2)
C    BHT             Real*4      Building height of release (m)
C    SRAD            Real*4      Stack Radius of release (m)
C    SHGHT           Real*4      Stack Height of release (m)
C
C  MODULE CALLED FROM:
C    CHSRELES
C

```

c	PARAMETER PASSING:	c
c	Input Values:	c
c	sflow bdarea bht	c
c	shght srاد	c
c	Values Returned as ARGUMENTS:	c
c	sflow bdarea bht	c
c	shght srاد	c
c		c
c	SUBORDINATE ROUTINES CALLED:	c
c	screl4	c
c		c
c	MODULE ALGORITHM:	c
c	A menu listing several questions about the release	c
c	appears on the screen. SCREL4 is called to accept	c
c	user input.	c
c		c
c	ERROR HANDLING:	c
c	None.	c

```

/*****/
/* */
/*  MODULE NAME: */
/*    SCREL4 */
/* */
/*  ABSTRACT: */
/*    A routine to help users input values for release */
/*    type 4: Elevated Release Near a building */
/* */
/*  AUTHOR: */
/*    R. I. Scherpelz */
/*    Pacific Northwest Laboratory */
/*    P.O. Box 999 */
/*    Richland, WA 99352 */
/*    509-375-2454 */
/* */
/*  CREATION DATE: */
/*    July 4, 1989 */
/* */
/*  I/O: */
/*    User input from keyboard */
/*    Output written to screen and through arguments passed */
/* */
/*  CONSTANTS: */
/*    Name          Type          Description */
/*    CNVRT[5]      Floating      Conversion values for each question */
/*    LOVAL[5]       Floating      Low values for each answer */
/*    HIVAL[5]       Floating      High values for each answer */
/* */
/*  LOCAL VARIABLES: */
/*    Name          Type          Description */
/*    SFLOW          Floating      Stack flow rate of release (m^3/sec) */
/*    BDAREA          Floating      Building cross-sectional */
/*                                Area of release (m^2) */
/*    BHT             Floating      Building Height of release (m) */

```

```

/*      SRAD          Floating  Stack Radius of release (m)          */
/*      SHGHT         Floating  Stack Height of release (m)         */
/*      ANSR[10]       Character Operator entry for answer          */
/*      DEFUNITS[10]   Character Default units                      */
/*      IROW           Integer   Row number for cursor              */
/*      ROW[5]         Integer   Screen row for each question       */
/*      KEY            Integer   ASCII code returned by keystroke   */
/*      IKEY           Integer   Scan code returned by keystroke    */
/*      FKEY           Integer   ASCII code returned by keystroke   */
/*      LCHOIC         Integer   Which choice is selected: 0= Escape */
/*                               1= sflow, 2= bdarea, 3= bht,         */
/*                               4= shght, 5= srad                   */
/*      ICH            Integer   Index -- blanks out answer space   */
/*                               (10 characters)                     */
/*      NCH1           Integer   Cursor position for answers        */
/*                               (20 or 45 usually)                  */
/*      IFORE          Integer   Foreground color                   */
/*      IBKG           Integer   Background color                   */
/*      XIN[5]         Floating  Values for five answers            */
/*                               (same as sflow,bdarea,bht,shght,srad ) */
/*                                                                */
/*      MODULE CALLED FROM:                                         */
/*      CHREL4                                                  */
/*                                                                */
/*      PARAMETER PASSING:                                         */
/*      Input Values:                                             */
/*      sflow          bdarea          bht                        */
/*      shght          srad                                                     */
/*      Values Returned:                                         */
/*      sflow          bdarea          bht                        */
/*      shght          srad                                                     */
/*                                                                */
/*      SUBORDINATE ROUTINES CALLED:                               */
/*      None                                                    */
/*                                                                */

```

```

/*  MODULE ALGORITHM:                                     */
/*      A menu listing several questions about the release */
/*      appears on the screen.  The cursor moves from question */
/*      to question as they are answered, usually with number */
/*      entries.  If the escape key is pressed, exit with no */
/*      entry.  Handles 1-Effluent flow, 2-Building area, */
/*      3-Building height, 4-Stack height, 5-Stack Radius */
/*                                                         */
/*  ERROR HANDLING:                                       */
/*      When reading keystrokes, only keystrokes that are */
/*      applicable to code are read, all others are ignored. */
/*      Backspace is permitted; Escape key exits */
/*      out of routine with no result. */
/*                                                         */
/*  ESI C Utilities routines called:                     */
/*      curlocat    getkey    paint    colrprtf          */
/*      wrtch       rdchatr   colorcprt  colrprts        */

```

```

/*****/
/* */
/*  MODULE NAME: */
/*    RELCHS */
/* */
/*  ABSTRACT: */
/*    Handles the screen display and pull in an input value */
/*    for ITREL for the user choosing release conditions */
/* */
/*  AUTHOR: */
/*    R. I. Scherpelz */
/*    Pacific Northwest Laboratory */
/*    P.O. Box 999 */
/*    Richland, WA 99352 */
/*    509-375-2454 */
/* */
/*  CREATION DATE: */
/*    June 30, 1989 */
/* */
/*  I/O: */
/*    User input from keyboard */
/*    Output written to screen and through arguments passed */
/* */
/*  LOCAL VARIABLES: */
/*    Name          Type          Description */
/*    ITR           Integer       Index row or question being answered */
/*    ITRNEW         Integer       Index next row or question */
/*                                being answered */
/*    COLINV[4]      Integer       Screen column position */
/*                                for inverse video */
/*    ROW[4]         Integer       Screen row for top line of release */
/*    ROW2           Integer       Screen row for the end of */
/*                                the release description */
/*    IKEY           Integer       Scan code returned by keystroke */
/*    FKEY           Integer       ASCII code returned by keystroke

```



```

/*      ITREL      Integer      Release number value (1 to 4)      */
/*                                                    */
/*  MODULE CALLED FROM:      */
/*      CHSRELS      */
/*                                                    */
/*  PARAMETER PASSING:      */
/*      Input Values:      */
/*      None      */
/*  Values Returned:      */
/*      itrel      */
/*                                                    */
/*  SUBORDINATE ROUTINES CALLED:      */
/*      None      */
/*                                                    */
/*  MODULE ALGORITHM:      */
/*      A menu listing several questions about the release      */
/*      appears on the screen. The cursor moves from question      */
/*      to question as they are answered, usually with number      */
/*      entries. If the Esc key is pressed, exit with no entry.      */
/*                                                    */
/*  ERROR HANDLING:      */
/*      When reading keystrokes, only keystrokes that are      */
/*      applicable to code are read, all others are ignored.      */
/*      Backspace is permitted; Escape key exits      */
/*      out of routine with no result.      */
/*                                                    */
/*  ESI C Utilities routines called:      */
/*      curlocat      getkey      paint      colorcprt      */

```

```

C=====C
C
C  MODULE NAME:
C    FACLRD
C
C  ABSTRACT:
C    Reads data file with facility source terms
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C
C  CREATION DATE:
C    February 21, 1990
C
C  I/O:
C    Input through variables in commons
C    Output through variables in arguments and commons
C
C  CONSTANTS:
C    None
C
C  LOCAL VARIABLES:
C
C    Name          Type          Description
C    JTREL         Integer       Index of release type (1 to 4)
C    OTHARES       Chr*79        Names of other Hanford areas
C                                (those not displayed)
C    JA            Integer       Index: 1 to number of areas
C    IC            Integer       Index for position in string
C    IF            Integer       Index for which facility
C    IFAC          Integer       Facility # chosen by user
C    ICH           Integer       Index: Release type (1 to 4)

```

c	JCH	Integer	Index for position in string	c
c	IN	Integer	Index: 1 to number of nuclides	c
c	NN	Integer	Number of nuclides with > 0 Ci released	c
c	IYESNO	Integer	Index for answer to question	c
c	NOAREA(6)	Integer	ID number for facility	c
c			that is first for this area	c
c	JN	Integer	Index: nuclide number	c
c	NFAC	Integer	Number of facilities in desired area	c
c	N1AREA	Integer	ID number for facility	c
c			that is last for this area	c
c	KN	Integer	Index: Nuclide back to NN	c
c	IFP	Integer	Index: which facility + 1	c
c	IAREA	Integer	Index: chosen area to display	c
c	ILN	Integer	Index: line number of display	c
c	INN	Integer	Index: 1 to nuclide number in facility	c
c	NAREA	Integer	Index: 1 to Number of areas	c
c	NUMF2	Integer	Index: # of facilities in area/2	c
c	AREANAME(6)	Chr*12	Name of Hanford area	c
c	INUC	Integer	Index: nuclide ID	c
c	QNUC(300)	Real*4	Curies released - temp. updatable array	c
c	ELTAW(300)	Chr*7	Nuclide name	c
c				c
c	DATA STRUCTURES:			c
c	Common /nuclide/			c
c	NNUC:	Integer	Number of radionuclides in the master	c
c			library 'RMDLIB', 1 <= NUC => 300	c
c	NCH	Integer	Number of decay chains in the master	c
c			library 'RMDLIB', 1 <= NCH => 200.	c
c	NOFNUC(200)	Integer	Number of radionuclides in each	c
c			decay chain. 1 <= NOFNUC(I) => 9.	c
c			When NOFNUC(I) = 1, No daughters.	c
c	NCHST(200)	Integer	Location in the master radionuclide	c
c			list of the 1st member of each chain.	c
c			1 <= NCHST(I) => 300.	c
c	IFR(2,300)	Integer	IFR(1,I) gives the chain member that	c

c			is the 1st precursor to radionuclide I.	c
c			IFR(2,I) is location of 2nd precursor.	c
c			IFR(1,I) < IFR(2,I) < IMEM(I)	c
c	DKF(2,300)	Real*4	Fraction of 1st and 2nd precursor	c
c			that decays to this radionuclide.	c
c	AL(300)	Real*4	Radiological decay constant for each	c
c			radionuclide day ** -1.	c
c	NCHN(300)	Integer	Chain number for each radionuclide.	c
c	NUCNAM(300)	Chr*8	8-character nuclide identifier:	c
c			First 2 Chars: Element name for each	c
c			radionuclide in the Master	c
c			Radionuclide Data library.	c
c			Chars. 3-8: Atomic weight symbol for	c
c			each radionuclide in the Master	c
c			Radionuclide Data library.	c
c			Isomeric states are indicated by the	c
c			letter 'M' after the atomic weight.	c
c			Daughter contributions are indicated by	c
c			'+D' after the atomic weight	c
c			and 'M' if present.	c
c	RMDTITL	Chr*80	80-character title of Radionuclide	c
c			Master Data Library.	c
c	HTITLE	Chr*80	80-character title of HUDU	c
c			Dose Factor Library.	c
c	EXTDF(300)	Real*4	External dose factor (Sv/yr per Bq/m ³)	c
c			for each nuclide. Value of -1 means	c
c			that a nuclide in the 'RMDLIB' library	c
c			was not found in the Dose Factor librar	c
c	DOSINH(2,5,300	Real*4	Inhalation dose factors (Sv/Bq).	c
c			First index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1=Lungs, 2=Bone Surf,	c
c			3=Red Marrow, 4=Thyroid,	c
c			5=Effective Dose Equivalent	c
c			3rd Index: nuclide	c
c	GRPNAM(5)	Chr*80	Title for a group of nuclides in the	c

c			Radionuclide Master Data Library	c
c	NUCGRP(300)	Integer	Group ID# for this nuclide	c
c	NUMGRP(5)	Integer	Number of nuclides in this group	c
c	Q0(300)	Real*4	Curies of this nuclide released	c
c	IFQMOD	Logical	Whether user has modified a set of q0	c
c			values from a source term file	c
c				c
c	DATA STRUCTURES:			c
c	Common /release/			c
c	SHGHT	Real*4	Stack height of release (m)	c
c	SFLOW	Real*4	Stack flow of release (m ³ /sec)	c
c	SRAD	Real*4	Stack radius of release (m)	c
c	ETEMP	Real*4	Effluent temperature of release (C)	c
c	BDAREA	Real*4	Building Area of release (m ²)	c
c	BHT	Real*4	Building height of release (m)	c
c	ITREL	Integer	Release number value (1 to 4)	c
c			1 - Open Area Ground Level, 2 - Open	c
c			Area Elevated, 3 - Ground Level,	c
c			4 - Effective release height (m)	c
c	OHT	Real*4	Open Area Elevated Height (m)	c
c	ERHT	Real*4	Effective Release height (m)	c
c	PRISE	Real*4	Hight the plume rises (m)	c
c	Common /general/			c
c	TITLE	Chr*78	Title message for display screen	c
c	INPLIN(25)	Chr*78	Input lines for main menu display	c
c	MONTH	Integer	Current month	c
c	IHOUR	Integer	Current hour	c
c	IFMAYGO	Logical	Flags if sufficient data has been	c
c			entered to perform the atmospheric	c
c			transport calculation	c
c	Common /facilty/			c
c	FTITLE	Chr*80	Title of facility data file	c
c	NUMFAC	Integer	Number of facilities (< 101)	c
c	FACNAME(100)	Chr*40	Name of the facility	c
c			(with a short accident description)	c

c	FACAREA(100)	Chr*12	Name of the Hanford area containing	c
c			the facility	c
c	ACCDES(8,100)	Chr*80	Up to 8 lines of text describing	c
c			the accident scenario	c
c	NUMNUC(100)	Integer	Number of nuclides in each facility's	c
c			release list (<201)	c
c	NUCID(200,100)	Integer	Id number of nuclide in list	c
c			(corresponds to order read from HRMOLIB	c
c	CIRD(200,100)	Real*4	Radioactivity released of nuclide (Ci)	c
c	RELHT(100)	Real*4	Release height of scenario (m)	c
c				c
c	MODULE CALLED FROM:			c
c	INPUT			c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	None			c
c	Values Returned as ARGUMENTS:			c
c	None			c
c	Values Returned in COMMONS:			c
c	Name	Via		c
c	inplin	/General/		c
c	Q0	/Nuclide/		c
c	shght	/Release/		c
c	sflow	/Release/		c
c	srad	/Release/		c
c	etemp	/Release/		c
c				c
c	SUBORDINATE ROUTINES CALLED:			c
c	scfac1	ynfac1		c
c				c
c	MODULE ALGORITHM:			c
c	Displays the facilities for first area, then calls 'SCFACL'			c
c	for user input - if user chooses another area, code repeats			c
c	this; if user chooses a facility, code calls 'YNFACL' to			c

c	confirm. Finally, when a facility is chosen and confirmed,	c
c	'INPLIN' is updated with new data.	c
c		c
c	ERROR HANDLING:	c
c	User pressing escape key allows return with no changes;	c
c	'ynfac1' routine allows user to confirm or reject a choice	c
c	before it's definitely selected.	c

```

/*****/
/* */
/* MODULE NAME: */
/* SCFACL */
/* */
/* ABSTRACT: */
/* Allow the user to choose a facility-specific source term. */
/* */
/* AUTHOR: */
/* R. I. Scherpelz */
/* Pacific Northwest Laboratory */
/* P.O. Box 999 */
/* Richland, WA 99352 */
/* 509-375-2454 */
/* */
/* CREATION DATE: */
/* February 21, 1990 */
/* */
/* I/O: */
/* User input from keyboard and variables from arguments */
/* Output written to the screen and variables via arguments. */
/* */
/* CONSTANTS: */
/* Name Type Description */
/* NUMFAC Integer Number of facility source terms */
/* on this screen */
/* NAREA Integer Total number of Hanford areas in file */
/* OTHAREAS[79] Character String with names of those */
/* Hanford areas not displayed */
/* */
/* LOCAL VARIABLES: */
/* Name Type Description */
/* NUMF2 Integer Number of facilities * 0.5 */
/* IRTCOL Integer Column number for end of line */
/* with other area names */

```



```

/*      NROWS      Integer  Number of rows with facility data      */
/*      NROWRT     Integer  Number of rows in right column of      */
/*                  facility data                                    */
/*      NROWLT     Integer  Number of rows in left column of       */
/*                  facility data                                    */
/*      NROWO      Integer  Top screen row with facility data      */
/*      IKEY       Integer  Scan code returned by keystroke        */
/*      KEY        Integer  ASCII value returned by keystroke      */
/*      ICOL       Integer  Column number for cursor               */
/*      IROW       Integer  Row number for cursor                  */
/*      IFAC       Integer  ID for source term chosen by user      */
/*                                                                */
/*  MODULE CALLED FROM:                                          */
/*      FACLRD                                              */
/*                                                                */
/*  PARAMETER PASSING:                                          */
/*      Input Values:                                          */
/*          numfac      narea      otherareas                */
/*  Values Returned:                                          */
/*      ifac                                              */
/*                                                                */
/*  SUBORDINATE ROUTINES CALLED:                                */
/*      None                                              */
/*                                                                */
/*  MODULE ALGORITHM:                                          */
/*      Most facility data is already displayed on screen before */
/*      this routine is called. It colors these lines, then prints */
/*      other areas at bottom. It looks for a returned keystroke,  */
/*      then responds as appropriate, then looks for another      */
/*      keystroke. "End" or "Enter" key means accept the selection */
/*      and exit. IFAC > 1000 means the user chose another area   */
/*      "Escape" means exit with no change.                    */
/*                                                                */
/*  ERROR HANDLING:                                          */
/*      Only appropriate keystrokes are accepted. Others cause no */

```

```
/*      action in the code. Pressing "Escape" gets the user out      */
/*      without changes.                                              */
/*                                                                    */
/*      ESI C Utilities routines called:                             */
/*      colrcprt   colrprtf   curlocat   getkey                       */
/*      paint                                            */
```

```

/*****
/*
/* MODULE NAME:
/*   YNFACL
/*
/* ABSTRACT:
/*   Allow the user to answer yes or no to a facility-specific
/*   source term
/*
/* AUTHOR:
/*   R. I. Scherpelz
/*   Pacific Northwest Laboratory
/*   P.O. Box 999
/*   Richland, WA 99352
/*   509-375-2454
/*
/* CREATION DATE:
/*   June 13, 1988
/*
/* I/O:
/*   User input from keyboard
/*   Output written to screen and by argument passed
/*
/* CONSTANTS:
/*   Name          Type          Description
/*   NROWS         Integer      Number of last screen row with
/*                           choices to select
/*   NROWO         Integer      First row with a choice
/*
/* LOCAL VARIABLES:
/*   Name          Type          Description
/*   ICOL          Integer      Column number for cursor
/*   KEY           Integer      ASCII code returned by keystroke
/*   IKEY          Integer      Scan code returned by keystroke
/*   IROW          Integer      Row number for cursor

```

```

/*      IYESNO      Integer      Indication of user's choice:      */
/*                                          1: yes, 2: select another source term, */
/*                                          3: quit source term selection      */
/*                                          */
/*      MODULE CALLED FROM:      */
/*      FACLRD      */
/*                                          */
/*      PARAMETER PASSING:      */
/*      Input Values:      */
/*      None      */
/*      Values Returned:      */
/*      iyesno      */
/*                                          */
/*      SUBORDINATE ROUTINES CALLED:      */
/*      None      */
/*                                          */
/*      MODULE ALGORITHM:      */
/*      Facility source term that's been tentatively chosen and      */
/*      8 lines of accident description are already on the screen.      */
/*      This routine paints them, prints out the choices, then looks      */
/*      for a keystroke. It responds to an appropriate keystroke,      */
/*      then looks for another. "End" or "Enter" key means      */
/*      accept the selection and Exit; "Escape" means exit with      */
/*      iyesno=3 (quit source term)      */
/*                                          */
/*      ERROR HANDLING:      */
/*      Only appropriate keystrokes are accepted: others cause no      */
/*      action in the code. Pressing "Escape" gets the user out      */
/*      with no changes.      */
/*                                          */
/*      ESI C Utilities routines called:      */
/*      colrcprt      colrprts      curlocat      getkey      */
/*      paint      */

```

```

/*****
/*
/* MODULE NAME:
/*   CHOOST
/*
/* ABSTRACT:
/*   A menu selection routine using inverse video
/*   & function keys
/*
/* AUTHOR:
/*   R. I. Scherpelz
/*   Pacific Northwest Laboratory
/*   P.O. Box 999
/*   Richland, WA 99352
/*   509-375-2454
/*   S. D. Miller
/*   509-375-3843
/*
/* CREATION DATE:
/*   February 21, 1990
/*
/* I/O:
/*   Input by arguments passed
/*   Output written to the screen and through arguments passed
/*
/* CONSTANTS:
/*   Name           Type           Description
/*   LINE1          Integer        Top line of text to choose
/*   ROW[21]        Integer        Vertical position on screen matching
/*                                   the vertical cursor movement
/*   LINLEN[21]     Integer        Number of characters in each line
/*   NSELECT        Integer        Number of selections available
/*   NUMLIN         Integer        Number of lines available
/*
/* LOCAL VARIABLES:

```

Name	Type	Description
FKEY	Integer	ASCII code returned by keystroke
JLINE	Integer	Temp. variable for translating *iline
IKEY	Integer	Scan code returned by keystroke
IROW	Integer	Row number for cursor
ILINE	Integer	Line number of cursor location and choice selected upon return
MODULE CALLED FROM:		
INPUT		
PARAMETER PASSING:		
Input Values:		
line1	nselect	iline
Values Returned:		
iline		
OTHER ROUTINES CALLED:		
Clrit		
SUBORDINATE ROUTINES CALLED:		
None		
MODULE ALGORITHM:		
Writes messages to screen and reads keystrokes.		
ERROR HANDLING:		
None		
ESI C Utilities routines called:		
colrcprt	curlocat	getkey
paint	setscmod	

```

=====C
C
C
C   MODULE NAME:
C   EQQCALC
C
C
C   ABSTRACT:
C   Calculates integrated Chi/Q values for each of the four
C   Release types: 1-Open Area Ground Level,
C   2-Open Area Elevated Level
C   3-Ground Level, 4-Elevated Release near buildings
C
C
C   AUTHOR:
C   R. I. Scherpelz
C   Pacific Northwest Laboratory
C   P.O. Box 999
C   Richland, WA 99352
C   509-375-2454
C
C
C   CREATION DATE:
C   June 17, 1988
C
C
C   I/O:
C   Input through variables in common
C   Output through variables in common
C
C
C   CONSTANTS:
C
C   Name          Type          Description
C   Z0            Real*4        Surface roughness length (m)
C   PI            Real*4        PI -> 3.14159265
C
C
C   LOCAL VARIABLES:
C
C   Name          Type          Description
C   SIGMAZ        Real*4        Vertical diffusion coeff. (m)
C   SIGMAY        Real*4        Horizontal diffusion coeff. (m)
C   W0            Real*4        Vertical effluent velocity (m/sec)

```

c	FLAYER	Real*4	Effluent layer converted to real (m)	c
c	EARG(5)	Real*4	Exponent of arg 1- 2*arg, 2- 8*arg (gz)	c
c			(erht/sigmaz)^2/2, 2*flayer +/-,	c
c			4*flayer +/- (elevated)	c
c	VWIND10	Real*4	Final wind speed at 10 m	c
c			elevation (m/sec)	c
c	PRISE	Real*4	Plume rise (m)	c
c	ERHT	Real*4	Effective release height (m)	c
c	IR	Integer	Index: 1 to number of downwind ranges	c
c	IE	Integer	Index: 1= 2*arg, 2=8*arg (gz) or	c
c			Index: 1= (erht/sigmaz)^2/2, (elevated)	c
c			2= (2*flayer+erht)/sigmaz)^2/2,	c
c			3= (...erht..)^2/2	c
c			4= (4*flayer+erht)/sigmaz)^2/2,	c
c			5= (...erht..)^2/2	c
c	ARG	Real*4	Intermediate variable for argument	c
c			of exponential	c
c	GZ	Real*4	Intermediate variable for finding the	c
c			vertical spread of the plume	c
c				c
c	DATA STRUCTURES:			c
c	Common /downwind/			c
c	NRANGE	Integer	Number of downwind ranges for dose	c
c			calculation (< = 20)	c
c	RANGE(20)	Real*4	Downwind distance, meters	c
c	EOQ(20)	Real*4	Time-integrated relative air	c
c			concentration at each range (sec/m^3)	c
c	RGTITL(20)	Chr*25	Title for each downwind range	c
c	ETA(20)	Real*4	Estimated time of plume arrival;	c
c			actually the plume transit time to	c
c			each downwind range (sec)	c
c	Common /release/			c
c	SHGHT	Real*4	Stack height of release (m)	c
c	SFLOW	Real*4	Stack flow of release (m^3/sec)	c
c	SRAD	Real*4	Stack radius of release (m)	c

c	ETEMP	Real*4	Effluent temperature of release (C)	c
c	BDAREA	Real*4	Building Area of release (m ²)	c
c	BHT	Real*4	Building height of release (m)	c
c	ITREL	Integer	Release number value (1 to 4)	c
c			1 - Open Area Ground Level, 2 - Open	c
c			Area Elevated, 3 - Ground Level,	c
c			4 - Effective release height (m)	c
c	OHT	Real*4	Open Area Elevated Height (m)	c
c	ERHT	Real*4	Effective Release height (m)	c
c	PRISE	Real*4	Hight the plume rises (m)	c
c	Common	/meteo/		c
c	JSTAB	Integer	Stability class	c
c	WINDSPD	Real*4	Wind speed (m/sec)	c
c	LAYER	Integer	Mixing layer thickness (m)	c
c	AIRTEMP	Real*4	Air Temperature (C)	c
c	INDEXC	Integer	Cloudiness index	c
c	DEFSTAB	Logical	Flags default stability	c
c	DEFWSPD	Logical	Flags default wind speed	c
c	DEFLAYER	Logical	Flags default mixing layer thickness	c
c	DEFTEMP	Logical	Flags default effluent temperature	c
c	DEFHRMO	Logical	Flags default hour and month	c
c	STABNAM(7)	Chr*25	Names of the seven stability classes:	c
c			A: Extremely, B: Moderately Unstable,	c
c			C: Slightly Unstable, D: Neutral,	c
c			E: Slightly, F: Moderately Stable,	c
c			G: Extremely Stable	c
c				c
c	MODULE CALLED FROM:			c
c	MAIN			c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	None			c
c	Values Returned as ARGUMENTS:			c
c	None			c

c	Values Returned in COMMONS:	c
c	Name Via	c
c	eoq /downwind/	c
c	eta /downwind/	c
c		c
c	SUBROUTINE ROUTINES CALLED:	c
c	plmriz profile rwake sigma	c
c		c
c		c
c	MODULE ALGORITHM:	c
c	Calculate the vertical effluent velocity. Find wind speed	c
c	at release hight. Calculate Plume Rise, E/Q for Open Area	c
c	(no bldg wake) conditions, and building wake conditions.	c
c	Calculate estimated time of arrival of plume and divide	c
c	range by release height wind speed.	c
c		c
c	ERROR HANDLING:	c
c	None	c

```

C=====C
C
C
C  MODULE NAME:
C    PLMRIZ
C
C
C  ABSTRACT:
C    Calculate plume rise of a release
C
C
C  AUTHOR:
C    G. F. Athey
C    Phoenix Associates
C    Bethesda, MD
C    301-654-0850
C
C    J. V. Ramsdell
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-376-8626
C
C
C  CREATION DATE:
C    February 5, 1988
C
C
C  I/O:
C    Input through variables in arguments
C    Output through variables in arguments
C
C
C  CONSTANTS:
C
C    Name          Type          Description
C    ZO            Real*4        Surface Roughness Length (m)
C    SRAD          Real*4        Stack radius (m)
C    SHGHT         Real*4        Stack height (m)
C    SFLOW         Real*4        Stack flow (m^3/sec)
C    ETEMP         Real*4        Effluent Temperature (C)
C    ATEMP         Real*4        Air Temperature (C)

```

c	RSPD	Real*4	Release height wind speed (m/sec)	c	
c	STAB	Integer	Stability class	c	
c	LAYER	Integer	Mixing layer thickness (m)	c	
c	C(3)	Real*4	Stability class constants	c	
c			Index for SC: 1= E, 2= F, 3= G	c	
c	PI	Real*4	PI -> 3.14159265	c	
c				c	
c	LOCAL VARIABLES:			c	
c	Name	Type	Description	c	
c	ETEMPK	Real*4	Effluent Temperature (K)	c	
c	ATEMPK	Real*4	Air Temperature (K)	c	
c	PRMAX	Real*4	Maximum plume rise (m)	c	
c	PRISE	Real*4	Plume rise (m)	c	
c	FM	Real*4	Plume momentum flux (sec/m ³)	c	
c	BF	Real*4	Plume buoyancy flux (?)	c	
c	USTR	Real*4	Characteristic Velocity (m/sec)	c	
c	RM	Real*4	Momentum rise limited by turbulence	c	
c	RB1	Real*4	Buoyancy rise - near neutral conditions	c	
c	RB2	Real*4	Buoyancy rise for stable conditions	c	
c	RB	Real*4	Minimum Buoyancy rise	c	
c	IS	Integer	Stable atmospheric conditions	c	
c			stability class	c	
c	S_	Real*4	Stable atmospheric conditions parameter	c	
c	USTAR	Real*4	Characteristic Velocity (m/sec)	c	
c				c	
c	MODULE CALLED FROM:			c	
c	EQQCALC			c	
c				c	
c	PARAMETER PASSING:			c	
c	Input Values:			c	
c	z0	srad	shght	sflow	c
c	etemp	atemp	rspd	stab	c
c	layer				c
c	Values Returned as ARGUMENTS:			c	
c	prise			c	

c		c
c	SUBORDINATE ROUTINES CALLED:	c
c	ustar	c
c		c
c	MODULE ALGORITHM:	c
c	Calculate final plume rise given atmospheric and effluent	c
c	release conditions. Plume rise calculations are made on	c
c	basis of information in Briggs (1984) using the equations	c
c	in Section 2 of the HEDUP Equation Formulation and	c
c	Parameter Defintition document.	c
c		c
c	ERROR HANDLING:	c
c	None	c

```

=====
C
C
C  MODULE NAME:
C    USTAR
C
C  ABSTRACT:
C    Function to compute the characteristic velocity (u*)
C    from the wind speed
C
C  AUTHOR:
C    J. V. Ramsdell
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-376-8626
C
C  CREATION DATE:
C    February 5, 1988
C
C  I/O:
C    Input through variables in arguments
C    Output through variables in arguments
C
C  CONSTANTS:
C
C    Name          Type          Description
C    HT            Real*4        Measurement height (m)
C    ZO            Real*4        Surface roughness length (m)
C    SPD           Real*4        Wind Speed (m/sec)
C    IST           Integer       Atmospheric stability class
C    PI            Real*4        PI -> 3.14159265
C
C  LOCAL VARIABLES:
C
C    Name          Type          Description
C    INVMOL        Real*4        1/Monin-Obukov length used in
C                                diabatic wind profiles (1/m)

```

```

c      MOLINV      Real*4      1/Monin-Obukove length used in      c
c                                     diabatic wind profiles (1/m)      c
c      X_          Real*4      Holding register for calculations      c
c      PSI         Real*4      Dimensionless empirical function      c
c      USTAR       Real*4      Characteristic Velocity (m/sec)      c
c                                                                c
c      MODULE CALLED FROM:      c
c          PLMRIZ      PROFILE      c
c                                                                c
c      PARAMETER PASSING:      c
c          Input Values:      c
c          ht          z0          spd          ist      c
c      Values Returned as ARGUMENTS:      c
c          ustar      c
c                                                                c
c      SUBORDINATE ROUTINES CALLED:      c
c          invmol      c
c                                                                c
c      MODULE ALGORITHM:      c
c          The function uses an observed wind, its measurement height,      c
c          and the surface roughness length along with the diabatic      c
c          wind profile -- see Panofsky and Dutton (1984) Section 6.5      c
c          to estimate USTAR. The specific profile used is determined      c
c          by the atmospheric stability class.      c
c                                                                c
c      ERROR HANDLING:      c
c          None      c

```

```

C=====C
C
C  MODULE NAME:
C    INVMOL
C
C  ABSTRACT:
C    Compute the inverse of the Monin-Obukov length
C
C  AUTHOR:
C    J. V. Ramsdell
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-376-8626
C
C  CREATION DATE:
C    February 5, 1988
C
C  I/O:
C    Input through variables in arguments
C    Output through variables in arguments
C
C  CONSTANTS:
C
C      Name          Type          Description
C      ZO            Real*4        Surface roughness length (m)
C      IST           Integer       Atmospheric stability class
C      SLOPE(7)       Real*4        Empirical table values
C      CONST(7)       Real*4        Empirical Table values
C
C  LOCAL VARIABLES:
C
C      Name          Type          Description
C      INVMOL        Real*4        Inverse of Monin-Obukov length (1/m)
C
C  MODULE CALLED FROM:
C    USTAR          PROFILE
C

```


c		c
c	PARAMETER PASSING:	c
c	Input Values:	c
c	z0 ist	c
c	Values Returned as ARGUMENTS:	c
c	invmol	c
c		c
c	SUBORDINATE ROUTINES CALLED:	c
c	None	c
c		c
c	MODULE ALGORITHM:	c
c	The Monin-Obukhov length is a scale length in the	c
c	atmospheric boundary layer. Golder (Boundary Layer	c
c	Meteorology 3:47-58) has related 1/Monin-Obukhov length	c
c	to the surface roughness length and stability class.	c
c	This function estimates 1/L on the basis of Golder's paper.	c
c		c
c	ERROR HANDLING:	c
c	None	c

```

=====
C
C
C  MODULE NAME:
C    PROFILE
C
C  ABSTRACT:
C    Compute wind speed at an arbitrary height
C
C  AUTHOR:
C    J. V. Ramsdell
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-376-8626
C
C  CREATION DATE:
C    February 5, 1988
C
C  I/O:
C    Input through variables in arguments
C    Output through variables in arguments
C
C  CONSTANTS:
C
C    Name          Type          Description
C    HGHT          Real*4        Height for output wind speed (m)
C    HT            Real*4        Wind measurement height (m)
C    ZO            Real*4        Surface roughness length (m)
C    SPD           Real*4        Measured Wind Speed (m/sec)
C    IST           Integer       Atmospheric stability class
C    PI            Real*4        PI -> 3.14159265
C
C  LOCAL VARIABLES:
C
C    Name          Type          Description
C    INVMOL        Real*4        1/Monin-Obukov length used in
C                                diabatic wind profiles (1/m)

```

c	MOLINV	Real*4	1/Monin-Obukov length used in	c
c			diabatic wind profiles (1/m)	c
c	X_	Real*4	Holding register for calculations	c
c	PSI	Real*4	Dimensionless empirical function	c
c	USTAR1	Real*4	Characteristic Velocity (m/sec)	c
c	WIND	Real*4	Wind speed at selected height (m/sec)	c
c	PROFILE	Real*4	Wind speed at selected height (m/sec)	c
c				c
c	MODULE CALLED FROM:			c
c	EQQCALC	DFSPD		c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	z0	ht	spd	c
c	ist	hght		c
c	Values Returned as ARGUMENTS:			c
c	profile			c
c				c
c	SUBORDINATE ROUTINES CALLED:			c
c	ustar	invmol		c
c				c
c	MODULE ALGORITHM:			c
c	Computes a wind at any height using diabatic wind profile			c
c	see Panofsky and Dutton (1984) section 6.5 -- from a wind			c
c	measurement at another height. The profile used is			c
c	determined by the atmospheric stability class. The profile			c
c	uses the measured wind, the height of measurement, and a			c
c	surface roughness length to estimate USTAR. It then			c
c	computes the wind at the desired height directly.			c
c				c
c	ERROR HANDLING:			c
c	None			c

```

C=====C
C
C  MODULE NAME:
C    RWAKE
C
C  ABSTRACT:
C    Compute diffusion estimates for releases made in
C    building wakes.
C
C  AUTHOR:
C    J. V. Ramsdell
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-376-8626
C
C  CREATION DATE:
C    January 30, 1988
C
C  I/O:
C    Input through variables in arguments
C    Output through variables in arguments
C
C  CONSTANTS:
C
C    Name          Type          Description
C    AREA          Real*4        Building area (m^2)
C    CHT           Real*4        Building height (m)
C    RHT           Real*4        Release height (m)
C    W0            Real*4        Effluent vertical velocity (m/sec)
C    F0            Real*4        Flow (m^3/sec)
C    DIST          Real*4        Horizontal distance to receptor (m)
C    OHT           Real*4        Receptor height (m)
C    U10           Real*4        Wind speed at 10 m height (m/sec)
C    RHU           Real*4        Release height wind speed (m)
C    IST           Integer       Diffusion class

```

c	SIGMAZ	Real*4	Vertical diffusion coeff. (m)	c
c	SIGMAY	Real*4	Horizontal diffusion coeff. (m)	c
c	LAYER	Integer	Mixing layer depth (m)	c
c	PI	Real*4	PI -> 3.14159265	c
c	CO	Real*4	Multiplication constant (k)	c
c	CX	Real*4	Empirical constant	c
c	CA	Real*4	Empirical constant	c
c	CU	Real*4	Empirical constant	c
c				c
c	LOCAL VARIABLES:			c
c	Name	Type	Description	c
c	PLUMED	Real*4	Denominator of Gaussian plume model	c
c	CL	Real*4	Limiting distance for wake enhancement	c
c			to the diffusion rate (m)	c
c	XS	Real*4	Stretched string distance (m)	c
c	LXS	Real*4	Minimum of wake enhancement limiting	c
c			and stretched string distance (m)	c
c	BMOD	Real*4	Building surface release x/q (sec/m ³)	c
c	ARG	Real*4	Square of mixing layer depth over	c
c			the vertical diffusion coeff.	c
c	WXOQ	Real*4	Composite wake x/q (sec/m ³)	c
c	GZ	Real*4	Vertical diffusion term	c
c	EMOD	Real*4	Elevated plume x/q (sec/m ³)	c
c	WSIGZ	Real*4	Vertical diffusion coeff. (m)	c
c	WSIGY	Real*4	Horizontal diffusion coeff. (m)	c
c	IST1	Integer	Atmospheric stability class	c
c	WR	Real*4	Wake vertical rise (m)	c
c	WF	Real*4	Fraction of time plume is in wake	c
c	RWAKE	Real*4	Diffusion estimate for building	c
c			wake releases	c
c				c
c	MODULE CALLED FROM:			c
c	EQQCALC			c
c				c
c	PARAMETER PASSING:			c

c	Input Values:	c
c	area cht rht w0	c
c	f0 dist oht u10	c
c	rhu ist sizmaz sigmay	c
c	layer	c
c	Values Returned as ARGUMENTS:	c
c	rwake	c
c		c
c	SUBORDINATE ROUTINES CALLED:	c
c	sigma	c
c		c
c	MODULE ALGORITHM:	c
c	The function RWAKE estimates normalized concentrations (X/Q)	c
c	resulting from releases made in building wakes. The	c
c	function is an implementation of the building wake	c
c	diffusion model developed for the U.S. Nuclear Regulatory	c
c	Commission by J. V. Ramsdell. The model was developed	c
c	using building wake diffusion data obtained in	c
c	experiments conducted at 7 reactors.	c
c		c
c	ERROR HANDLING:	c
c	None.	c

```

C=====C
C
C      MODULE NAME:
C      SIGMA
C
C      ABSTRACT:
C      Sigma curves used for routine hanford dose calculations
C
C      AUTHOR:
C      G. F. Athey
C      Phoenix Associates
C      Bethesda, MD
C      301-654-0850
C
C      J. V. Ramsdell
C      Pacific Northwest Laboratory
C      P.O. Box 999
C      Richland, WA 99352
C      509-376-8626
C      C. S. Glantz
C      509-376-7741
C
C      CREATION DATE:
C      September 30, 1986
C
C      I/O:
C      Input through variables in arguments
C      Output through variables in arguments
C
C      CONSTANTS:
C      Name          Type          Description
C      X_            Real*4        distance (m)
C      STAB          Real*4        stability class
C      AY(7)         Real*4        Horizontal coeff. constants
C      AZ(7,3)       Real*4        Vertical coeff. constants #1

```

c			Index: 1- X<100, 2- <1000, 3- >1000	c
c	BZ(7,3)	Real*4	Vertical coeff. constants #2	c
c			Index: 1- X<100, 2- <1000, 3- >1000	c
c	CZ(7,3)	Real*4	Vertical coeff. constants #3	c
c			Index: 1- X<100, 2- <1000, 3- >1000	c
c				c
c	LOCAL VARIABLES:			c
c	Name	Type	Description	c
c	SIGMAZ	Real*4	Vertical diffusion coeff. (m)	c
c	SIGMAY	Real*4	Horizontal diffusion coeff. (m)	c
c				c
c	MODULE CALLED FROM:			c
c	EQQCALC	OUTPUT		c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	x	stab		c
c	Values Returned as ARGUMENTS:			c
c	sigmay	sigmaz		c
c				c
c	SUBORDINATE ROUTINES CALLED:			c
c	None			c
c				c
c	MODULE ALGORITHM:			c
c	SIGMA computations are made given the atmospheric			c
c	stability and distance from the source.			c
c	Basis: The curves are based on the parameterizations			c
c	of Martin and Tikvart (1968) and Tadmor and Gur (1969). The			c
c	parameterizations are used in the NRC PAVAN and XOQDOQ codes.			c
c				c
c	ERROR HANDLING:			c
c	None			c


```

C=====C
C
C      MODULE NAME:
C      DOSECALC
C
C      ABSTRACT:
C      Calculates doses incurred at each downwind range.
C
C      AUTHOR:
C      R. I. Scherpelz
C      Pacific Northwest Laboratory
C      P.O. Box 999
C      Richland, WA 99352
C      509-375-2454
C
C      CREATION DATE:
C      February 9, 1989
C
C      I/O:
C      Input through variables in commons
C      Output through variables in commons
C
C      CONSTANTS:
C      None
C
C      LOCAL VARIABLES:
C      Name          Type          Description
C      BONESURF(2)   Real*4        Bone surface dose (rem)
C                               Index: 1=1 yr 2=50 yr commitment time
C      REDSUM        Real*4        Summation of red marrow doses (rem)
C      IN            Integer       Index: (1 to 300) for each radionuclide
C      IR            Integer       Index: 1 to number of downwind ranges
C      SURFSUM       Real*4        Summation of bone surface doses (rem)
C      INUC          Integer       Index (1 to number nuclides in RMDLIB)
C      IYR           Integer       Index: 1=1 yr 2=50 yr commitment time

```

c	QNUC(300)	Real*4	Curies released - temp. updatable array	c
c			adjusted for decay (curies)	c
c			Index: (1 to 300) for each radionuclide	c
c	REDMAR(2)	Real*4	Red marrow dose (rem)	c
c			Index: 1=1 yr 2=50 yr commitment time	c
c	DKTIME	Real*4	Transit time for rad decay (days)	c
c				c
c	DATA STRUCTURES:			c
c	Common /downwind/			c
c	NRANGE	Integer	Number of downwind ranges for dose	c
c			calculation (≤ 20)	c
c	RANGE(20)	Real*4	Downwind distance, meters	c
c	EOQ(20)	Real*4	Time-integrated relative air	c
c			concentration at each range (sec/m^3)	c
c	RGITL(20)	Chr*25	Title for each downwind range	c
c	ETA(20)	Real*4	Estimated time of plume arrival;	c
c			actually the plume transit time to	c
c			each downwind range (sec)	c
c	Common /nuclide/			c
c	NNUC:	Integer	Number of radionuclides in the master	c
c			library 'RMDLIB', $1 \leq \text{NUC} \Rightarrow 300$	c
c	NCH	Integer	Number of decay chains in the master	c
c			library 'RMDLIB', $1 \leq \text{NCH} \Rightarrow 200$.	c
c	NOFNUC(200)	Integer	Number of radionuclides in each	c
c			decay chain. $1 \leq \text{NOFNUC}(I) \Rightarrow 9$.	c
c			When $\text{NOFNUC}(I) = 1$, No daughters.	c
c	NCHST(200)	Integer	Location in the master radionuclide	c
c			list of the 1st member of each chain.	c
c			$1 \leq \text{NCHST}(I) \Rightarrow 300$.	c
c	IFR(2,300)	Integer	IFR(1,I) gives the chain member that	c
c			is the 1st precursor to radionuclide I.	c
c			IFR(2,I) is location of 2nd precursor.	c
c			$\text{IFR}(1,I) < \text{IFR}(2,I) < \text{IMEM}(I)$	c
c	DKF(2,300)	Real*4	Fraction of 1st and 2nd precursor	c
c			that decays to this radionuclide.	c

c	AL(300)	Real*4	Radiological decay constant for each	c
c			radionuclide day ** -1.	c
c	NCHN(300)	Integer	Chain number for each radionuclide.	c
c	NUCNAM(300)	Chr*8	8-character nuclide identifier:	c
c			First 2 Chars: Element name for each	c
c			radionuclide in the Master	c
c			Radionuclide Data library.	c
c			Chars. 3-8: Atomic weight symbol for	c
c			each radionuclide in the Master	c
c			Radionuclide Data library.	c
c			Isomeric states are indicated by the	c
c			letter 'M' after the atomic weight.	c
c			Daughter contributions are indicated by	c
c			'+D' after the atomic weight	c
c			and 'M' if present.	c
c	RMDTITL	Chr*80	80-character title of Radionuclide	c
c			Master Data Library.	c
c	HTITLE	Chr*80	80-character title of HUDU	c
c			Dose Factor Library.	c
c	EXTDF(300)	Real*4	External dose factor (Sv/yr per Bq/m ³)	c
c			for each nuclide. Value of -1 means	c
c			that a nuclide in the 'RMDLIB' library	c
c			was not found in the Dose Factor librar	c
c	DOSINH(2,5,300)	Real*4	Inhalation dose factors (Sv/Bq).	c
c			First index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1=Lungs, 2=Bone Surf,	c
c			3=Red Marrow, 4=Thyroid,	c
c			5=Effective Dose Equivalent	c
c			3rd Index: nuclide	c
c	GRPNAM(5)	Chr*80	Title for a group of nuclides in the	c
c			Radionuclide Master Data Library	c
c	NUCGRP(300)	Integer	Group ID# for this nuclide	c
c	NUMGRP(5)	Integer	Number of nuclides in this group	c
c	Q0(300)	Real*4	Curies of this nuclide released	c
c	IFQMOD	Logical	Whether user has modified a set of q0	c

c			values from a source term file	c
c	Common	/doses/		c
c	BRATE	Real*4	Breathing rate, (l/min)	c
c	EXTDOS(20)	Real*4	External dose, semi-infinite	c
c			cloud submersion (mrem)	c
c			index: 1 to number downwind ranges	c
c	DOSLUNG(2,20)	Real*4	Inhalation dose to lung (mrem)	c
c			1st index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1 to number downwind ranges	c
c	DOSBONE(2,20)	Real*4	Inhalation dose to bone (mrem)	c
c			1st index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1 to number downwind ranges	c
c	DOSTHY(2,20)	Real*4	Inhalation dose to thyroid (mrem)	c
c			1st index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1 to number downwind ranges	c
c	DOSEDE(2,20)	Real*4	Effective dose equivalent (mrem)	c
c			inhalation (mrem)	c
c			1st index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1 to number downwind ranges	c
c	WHICHBONE	Chr*8	contains name of the bone part	c
c			(red marrow or bone surface)	c
c			with higher dose	c
c				c
c	MODULE CALLED FROM:			c
c	MAIN			c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	None			c
c	Values Returned as ARGUMENTS:			c
c	None			c
c	Values Returned in COMMONS:			c
c	Name	Via		c
c	extdos	/Doses/		c
c	doslung	/Doses/		c

c	dosthy	/Doses/	c
c	dosedc	/Doses/	c
c			c
c	SUBORDINATE ROUTINES CALLED:		c
c	decay		c
c			c
c	MODULE ALGORITHM:		c
c	For each range, this routine will loop through each of		c
c	the radionuclids that are in master library RDMLIB.		c
c	First calculate radioactive decay and buildup.		c
c	Then calculate the submersion, and inhalation doses.		c
c	Loop through (1yr & 50 yr) dose commitment times		c
c	for each calculation. The inhalation bone dose		c
c	is the maximum of the bone surface and		c
c	red marrow doses. Convert submersion dose into mrem/s per		c
c	curie, the inhalation into mrem. Sum the doses in the lungs,		c
c	bone surface, red marrow, thyroid, and the effective dose		c
c	equivalents as the calculations are made. After all		c
c	summations are complete, mark whether the		c
c	total bone surface or red marrow was the highest to		c
c	determine which bone dose to report.		c
c			c
c	ERROR HANDLING:		c
c	None		c

```

C=====C
C
C  MODULE NAME:
C    DECAY
C
C  ABSTRACT:
C    Calculates radiocative decay and buildin
C    for a given decay time
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C
C  CREATION DATE:
C    May 13, 1988
C
C  I/O:
C    Input through variables in arguments and commons
C    Output through variables in arguments
C
C  CONSTANTS:
C    None
C
C  LOCAL VARIABLES:
C
C    Name          Type          Description
C    QNUC(300)     Real*4        Curies released - temp. updatable array
C                                Adjusted for decay (curies)
C                                Index: (1 to 300) for each radionuclide
C    DKTIME        Real*4        Transit time for rad decay (days)
C    ICH           Integer       Index: decay chain member
C    IN            Integer       Index: nuclide member
C    JN            Integer       Index: nuclide position in chain

```

c	INUC	Integer	Index: nuclide numb in 'RDMLIB' library	c
c	AO(9)	Real*4	Original number of nuclides	c
c			Index: decay chain number	c
c	AOUT(9)	Real*4	Number of nuclides after decay	c
c			Index: decay chain number	c
c	QTCHN	Real*4	Total Curies released in chain	c
c				c
c	DATA STRUCTURES:			c
c	Common /nuclide/			c
c	NNUC:	Integer	Number of radionuclides in the master	c
c			library 'RDMLIB', 1 <= NUC => 300	c
c	NCH	Integer	Number of decay chains in the master	c
c			library 'RDMLIB', 1 <= NCH => 200.	c
c	NOFNUC(200)	Integer	Number of radionuclides in each	c
c			decay chain. 1 <= NOFNUC(I) => 9.	c
c			When NOFNUC(I) = 1, No daughters.	c
c	NCHST(200)	Integer	Location in the master radionuclide	c
c			list of the 1st member of each chain.	c
c			1 <= NCHST(I) => 300.	c
c	IFR(2,300)	Integer	IFR(1,I) gives the chain member that	c
c			is the 1st precursor to radionuclide I.	c
c			IFR(2,I) is location of 2nd precursor.	c
c			IFR(1,I) < IFR(2,I) < IMEM(I)	c
c	DKF(2,300)	Real*4	Fraction of 1st and 2nd precursor	c
c			that decays to this radionuclide.	c
c	AL(300)	Real*4	Radiological decay constant for each	c
c			radionuclide day ** -1.	c
c	NCHN(300)	Integer	Chain number for each radionuclide.	c
c	NUCNAM(300)	Chr*8	8-character nuclide identifier:	c
c			First 2 Chars: Element name for each	c
c			radionuclide in the Master	c
c			Radionuclide Data library.	c
c			Chars. 3-8: Atomic weight symbol for	c
c			each radionuclide in the Master	c
c			Radionuclide Data library.	c

```

c          Isomeric states are indicated by the      c
c          letter 'M' after the atomic weight.      c
c          Daughter contributions are indicated by c
c          '+D' after the atomic weight            c
c          and 'M' if present.                      c
c      RMDTITL      Chr*80      80-character title of Radionuclide c
c                               Master Data Library.      c
c      HTITLE       Chr*80      80-character title of HUDU      c
c                               Dose Factor Library.      c
c      EXTDF(300)   Real*4      External dose factor (Sv/yr per Bq/m^3) c
c                               for each nuclide. Value of -1 means c
c                               that a nuclide in the 'RMDLIB' library c
c                               was not found in the Dose Factor librar c
c      DOSINH(2,5,300Real*4      Inhalation dose factors (Sv/Bq).      c
c                               First index: 1=1 yr 2=50 yr commitment c
c                               2nd index: 1=Lungs, 2=Bone Surf,      c
c                               3=Red Marrow, 4=Thyroid,      c
c                               5=Effective Dose Equivalent      c
c                               3rd Index: nuclide      c
c      GRPNAM(5)    Chr*80      Title for a group of nuclides in the c
c                               Radionuclide Master Data Library      c
c      NUCGRP(300)  Integer      Group ID# for this nuclide      c
c      NUMGRP(5)    Integer      Number of nuclides in this group      c
c      Q0(300)      Real*4      Curies of this nuclide released      c
c      IFQMOO       Logical      Whether user has modified a set of q0 c
c                               values from a source term file      c
c
c      MODULE CALLED FROM:      c
c      DOSECALC      c
c
c      PARAMETER PASSING:      c
c      Input Values:      c
c      dktime      c
c      Values Returned as ARGUMENTS:      c
c      qnuc      c

```


c		c
c	SUBORDINATE ROUTINES CALLED:	c
c	bchain	c
c		c
c	MODULE ALGORITHM:	c
c	Routine loops through each nuclide chain, testing to see if	c
c	there is any released activity at all in the chain. If not,	c
c	it goes to the next chain. If so, it sets up data for the	c
c	chain in a format usable by 'BCHAIN', then calls 'BCHAIN'.	c
c	Output from 'BCHAIN' is used to update the QNUC array.	c
c		c
c	ERROR HANDLING:	c
c	None	c

```

C=====C
C
C  MODULE NAME:
C    BCHAIN
C
C  ABSTRACT:
C    Routine calculates radioactive decay and buildin for
C    a given decay time for one decay chain.
C
C  AUTHOR:
C    R. A. Peloquin
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-3916
C    R. I. Scherpelz
C    509-375-2454
C
C  CREATION DATE:
C    May 13, 1988
C
C  I/O:
C    Input through variables in arguments
C    Output through variables in arguements
C
C  CONSTANTS:
C    None
C
C  LOCAL VARIABLES:
C
C    Name          Type          Description
C    INTGRL        Integer      Flag: 0 - find end value; >0: integrate
C    AO(9)         Real*4       number of nuclides decayed over T
C                                Index: Nuclide decay chain position
C    AM(9)         Real*4       Radioactive Decay constant (1/days)
C                                Index: Nuclide decay chain position

```

c	AMD(9)	Real*4	Radioactive Decay constant (1/days)	c
c			in double precision	c
c			Index: Nuclide decay chain position	c
c	AB(9)	Real*4	Original quantity of nuclide	c
c			Index: Nuclide decay chain position	c
c	AL(9)	Real*4	Radioactive Decay constant (1/days)	c
c			Index: Nuclide decay chain position	c
c	IFRM(2,9)	Integer	chain member that is the	c
c			1st precursor to radionuclide	c
c			Index #1: precursor number	c
c			Index #2: Nuclide decay chain position	c
c	DK(2,9)	Real*4	Production fraction (0 - 1.)	c
c			Index #1: precursor number	c
c			Index #2: Nuclide decay chain position	c
c	T_	Real*4	transit time for rad decay (days)	c
c	A(45)	Real*4	Intermediate nuclide term array	c
c			Index: (Nuc^2+Nuc)/2 (45 if Nuc=9)	c
c	ABD(9)	Real*4	Original quantity of nuclide	c
c			in double precision	c
c			Index: Nuclide decay chain position	c
c	I_	Integer	Index: precursor number	c
c	J_	Integer	Index: Nuclide decay chain position	c
c	L_	Integer	Index: M to chain position - 1	c
c	M_	Integer	Index: 1 to chain position - 1	c
c	NUC	Integer	Number of nuclides in chain	c
c	N2N	Integer	Upper limit based on nuclides in chain	c
c			(Nuc^2+Nuc)/2 (45 - Nuc=9), (15 - Nuc=5)	c
c	JJ	Integer	Starting intermediate term (J^2+1)/2	c
c	JK	Integer	Inter. term + chain offset position	c
c	IN	Integer	Index: 1 to Nuclide decay chain pos.	c
c	SUMPR	Real*4	Intermediate sum & product	c
c	ARG	Real*4	Intermediate variable for argument	c
c			of exponential	c
c	IT	Integer	Index: 2 to Precursor number	c
c	FX	Real*4	Intermediate product	c

c	IJK	Integer	Index: decay chain number	c	
c	IRAP	Integer	Index: 1 to chain position-1	c	
c	IMAX	Integer	Maximum chain position (<= 2)	c	
c	ASUM	Real*4	Intermediate sum	c	
c	TERM	Real*4	Intermediate term	c	
c	J1	Integer	Chain position - 1	c	
c	EXPO	Real*4	Intermediate value	c	
c				c	
c	MODULE CALLED FROM:			c	
c	DECAY			c	
c				c	
c	PARAMETER PASSING:			c	
c	Input Values:			c	
c	nuc	t	dk	ifrm	c
c	a1	ab	am	intgr1	c
c	Values Returned as ARGUMENTS:			c	
c	ao			c	
c				c	
c	SUBORDINATE ROUTINES CALLED:			c	
c	None			c	
c				c	
c	MODULE ALGORITHM:			c	
c	Routine solves the Bateman equations and returns the			c	
c	updated values of nuclide activity.			c	
c				c	
c	ERROR HANDLING:			c	
c	Checks for possible errors in calculating exponentials.			c	

```

C=====C
C
C      MODULE NAME:
C      OUTPUT
C
C      ABSTRACT:
C      This routine writes output to the screen and to a log file
C
C      AUTHOR:
C      R. I. Scherpelz
C      Pacific Northwest Laboratory
C      P.O. Box 999
C      Richland, WA 99352
C      509-375-2454
C      S. D. Miller
C      509-375-3843
C
C      CREATION DATE:
C      March 39, 1990
C
C      I/O:
C      Input through variables in arguments
C      Output through variables in arguments, screen, and log files
C
C      CONSTANTS:
C      Name          Type          Description
C      SKIPAGE       Chr*1         Skip page character
C      REM           Chr*53        Rem column headers for output
C      MREM          Chr*53        Mrem column headers for output
C
C      LOCAL VARIABLES:
C      Name          Type          Description
C      ETAMIN(20)    Chr*3         ETA expressed as "hr:min"(minutes part)
C      CDIST1         Chr*6         character output of distance (km)
C      CDIST2         Chr*6         character output of distance (miles)

```

c	CHBON1	Chr*7	character output of bone dose (rem)	c
c	CHBON2	Chr*7	character output of bone dose (rem)	c
c	CHORG	Chr*8	character output of organ with	c
c			biggest dose type	c
c	NMPRINT(300)	Chr*8	character output of nuclide identifier	c
c			(Element Name, Atomic Weight, ..)	c
c	CHEFFDOSE	Chr*14	Effective Dose Equivalent output (rem)	c
c	CHORGDOSE	Chr*14	Organ dose for selected distance (rem)	c
c	PRTFORM(5)	Chr*11	Exterior, Lung, bone, thyroid, ede	c
c			doses in an 11 character string (rem)	c
c	REMLINE	Chr*53	Rem/mrem headers used for this output	c
c	QPRINT(300)	Real*4	Curies of this nuclide released	c
c	RANGMILE(20)	Real*4	Downwind range to 2 sf's (miles)	c
c	RNGPRT(20)	Real*4	Downwind range to 2 sf's (km)	c
c	PRTDOS(5)	Real*4	Exterior, Lung, bone, thyroid, ede	c
c			dose outputs (rem)	c
c	SIGZ(20)	Real*4	Vertical diffusion coeff. (m)	c
c	SIGY(20)	Real*4	Horizontal diffusion coeff. (m)	c
c	RTEMP(20)	Real*4	External dose for that nuclide downwind	c
c			range (rem), temporary holding area	c
c	IHRETA(20)	Integer	Eta (hour) - rounded value	c
c	REMFLAG	Logical	flags if rem or mrem to be displayed	c
c	DEFLAG	Logical	flags if external dose exceeds	c
c			1 rem ede or 5 rem organ dose	c
c	DISTANCE	Real*4	Distance where the	c
c			maximum dose is exceeded (m)	c
c	NQNUC	Integer	Number of nuclides w/ > 0 Ci released	c
c	IR	Integer	Do-loop index	c
c	IN	Integer	Do-loop index	c
c	I_	Integer	Do-loop index	c
c	ID	Integer	Do-loop index	c
c	II	Integer	Do-loop index	c
c	IL	Integer	Do-loop index	c
c	MAXNUM	Integer	Flag for organ with highest dose equiv.	c
c	INUC	Integer	Which nuclide	c

c	EDEDOS	Real*4	Effective Dose Equivalent:	c
c			internal + external (mrem)	c
c	HRETA	Integer	Estimated time of plume arrival (hrs)	c
c	RMAX	Real*4	Temporary variable: Highest dose (rem)	c
c	BIGDOSE	Real*4	Highest dose among user-input	c
c			ranges (rem)	c
c	MINETA	Integer	ETA: Number of minutes	c
c			(remainder for hours)	c
c				c
c	DATA STRUCTURES:			c
c	Common /doses/			c
c	BRATE	Real*4	Breathing rate, (l/min)	c
c	EXTDOS(20)	Real*4	External dose, semi-infinite	c
c			cloud submersion (mrem)	c
c			index: 1 to number downwind ranges	c
c	DOSLUNG(2,20)	Real*4	Inhalation dose to lung (mrem)	c
c			1st index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1 to number downwind ranges	c
c	DOSBONE(2,20)	Real*4	Inhalation dose to bone (mrem)	c
c			1st index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1 to number downwind ranges	c
c	DOSTHY(2,20)	Real*4	Inhalation dose to thyroid (mrem)	c
c			1st index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1 to number downwind ranges	c
c	DOSEDE(2,20)	Real*4	Effective dose equivalent (mrem)	c
c			inhalation (mrem)	c
c			1st index: 1=1 yr 2=50 yr commitment	c
c			2nd index: 1 to number downwind ranges	c
c	WHICHBONE	Chr*8	contains name of the bone part	c
c			(red marrow or bone surface)	c
c			with higher dose	c
c	Common /general/			c
c	TITLE	Chr*78	Title message for display screen	c
c	INPLIN(25)	Chr*78	Input lines for main menu display	c
c	MONTH	Integer	Current month	c

c	IHOUR	Integer	Current hour	c
c	IFMAYGO	Logical	Flags if sufficient data has been	c
c			entered to perform the atmospheric	c
c			transport calculation	c
c	Common	/downwind/		c
c	NRANGE	Integer	Number of downwind ranges for dose	c
c			calculation (≤ 20)	c
c	RANGE(20)	Real*4	Downwind distance, meters	c
c	EQQ(20)	Real*4	Time-integrated relative air	c
c			concentration at each range (sec/m^3)	c
c	RGTITL(20)	Chr*25	Title for each downwind range	c
c	ETA(20)	Real*4	Estimated time of plume arrival;	c
c			actually the plume transit time to	c
c			each downwind range (sec)	c
c	Common	/meteo/		c
c	JSTAB	Integer	Stability class	c
c	WINDSPD	Real*4	Wind speed (m/sec)	c
c	LAYER	Integer	Mixing layer thickness (m)	c
c	AIRTEMP	Real*4	Air Temperature (C)	c
c	INDEXC	Integer	Cloudiness index	c
c	DEFSTAB	Logical	Flags default stability	c
c	DEFWSPD	Logical	Flags default wind speed	c
c	DEFLAYER	Logical	Flags default mixing layer thickness	c
c	DEFTEMP	Logical	Flags default effluent temperature	c
c	DEFHRMO	Logical	Flags default hour and month	c
c	STABNAM(7)	Chr*25	Names of the seven stability classes:	c
c			A: Extremely, B: Moderately Unstable,	c
c			C: Slightly Unstable, D: Neutral,	c
c			E: Slightly, F: Moderately Stable,	c
c			G: Extremely Stable	c
c	Common	/nuclide/		c
c	NNUC:	Integer	Number of radionuclides in the master	c
c			library 'RMDLIB', $1 \leq \text{NUC} \Rightarrow 300$	c
c	NCH	Integer	Number of decay chains in the master	c

c			library 'RMDLIB', 1 <= NCH => 200.	c
c	NOFNUC(200)	Integer	Number of radionuclides in each	c
c			decay chain. 1 <= NOFNUC(I) => 9.	c
c			When NOFNUC(I) = 1, No daughters.	c
c	NCHST(200)	Integer	Location in the master radionuclide	c
c			list of the 1st member of each chain.	c
c			1 <= NCHST(I) => 300.	c
c	IFR(2,300)	Integer	IFR(1,I) gives the chain member that	c
c			is the 1st precursor to radionuclide I.	c
c			IFR(2,I) is location of 2nd precursor.	c
c			IFR(1,I) < IFR(2,I) < IMEM(I)	c
c	DKF(2,300)	Real*4	Fraction of 1st and 2nd precursor	c
c			that decays to this radionuclide.	c
c	AL(300)	Real*4	Radiological decay constant for each	c
c			radionuclide day ** -1.	c
c	NCHN(300)	Integer	Chain number for each radionuclide.	c
c	NUCNAM(300)	Chr*8	8-character nuclide identifier:	c
c			First 2 Chars: Element name for each	c
c			radionuclide in the Master	c
c			Radionuclide Data library.	c
c			Chars. 3-8: Atomic weight symbol for	c
c			each radionuclide in the Master	c
c			Radionuclide Data library.	c
c			Isomeric states are indicated by the	c
c			letter 'M' after the atomic weight.	c
c			Daughter contributions are indicated by	c
c			'+D' after the atomic weight	c
c			and 'M' if present.	c
c	RMOTITL	Chr*80	80-character title of Radionuclide	c
c			Master Data Library.	c
c	HTITLE	Chr*80	80-character title of HUDU	c
c			Dose Factor Library.	c
c	EXTDF(300)	Real*4	External dose factor (Sv/yr per Bq/m ³)	c
c			for each nuclide. Value of -1 means	c
c			that a nuclide in the 'RMDLIB' library	c

```

c                                     was not found in the Dose Factor library c
c      DOSINH(2,5,300Real*4      Inhalation dose factors (Sv/Bq).      c
c                                     First index: 1=1 yr 2=50 yr commitment c
c                                     2nd index: 1=Lungs, 2=Bone Surf,      c
c                                     3=Red Marrow, 4=Thyroid,      c
c                                     5=Effective Dose Equivalent      c
c                                     3rd Index: nuclide      c
c      GRPNAM(5)      Chr*80      Title for a group of nuclides in the c
c                                     Radionuclide Master Data Library      c
c      NUCGRP(300)      Integer      Group ID# for this nuclide      c
c      NUMGRP(5)      Integer      Number of nuclides in this group      c
c      Q0(300)      Real*4      Curies of this nuclide released      c
c      IFQMOD      Logical      Whether user has modified a set of q0 c
c                                     values from a source term file      c
c                                     c
c      MODULE CALLED FROM:      c
c      MAIN      c
c      c
c      PARAMETER PASSING:      c
c      Input Values:      c
c      None      c
c      Values Returned as ARGUMENTS:      c
c      None      c
c      c
c      SUBORDINATE ROUTINES CALLED:      c
c      intrp      curloc      scout1      scout2      c
c      sigma      chardos      form_      sigfig      c
c      c
c      c
c      MODULE ALGORITHM:      c
c      Convert ranges and etas, calculate sigma for each nuclide      c
c      downwind range write main menu screen to log file write dose      c
c      results to CRT - first screen user-selected functions first      c
c      screen goes to HUDU log find biggest dose -- lung, bone,      c
c      thyroid, or external for nuclide ranges > 13 print doses for      c

```

c	this distance check arrays to see if exceed 1 rem effective	c
c	dose equiv and 5 rem organ doses and report accordingly	c
c	summarize q0 (released Ci) values write results of	c
c	atmospheric dispersion calculations to log file print out	c
c	calculated doses scaled to selected rem/mrem downwind range	c
c	convert doses over 10,000 mrem to rem for output	c
c	if nrange = 12 print 1 and 5 rem messages	c
c		c
c	ERROR HANDLING:	c
c	None	c

```

C=====C
C
C      MODULE NAME:
C      INTRP
C
C      ABSTRACT:
C      Perform linear interpolation using array values X and Y
C      having the dimension NUMB. The function evaluates the
C      distance where dose of (ylim mrem) is exceeded.
C
C      AUTHOR:
C      S. D. Miller
C      Pacific Northwest Laboratory
C      P.O. Box 999
C      Richland, WA 99352
C      509-375-3843
C      R. I. Scherpelz
C      509-375-2454
C
C      CREATION DATE:
C      August 18, 1989
C
C      I/O:
C      Input through variables in arguments
C      Output through variables in arguments
C
C      LOCAL VARIABLES:
C      Name          Type          Description
C      X(25)         Real*4        Downwind distance of ranges processed (
C      Y(25)         Real*4        Dose for nuclide processed (mrem)
C      XX(25)        Real*4        Downwind distance of ranges processed (
C      YY(25)        Real*4        Dose for nuclides passed (mrem)
C      YMAX          Real*4        Maximum dose found (mrem)
C      YLIM          Real*4        Maximum dose allowed (mrem)
C      WEEBIT        Real*4        Correction based on calculating

```

c			the extrapolated distance	c	
c	B_	Real*4	Used in extrapolation calculations	c	
c	I_	Integer	index: 1 to Number ranges	c	
c	J_	Integer	index: Range found at IMAX to	c	
c			Number ranges-I	c	
c	XDIST	Real*4	Distance value used in the	c	
c			extrapolation calculation	c	
c	IR	Integer	Index: 1 to number of ranges	c	
c	JR	Integer	Index: 1 to number of ranges-I	c	
c	KR	Integer	Index: IR downto JR+1	c	
c	XM	Real*4	Used in extratoplation calculations	c	
c	IRM	Integer	Index: IR - I (previous range)	c	
c	DELTA	Real*4	Calculated extrapolation distance	c	
c	IMAX	Integer	Location of maximum dose	c	
c	NUMB	Integer	Number of ranges being processed	c	
c	DISTANCE	Real*4	Distance where the	c	
c			maximum dose is exceeded (m)	c	
c				c	
c	MODULE CALLED FROM:			c	
c	OUTPUT			c	
c				c	
c	PARAMETER PASSING:			c	
c	Input Values:			c	
c	numb	xx	yy	ylim	c
c	Values Returned as ARGUMENTS:			c	
c	distance			c	
c				c	
c	SUBORDINATE ROUTINES CALLED:			c	
c	None			c	
c				c	
c	MODULE ALGORITHM:			c	
c	Line up the arrays in order. For ranges beyond the 12th,			c	
c	fit into the others. Put the largest ranges in beyond			c	
c	the 12th. Find the maximum dose equiv value > ylim.			c	
c	Solve for distance and add a wee bit to extrapolate.			c	

c Leave if no ymax > ylim.

c

c ERROR HANDLING:

c None

c

c

c

c

```

/*****/
/* */
/*  MODULE NAME: */
/*    SCOUT1 */
/* */
/*  ABSTRACT: */
/*    Pretties up first output screen and accept any keystroke */
/* */
/*  AUTHOR: */
/*    R. I. Scherpelz */
/*    Pacific Northwest Laboratory */
/*    P.O. Box 999 */
/*    Richland, WA 99352 */
/*    509-375-2454 */
/*    S. D. Miller */
/*    509-375-3843 */
/* */
/*  CREATION DATE: */
/*    February 9, 1989 */
/* */
/*  I/O: */
/*    Input key struck by operator */
/*    Output through CRT screen */
/* */
/*  CONSTANTS: */
/*    None. */
/* */
/*  LOCAL VARIABLES: */
/*    Name          Type          Description */
/*    KEY           Integer      ASCII code returned by keystroke */
/*    IKEY          Integer      Scan code returned by keystroke */
/* */
/*  MODULE CALLED FROM: */
/*    OUTPUT */
/* */

```

```

/*  PARAMETER PASSING:                                */
/*    Input Values:                                    */
/*    None                                             */
/*  Values Returned:                                    */
/*    None                                             */
/*                                                     */
/*  SUBORDINATE ROUTINES CALLED:                        */
/*    None                                             */
/*                                                     */
/*  MODULE ALGORITHM:                                  */
/*    Pretty up screen as follows: light green heading, light blue */
/*    location descriptions, light cyan distances in miles, yellow */
/*    ETA column, light magenta effective dose equivalent column, */
/*    red limiting organ dose, green on black 1 and 5 Rem messages, */
/*    and red instructions on bottom. Finally accept any keystroke. */
/*                                                     */
/*  ERROR HANDLING:                                    */
/*    None                                             */
/*                                                     */
/*  ESI C Utilities routines called:                  */
/*    colrcprt  curlocat  getkey  paint                */

```



```

/*****/
/* */
/*  MODULE NAME: */
/*    SCOUT2 */
/* */
/*  ABSTRACT: */
/*    Pretties up second output screen and accept any keystroke */
/* */
/*  AUTHOR: */
/*    R. I. Scherpelz */
/*    Pacific Northwest Laboratory */
/*    P.O. Box 999 */
/*    Richland, WA 99352 */
/*    509-375-2454 */
/*    S. D. Miller */
/*    509-375-3843 */
/* */
/*  CREATION DATE: */
/*    November 16, 1988 */
/* */
/*  I/O: */
/*    Input key struck by operator and through arguments */
/*    Output through CRT screen */
/* */
/*  CONSTANTS: */
/*    None. */
/* */
/*  LOCAL VARIABLES: */
/*    Name          Type          Description */
/*    KEY           Integer      ASCII code returned by keystroke */
/*    IKEY          Integer      Scan code returned by keystroke */
/*    NRRANGE       Integer      Number of downwind ranges for dose */
/*                                calculation (<= 20) */
/* */
/*  MODULE CALLED FROM: */

```

```

/*      OUTPUT                                          */
/*                                                    */
/*      PARAMETER PASSING:                            */
/*      Input Values:                                */
/*      nrange                                         */
/*      Values Returned:                             */
/*      None                                           */
/*                                                    */
/*      SUBORDINATE ROUTINES CALLED:                  */
/*      None                                           */
/*                                                    */
/*      MODULE ALGORITHM:                             */
/*      Pretty up sreen as follows: light green 'EXTERNAL' heading, */
/*      light magenta 'INHALATION' column, light cyan distances, */
/*      yellow ETA column. If no user ranges are entered, */
/*      nrange > 12 then green on black 1 and 5 Rem messages appear, */
/*      and red instructions on bottom. Finally accept any keystroke.*/
/*                                                    */
/*      ERROR HANDLING:                               */
/*      None                                           */
/*                                                    */
/*      ESI C Utilities routines called:              */
/*      colrcprt  curlocat  getkey  paint             */

```

```

=====C
C
C      MODULE NAME:
C      CHARDOS
C
C      ABSTRACT:
C      Converts dose value, in mrem, to a 14 char string, w/ units
C
C      AUTHOR:
C      R. I. Scherpelz
C      Pacific Northwest Laboratory
C      P.O. Box 999
C      Richland, WA 99352
C      509-375-2454
C
C      CREATION DATE:
C      February 13, 1990
C
C      I/O:
C      Input through variables in arguments
C      Output through variables in arguments
C
C      CONSTANTS:
C      None
C
C      LOCAL VARIABLES:
C      Name          Type          Description
C      CHFORM        Chr*11        Input dose - 11 char. format (mrem)
C      DOSIN          Real*4        Input dose (mrem)
C      CHDOS          Chr*14        Converted input dose including units
C                                in string format (rem/mrem)
C      IFREM          Logical       Flags if rem or mrem output
C      S2DOS          Real*4        Input dose to 2 sf's (rem/mrem)
C
C      MODULE CALLED FROM:

```

c	OUTPUT	c
c		c
c	PARAMETER PASSING:	c
c	Input Values:	c
c	dosin	c
c	Values Returned as ARGUMENTS:	c
c	chdos	c
c		c
c	SUBORDINATE ROUTINES CALLED:	c
c	form_ sigfig	c
c		c
c	ABSTRACT:	c
c	Convert the dose to 2 significant figures. If the dose	c
c	is larger than a rem, then convert to rem and use its units	c
c	Locate the REM units based on the size of the value.	c
c		c
c	ERROR HANDLING:	c
c	None	c

```

C=====C
C
C  MODULE NAME:
C    FORM_
C
C  ABSTRACT:
C    Converts a dose value, in rem or mrem, to an 11-char. string
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C    S. D. Miller
C    509-375-3843
C
C  CREATION DATE:
C    February 10, 1989
C
C  I/O:
C    Input through variables in arguments
C    Output through variables in arguments
C
C  CONSTANTS:
C
C    Name          Type          Description
C    COMMA         Chr*1        Comma ',' character
C    PERIOD        Chr*1        Period '.' character
C    RNUM          Real*4        Input dose value (rem/mrem)
C
C  LOCAL VARIABLES:
C
C    Name          Type          Description
C    CRNUM         Real*4        Rounded value of dose value to
C                                significant figures (rem)
C    FLAG          Logical       Flags that dose value is processed

```

c	REMFLAG	Logical	Flags units of dose value (rem/mrem)	c
c	PRTFORM	Chr*11	Dose value in 11 character format	c
c				c
c	MODULE CALLED FROM:			c
c	OUTPUT	CHARDOS		c
c				c
c	PARAMETER PASSING:			c
c	Input Values:			c
c	rnum	remflag		c
c	Values Returned as ARGUMENTS:			c
c	prtform			c
c	Values Returned in COMMONS:			c
c	None			c
c				c
c	SUBORDINATE ROUTINES CALLED:			c
c	sigfig			c
c				c
c	MODULE ALGORITHM:			c
c	Figures out the best format to put out the dose value			c
c	and puts it in an 11 character string.			c
c				c
c	ERROR HANDLING:			c
c	None			c

```

C=====C
C
C  MODULE NAME:
C    SIGFIG
C
C  ABSTRACT:
C    Converts a real number to a new number with the
C    desired number of significant figures (sf's)
C
C  AUTHOR:
C    R. I. Scherpelz
C    Pacific Northwest Laboratory
C    P.O. Box 999
C    Richland, WA 99352
C    509-375-2454
C
C  CREATION DATE:
C    February 22, 1990
C
C  I/O:
C    Input through variables in arguments
C    Output through variables in arguments
C
C  CONSTANTS:
C
C    Name          Type          Description
C    NFIG          Integer       Number of desired significant figures
C    XIN           Real*4        Original real number
C
C  LOCAL VARIABLES:
C
C    Name          Type          Description
C    XOUT          Real*4        Input number converted to have
C                                NFIG significant figures (sf's).
C    IARG          Integer       Input number mult. by 10 ^NFIG power
C    MFIG          Integer       One less than the number passed
C    IFNEG         Logical       Flags if input number is negative

```

c	IXP	Integer	Log base 10 of input number	c
c			(power of 10) (One less if negative)	c
c	TENFIG	Real*4	Ten to the NFIG-1 power	c
c				c
c	SUBORDINATE ROUTINES CALLED:			c
c	None			c
c				c
c	MODULE ALGORITHM:			c
c	Analyze input number. Return 0 if it is 0; use its			c
c	absolute value if it is < 0. Round off the new number			c
c	multiplied by ten to the number of significant digits			c
c	power and make it into an integer. Recalculate the			c
c	original number with the significant digits, put the			c
c	sign back if the number was negative.			c
c				c
c	ERROR HANDLING:			c
c	Absolute value used to avoid processing negative numbers.			c
c				

^Z

APPENDIX B

DATA LIBRARY LISTINGS

APPENDIX B. DATA LIBRARY LISTINGS

HUOU reads a single library data file, HUDATA.DAT. This file is an unformatted Fortran file, so it cannot be read by simple text editors. HUDATA.OAT incorporates the data from three ASCII files: HRMDLIB.DAT, HUOUFACT.DAT, and FACILITY.OAT. Listings of these three files are presented in this appendix.

HRMDLIB.OAT:

HRMDLIB - Radionuclide Master Library (4-Dec-87 RAP) Modif. for HUDU 4/28/88

Group: Light Elements & Activation Products

H 3	4.49E+3	1	0	0.0000	0	0.0000	1	NO
BE10	5.84E+8	1	0	0.0000	0	0.0000	4	VY
C 14	2.09E+6	1	0	0.0000	0	0.0000	6	ND
N 13	6.92E-3	1	0	0.0000	0	0.0000	7	NO
F 18	7.62E-2	1	0	0.0000	0	0.0000	9	SD
NA22	9.50E+2	1	0	0.0000	0	0.0000	11	VO
NA24	6.25E-1	1	0	0.0000	0	0.0000	11	VD
P 32	1.43E+1	1	0	0.0000	0	0.0000	15	SO
P 33	2.54E+1	1	0	0.0000	0	0.0000	15	VD
S 35	8.74E+1	1	0	0.0000	0	0.0000	16	NW
CL36	1.1E+8	1	0	0.0000	0	0.0000	17	ND
K 40	4.67E11	1	0	0.0000	0	0.0000	19	NO
AR39	9.83E+4	1	0	0.0000	0	0.0000	18	ND
AR41	7.61E-2	1	0	0.0000	0	0.0000	18	NO
CA41	3.67E+7	1	0	0.0000	0	0.0000	20	1 VW
CA45	1.63E+2	1	0	0.0000	0	0.0000	20	1 VW
SC46	8.38E+1	1	0	0.0000	0	0.0000	21	VY
CR51	2.77E+1	1	0	0.0000	0	0.0000	24	VY
MN54	3.13E+2	1	0	0.0000	0	0.0000	25	SW
MN56	1.07E-1	1	0	0.0000	0	0.0000	25	SW
FE55	9.86E+2	1	0	0.0000	0	0.0000	26	NW
FE59	4.46E+1	1	0	0.0000	0	0.0000	26	NW
CO57	2.71E+2	1	0	0.0000	0	0.0000	27	NY

C058	7.08E+1	1	0	0.0000	0	0.0000	27		NY
C060	1.92E+3	1	0	0.0000	0	0.0000	27	T	NY
NI59	2.74E+7	1	0	0.0000	0	0.0000	28		NW
NI63	3.65E+4	1	0	0.0000	0	0.0000	28		NW
NI65	1.05E-1	1	0	0.0000	0	0.0000	28		NW
CU64	5.29E-1	1	0	0.0000	0	0.0000	29		ND
ZN65	2.44E+2	1	0	0.0000	0	0.0000	30	T	VY
ZN69M	5.73E-1	1	0	0.0000	0	0.0000	30		SY
ZN69	3.86E-2	2	1	1.0000	0	0.0000	30		SY
AS76	1.10E+0	1	0	0.0000	0	0.0000	33		NW
SE75	1.2E+2	1	0	0.0000	0	0.0000	34		NW
SE79	2.37E+7	1	0	0.0000	0	0.0000	34		NW
Group: Fission Products (mostly)									
BR82	1.47E+0	1	0	0.0000	0	0.0000	35		ND
BR83	9.96E-2	1	0	0.0000	0	0.0000	35		ND
KR83M	7.63E-2	2	1	1.0000	0	0.0000	36		ND
BR84	2.21E-2	1	0	0.0000	0	0.0000	35		ND
KR85M	1.87E-1	1	0	0.0000	0	0.0000	36		ND
KR85	3.91E+3	2	1	0.2110	0	0.0000	36		ND
KR87	5.30E-2	1	0	0.0000	0	0.0000	36		ND
RB87	1.73E13	2	1	1.0000	0	0.0000	37		VD
KR88	1.18E-1	1	0	0.0000	0	0.0000	36		ND
RB88	1.24E-2	2	1	1.0000	0	0.0000	37		VD
KR89	2.20E-3	1	0	0.0000	0	0.0000	36		ND
RB89	1.07E-2	2	1	1.0000	0	0.0000	37		VD
SR89	5.06E+1	3	2	1.0000	0	0.0000	38	1	VD
RB86	1.87E+1	1	0	0.0000	0	0.0000	37		VD
SR85	6.5E+1	1	0	0.0000	0	0.0000	38	1	VD
SR90	1.04E+4	1	0	0.0000	0	0.0000	38	T 1	VD
Y 90	2.67E+0	2	1	1.0000	0	0.0000	39	T	SY
SR91	3.96E-1	1	0	0.0000	0	0.0000	38	1	SD
Y 91M	3.45E-2	2	1	0.5740	0	0.0000	39		SY
Y 91	5.85E+1	3	2	1.0000	1	0.4260	39		SY
SR92	1.13E-1	1	0	0.0000	0	0.0000	38	1	SD
Y 92	1.48E-1	2	1	1.0000	0	0.0000	39		SY

Y 93	4.21E-1	1	0	0.0000	0	0.0000	39	SY
M093	1.28E+6	2	0	0.0000	0	0.0000	42	SD
ZR93	5.58E+8	3	1	1.0000	0	0.0000	40	SW
NB93M	5.33E+3	4	3	1.0000	2	1.0000	41	VY
ZR95	6.40E+1	1	0	0.0000	0	0.0000	40	SW
NB95M	3.61E+0	2	1	0.0080	0	0.0000	41	SY
NB95	3.51E+1	3	2	0.9450	1	0.9922	41	SY
ZR97	7.04E-1	1	0	0.0000	0	0.0000	40	SW
NB97M	6.94E-4	2	1	0.9470	0	0.0000	41	SY
NB97	5.01E-2	3	2	1.0000	1	0.0530	41	SY
NB94	7.41E+6	1	0	0.0000	0	0.0000	41	VY
M099	2.75E+0	1	0	0.0000	0	0.0000	42	SD
TC99M	2.51E-1	2	1	0.8860	0	0.0000	43	NW
TC99	7.77E+7	3	2	1.0000	1	0.1140	43 T	NW
TC101	9.86E-3	1	0	0.0000	0	0.0000	43	NW
RU103	3.94E+1	1	0	0.0000	0	0.0000	44	NY
PD103	1.70E+1	2	0	0.0000	0	0.0000	46	VY
RH103M	3.90E-2	3	1	0.9974	2	0.9997	45	NY
RU105	1.85E-1	1	0	0.0000	0	0.0000	44	NY 1 RH105M 1.000
RH105	1.47E+0	2	1	1.0000	0	0.0000	45	NY
RU106	3.68E+2	1	0	0.0000	0	0.0000	44 T	NY 1 RH106 1.000
PD107	2.37E+9	1	0	0.0000	0	0.0000	46	VY
PD109	5.61E-1	1	0	0.0000	0	0.0000	46	VY 1 AG109M 1.000
AG110M	2.50E+2	1	0	0.0000	0	0.0000	47	ND 1 AG110 0.985
AG111	7.46E+0	1	0	0.0000	0	0.0000	47	ND
CD109	4.64E+2	1	0	0.0000	0	0.0000	48	ND
CD113M	5.00E+3	1	0	0.0000	0	0.0000	48	ND
CD115M	4.46E+1	1	0	0.0000	0	0.0000	48	ND
CD115	2.23E+0	2	0	0.0000	0	0.0000	48	ND
IN115M	1.82E-1	3	2	1.0000	0	0.0000	49	VD
IN111	2.8E+0	1	0	0.0000	0	0.0000	49	VD
IN114M	5.00E+1	1	0	0.0000	0	0.0000	49	VD 1 IN114 0.957
SN117M	1.40E+1	1	0	0.0000	0	0.0000	50	SW
SN119M	2.93E+2	1	0	0.0000	0	0.0000	50	VW
SN121M	2.01E+4	1	0	0.0000	0	0.0000	50	VW

SN121	1.13E+0	2	1	0.776	0	0.0000	50	VW
SN123	1.29E+2	1	0	0.0000	0	0.0000	50	VW
I 125	6.01E+1	1	0	0.0000	0	0.0000	53	2 ND
SN125	9.64E+0	1	0	0.0000	0	0.0000	50	SW
SB125	1.01E+3	2	1	1.0000	0	0.0000	51	SW
TE125M	5.80E+1	3	2	0.2310	0	0.0000	52	SW
SN126	3.65E+7	1	0	0.0000	0	0.0000	50	VW
SB126M	1.32E-2	2	1	1.0000	0	0.0000	51	SW
SB126	1.24E+1	3	2	0.1400	0	0.0000	51	SW
SB124	6.02E+1	1	0	0.0000	0	0.0000	51	SW
SB127	3.85E+0	1	0	0.0000	0	0.0000	51	SW
TE127M	1.09E+2	2	1	0.1690	0	0.0000	52	SW
TE127	3.90E-1	3	2	0.9820	1	0.8310	52	SW
TE123M	1.20E+2	1	0	0.0000	0	0.0000	52	SW
TE129M	3.36E+1	1	0	0.0000	0	0.0000	52	SW
TE129	4.83E-2	2	1	0.6290	0	0.0000	52	SW
I 129	5.73E+9	3	2	1.0000	1	0.3710	53	T 2 ND
TE131M	1.25E+0	1	0	0.0000	0	0.0000	52	SW
TE131	1.74E-2	2	1	0.2220	0	0.0000	52	T SW
I 131	8.04E+0	3	2	1.0000	1	0.7780	53	T 2 NO
XE131M	1.18E+1	4	3	0.0109	0	0.0000	54	ND
TE132	3.26E+0	1	0	0.0000	0	0.0000	52	SW
I 132	9.58E-2	2	1	1.0000	0	0.0000	53	2 ND
TE133M	3.85E-2	1	0	0.0000	0	0.0000	52	SW
TE133	8.65E-3	2	1	0.1300	0	0.0000	52	SW
I 133	8.67E-1	3	2	1.0000	1	0.8700	53	2 NO
XE133M	2.19E+0	4	3	0.0288	0	0.0000	54	NO
XE133	5.25E+0	5	4	1.0000	3	0.9712	54	NO
TE134	2.90E-2	1	0	0.0000	0	0.0000	52	SW
I 134	3.65E-2	2	1	1.0000	0	0.0000	53	2 ND
CS134M	1.21E-1	1	0	0.0000	0	0.0000	55	ND
CS134	7.53E+2	1	1	1.0000	0	0.0000	55	ND
I 130	5.15E-1	1	0	0.0000	0	0.0000	53	2 ND
I 135	2.75E-1	1	0	0.0000	0	0.0000	53	2 ND
XE135M	1.07E-2	2	1	0.1650	0	0.0000	54	ND

XE135	3.80E-1	3	2	1.0000	1	0.8350	54	ND
CS135	8.40E+8	4	3	1.0000	0	0.0000	55	ND
XE137	2.66E-3	1	0	0.0000	0	0.0000	54	ND
CS137	1.10E+4	2	1	1.0000	0	0.0000	55 T	ND 1 BA137M 0.946
XE138	9.81E-3	1	0	0.0000	0	0.0000	54	ND
CS138	2.24E-2	2	1	1.0000	0	0.0000	55	ND
CS139	6.53E-3	1	0	0.0000	0	0.0000	55	ND
BA139	5.77E-2	2	1	1.0000	0	0.0000	56	1 SD
BA140	1.28E+1	1	0	0.0000	0	0.0000	56 T 1	SD
LA140	1.68E+0	2	1	1.0000	0	0.0000	57 T	SD
CS136	1.32E+1	1	0	0.0000	0	0.0000	55	ND
BA141	1.27E-2	1	0	0.0000	0	0.0000	56	1 SD
LA141	1.64E-1	2	1	1.0000	0	0.0000	57	SD
CE141	3.25E+1	3	2	1.0000	0	0.0000	58	SY
BA142	7.43E-3	1	0	0.0000	0	0.0000	56	1 SD
LA142	6.63E-2	2	1	1.0000	0	0.0000	57	SD
CE143	1.38E+0	1	0	0.0000	0	0.0000	58	SY
PR143	1.36E+1	2	1	1.0000	0	0.0000	59	SY
CE144	2.84E+2	1	0	0.0000	0	0.0000	58 T	SY
PR144M	5.00E-3	2	1	0.0143	0	0.0000	59	SY
PR144	1.20E-2	3	2	1.0000	1	0.9857	59 T	SY
Group: Heavy Elements & Actinides								
ND147	1.10E+1	1	0	0.0000	0	0.0000	60	SY
PM147	9.58E+2	2	1	1.0000	0	0.0000	61	SY
SM147	3.87E13	3	2	1.0000	0	0.0000	62	SW
PM148M	4.13E+1	1	0	0.0000	0	0.0000	61	SY
PM148	5.37E+0	2	1	0.0420	0	0.0000	61	SY
PM149	2.21E+0	1	0	0.0000	0	0.0000	61	SY
PM151	1.18E+0	1	0	0.0000	0	0.0000	61	SY
SM151	3.29E+4	2	1	1.0000	0	0.0000	62	SW
SM153	1.95E+0	1	0	0.0000	0	0.0000	62	SW
EU152	4.96E+3	1	0	0.0000	0	0.0000	63	SW
EU154	3.21E+3	1	0	0.0000	0	0.0000	63	SW
EU155	1.81E+3	1	0	0.0000	0	0.0000	63	SW
EU156	1.52E+1	1	0	0.0000	0	0.0000	63	SW

GD153	2.42E+2	1	0	0.0000	0	0.0000	64	SD
TB160	7.23E+1	1	0	0.0000	0	0.0000	65	SW
H0166M	4.38E+5	1	0	0.0000	0	0.0000	67	SW
W 181	1.21E+2	1	0	0.0000	0	0.0000	74	VD
W 185	7.51E+1	1	0	0.0000	0	0.0000	74	VD
W 187	9.93E-1	1	0	0.0000	0	0.0000	74	SD
RE187	1.72E13	2	1	1.0000	0	0.0000	75	NW
OS185	9.36E+1	1	0	0.0000	0	0.0000	76	ND
OS191	1.5E+1	1	0	0.0000	0	0.0000	76	NO
IR192	7.40E+1	1	0	0.0000	0	0.0000	77	NY
HG203	4.66E+1	1	0	0.0000	0	0.0000	80	ND
TH230	2.81E+7	1	0	0.0000	0	0.0000	90	SY
RA226	5.84E+5	2	1	1.0000	0	0.0000	88 T 1	VW
RN222	3.82E+0	3	2	1.0000	0	0.0000	86 T	NO 4 P0218 1.000 PB214
1.000 BI214	1.000 P0214	1.000						
PB210	8.12E+3	4	3	1.0000	0	0.0000	82 T	VO
BI210	5.01E+0	5	4	1.0000	0	0.0000	83 T	NW
P0210	1.38E+2	6	5	1.0000	0	0.0000	84 T	NW
U 232	2.36E+4	1	0	0.0000	0	0.0000	92	VY
TH232	5.13E12	2	0	0.0000	0	0.0000	90	SY
RA228	2.10E+3	3	2	1.0000	0	0.0000	88 1	VW
AC228	2.55E-1	4	3	1.0000	0	0.0000	89	SY
TH228	6.98E+2	5	4	1.0000	1	1.0000	90	SY
RA224	3.62E+0	6	5	1.0000	0	0.0000	88 1	SW 2 RN220 1.000 P0216
1.000								
PB212	4.43E-1	7	6	1.0000	0	0.0000	82	SO
BI212	4.20E-2	8	7	1.0000	0	0.0000	83	NW 2 P0212 .6407 TL208
.3593								
U 234	8.29E+7	1	0	0.0000	0	0.0000	92	VY
U 236	8.55E+9	1	0	0.0000	0	0.0000	92	VY
U 235	2.57E11	1	0	0.0000	0	0.0000	92	VY
TH231	1.06E+0	2	1	1.0000	0	0.0000	90	SY
PA231	1.36E+7	3	2	1.0000	0	0.0000	91	SY
AC227	7.95E+3	4	3	1.0000	0	0.0000	89	SY
TH227	1.87E+1	5	4	0.9862	0	0.0000	90	SY

FR223	1.51E-2	6	4	0.0138	0	0.0000	87	ND	
RA223	1.14E+1	7	5	1.0000	6	1.0000	88	1 SW 5 RN219	1.000 P0215
1.000 PB211	1.000 BI211			1.000 TL207			1.000		
U 237	6.75E+0	1	0	0.0000	0	0.0000	92	SY	
NP237	7.81E+8	2	1	1.0000	0	0.0000	93	SW	
PA233	2.70E+1	3	2	1.0000	0	0.0000	91	SY	
U 233	5.58E+7	4	3	1.0000	0	0.0000	92	VY	
TH229	2.68E+6	5	4	1.0000	0	0.0000	90	SY	
RA225	1.48E+1	6	5	1.0000	0	0.0000	88	1 SW	
AC225	1.00E+1	7	6	1.0000	0	0.0000	89	SY 6 FR221	1.000 AT217
1.000 BI213	1.000 P0213			.9784 TL209			.0216 PB209	1.000	
U 238	1.63E12	1	0	0.0000	0	0.0000	92	VY	
TH234	2.41E+1	2	1	1.0000	0	0.0000	90	SY 1 PA234M	0.998
PA234	2.79E-1	3	2	0.0016	0	0.0000	91	SY	
PU236	1.04E+3	1	0	0.0000	0	0.0000	94	SY	
PU237	4.53E+1	1	0	0.0000	0	0.0000	94	SY	
AM242M	5.55E+4	1	0	0.0000	0	0.0000	95	SW	
AM242	6.68E-1	2	1	1.0000	0	0.0000	95	SW	
CM242	1.63E+2	3	2	0.8270	0	0.0000	96	SW	
PU242	1.37E+8	4	2	0.1730	0	0.0000	94	SY	
NP238	2.12E+0	5	0	0.0000	0	0.0000	93	SW	
PU238	3.20E+4	6	5	1.0000	3	1.0000	94	SY	
CM244	6.61E+3	1	0	0.0000	0	0.0000	96	SW	
PU244	3.01E10	2	0	0.0000	0	0.0000	94	SY	
U 240	5.88E-1	3	2	0.9988	0	0.0000	92	SY 1 NP240M	1.000
PU240	2.40E+6	4	3	1.0000	1	1.0000	94	SY	
CM245	3.10E+6	1	0	0.0000	0	0.0000	96	SW	
PU241	5.26E+3	2	1	1.0000	0	0.0000	94	SY	
AM241	1.58E+5	3	2	1.0000	0	0.0000	95	T SW	
CM246	1.73E+6	1	0	0.0000	0	0.0000	96	SW	
CM247	5.69E+9	1	0	0.0000	0	0.0000	96	SW	
CM243	1.04E+4	2	0	0.0000	0	0.0000	96	SW	
PU243	1.92E-1	3	1	1.0000	0	0.0000	94	SY	
AM243	2.69E+6	4	3	1.0000	2	0.0024	95	SW	
NP239	2.36E+0	5	4	1.0000	0	0.0000	93	SW	

PU239	8.81E+6	6	5	1.0000	2	0.9976	94	T	SY
CM248	1.24E+8	1	0	0.0000	0	0.0000	96		SW
CF252	9.63E+2	1	0	0.0000	0	0.0000	98		SW
		0	0	0.0000	0	0.0000			

HUDUFACT.DAT:

Dose Equiv. Factors for Acute Inhalation and Ext Air Submersion RIS 9/4/90

		AIR SUBMERSION Sv/Yr per Bq/m3	Acute Inhal. Committed Dose Equivalent					EFF DOSE EQUIV. Sv/Bq
			LUNGS Sv/Bq	BONE SURFACE Sv/Bq	RED MARROW Sv/Bq	THYROID Sv/Bq		
H 3	Class: D	1.95E-16						
	1 Yr:		2.5E-11	1.3E-11	2.5E-11	2.5E-11		2.4E-11
	50 Yr:		2.5E-11	1.3E-11	2.5E-11	2.5E-11		2.4E-11
BE10	Class: Y	4.21E-10						
	1 Yr:		1.6E-07	6.4E-10	2.2E-10	1.0E-11		2.0E-08
	50 Yr:		7.7E-07	2.2E-08	6.7E-09	1.0E-11		9.5E-08
C 14	Class: D	1.41E-11						
	1 Yr:		5.8E-10	3.0E-10	5.8E-10	5.8E-10		5.6E-10
	50 Yr:		5.8E-10	3.0E-10	5.8E-10	5.8E-10		5.6E-10
F 18	Class: D	1.87E-06						
	1 Yr:		1.1E-10	2.4E-11	2.5E-11	4.1E-12		2.2E-11
	50 Yr:		1.1E-10	2.4E-11	2.5E-11	4.1E-12		2.2E-11
NA22	Class: D	3.89E-06						
	1 Yr:		2.4E-09	3.7E-09	3.1E-09	2.1E-09		2.5E-09
	50 Yr:		2.4E-09	4.0E-09	3.3E-09	2.1E-09		2.6E-09
NA24	Class: D	8.08E-06						
	1 Yr:		1.2E-09	2.8E-10	2.2E-10	1.6E-10		3.2E-10
	50 Yr:		1.2E-09	2.8E-10	2.2E-10	1.6E-10		3.2E-10
P 32	Class: D	6.32E-09						
	1 Yr:		2.0E-09	5.9E-09	6.2E-09	5.1E-10		1.6E-09
	50 Yr:		2.0E-09	5.9E-09	6.2E-09	5.1E-10		1.6E-09
P 33	Class: D	4.90E-11						
	1 Yr:		2.3E-10	1.0E-09	3.9E-10	7.3E-11		1.6E-10
	50 Yr:		2.3E-10	1.0E-09	3.9E-10	7.3E-11		1.6E-10
S 35	Class: W	1.63E-11						
	1 Yr:		5.1E-09	2.2E-11	4.6E-11	4.6E-11		6.7E-10
	50 Yr:		5.1E-09	2.2E-11	4.6E-11	4.6E-11		6.7E-10
CL36	Class: D	7.52E-10						
	1 Yr:		8.2E-10	2.6E-10	5.1E-10	5.3E-10		5.4E-10
	50 Yr:		8.2E-10	2.6E-10	5.1E-10	5.3E-10		5.4E-10
AR39	NobleGas	4.22E-10						
	1 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00		0.0E-00
	50 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00		0.0E-00
AR41	NobleGas	2.14E-06						
	1 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00		0.0E-00

	50 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
K 40	Class: D	2.86E-07					
	1 Yr:		1.8E-09	1.6E-09	3.0E-09	3.1E-09	2.9E-09
	50 Yr:		1.8E-09	1.6E-09	3.0E-09	3.1E-09	2.9E-09
CA41	Class: W	2.65E-10					
	1 Yr:		4.4E-10	2.2E-10	1.6E-10	9.1E-13	8.4E-11
	50 Yr:		4.4E-10	3.6E-09	1.5E-09	9.1E-13	3.5E-10
CA45	Class: W	5.11E-11					
	1 Yr:		9.6E-09	3.4E-09	2.4E-09	2.0E-11	1.7E-09
	50 Yr:		9.6E-09	4.3E-09	3.0E-09	2.0E-11	1.8E-09
SC46	Class: Y	3.62E-06					
	1 Yr:		4.4E-08	1.6E-09	2.1E-09	2.0E-09	7.5E-09
	50 Yr:		4.6E-08	1.7E-09	2.2E-09	2.1E-09	7.7E-09
CR51	Class: Y	6.43E-08					
	1 Yr:		5.3E-10	1.4E-11	1.9E-11	1.1E-11	9.1E-11
	50 Yr:		5.3E-10	1.4E-11	1.9E-11	1.1E-11	9.1E-11
MN54	Class: W	1.46E-06					
	1 Yr:		6.7E-09	1.2E-09	1.1E-09	7.4E-10	1.7E-09
	50 Yr:		6.7E-09	1.2E-09	1.1E-09	7.4E-10	1.7E-09
MN56	Class: W	3.22E-06					
	1 Yr:		5.5E-10	8.6E-12	1.1E-11	6.5E-12	9.2E-11
	50 Yr:		5.5E-10	8.6E-12	1.1E-11	6.5E-12	9.2E-11
FE55	Class: W	6.07E-10					
	1 Yr:		8.9E-10	2.3E-11	4.8E-11	5.7E-11	1.8E-10
	50 Yr:		9.0E-10	7.5E-11	1.6E-10	1.9E-10	3.3E-10
FE59	Class: W	1.92E-06					
	1 Yr:		1.4E-08	9.3E-10	1.2E-09	1.2E-09	3.3E-09
	50 Yr:		1.4E-08	9.3E-10	1.2E-09	1.2E-09	3.3E-09
C057	Class: Y	1.79E-07					
	1 Yr:		1.2E-08	3.3E-10	4.3E-10	2.0E-10	1.7E-09
	50 Yr:		1.7E-08	4.4E-10	5.7E-10	2.7E-10	2.3E-09
C058	Class: Y	1.77E-06					
	1 Yr:		1.6E-08	6.8E-10	9.2E-10	8.6E-10	2.8E-09
	50 Yr:		1.6E-08	6.8E-10	9.4E-10	8.8E-10	2.8E-09
C060	Class: Y	4.31E-06					
	1 Yr:		1.3E-07	4.8E-09	6.2E-09	5.7E-09	2.0E-08
	50 Yr:		3.5E-07	1.3E-08	1.7E-08	1.6E-08	5.4E-08
NI59	Class: W	7.37E-10					
	1 Yr:		1.1E-09	8.3E-12	1.6E-11	2.1E-11	1.6E-10
	50 Yr:		1.1E-09	4.3E-11	8.7E-11	1.1E-10	2.2E-10
NI63	Class: W	6.50E-13					
	1 Yr:		2.8E-09	2.3E-11	4.4E-11	4.6E-11	4.0E-10
	50 Yr:		2.8E-09	1.2E-10	2.4E-10	2.4E-10	5.4E-10
NI65	Class: W	1.02E-06					
	1 Yr:		4.0E-10	2.6E-12	3.8E-12	2.4E-12	6.3E-11
	50 Yr:		4.0E-10	2.6E-12	3.8E-12	2.4E-12	6.3E-11
CU64	Class: D	3.57E-07					
	1 Yr:		2.0E-10	2.3E-11	1.4E-11	1.2E-11	5.3E-11
	50 Yr:		2.0E-10	2.3E-11	1.4E-11	1.2E-11	5.3E-11
ZN65	Class: Y	1.12E-06					
	1 Yr:		1.6E-08	2.6E-09	2.8E-09	2.4E-09	3.8E-09
	50 Yr:		2.1E-08	3.3E-09	3.6E-09	3.1E-09	4.9E-09

ZN69M	Class: Y	9.18E-07					
	1 Yr:		1.0E-09	2.6E-11	3.3E-11	1.4E-11	2.4E-10
	50 Yr:		1.0E-09	2.6E-11	3.3E-11	1.4E-11	2.4E-10
ZN69	Class: Y	1.34E-09					
	1 Yr:		8.1E-11	4.5E-14	5.9E-14	2.9E-14	1.1E-11
	50 Yr:		8.1E-11	4.5E-14	5.9E-14	2.9E-14	1.1E-11
AS76	Class: W	8.60E-07					
	1 Yr:		5.2E-09	4.2E-11	6.7E-11	5.0E-11	1.0E-09
	50 Yr:		5.2E-09	4.2E-11	6.7E-11	5.0E-11	1.0E-09
SE75	Class: W	6.05E-07					
	1 Yr:		5.3E-09	1.1E-09	1.4E-09	8.5E-10	2.1E-09
	50 Yr:		5.3E-09	1.1E-09	1.4E-09	8.7E-10	2.1E-09
SE79	Class: W	1.05E-11					
	1 Yr:		9.2E-09	2.6E-10	5.0E-10	5.0E-10	2.2E-09
	50 Yr:		9.3E-09	3.1E-10	6.1E-10	6.1E-10	2.4E-09
BR82	Class: D	4.81E-06					
	1 Yr:		7.4E-10	1.0E-10	2.4E-10	2.5E-10	3.3E-10
	50 Yr:		7.4E-10	1.0E-10	2.4E-10	2.5E-10	3.3E-10
BR83	Class: D	1.49E-08					
	1 Yr:		1.6E-10	1.9E-12	3.7E-12	3.8E-12	2.6E-11
	50 Yr:		1.6E-10	1.9E-12	3.7E-12	3.8E-12	2.6E-11
BR84	Class: D	3.30E-06					
	1 Yr:		1.6E-10	1.8E-12	3.0E-12	3.3E-12	2.7E-11
	50 Yr:		1.6E-10	1.8E-12	3.0E-12	3.3E-12	2.7E-11
KR83M	NobleGas	5.16E-10					
	1 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
	50 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
KR85M	NobleGas	2.30E-07					
	1 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
	50 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
KR85	NobleGas	4.80E-09					
	1 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
	50 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
KR87	NobleGas	1.66E-06					
	1 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
	50 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
KR88	NobleGas	3.63E-06					
	1 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
	50 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
KR89	NobleGas	3.45E-06					
	1 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
	50 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
RB86	Class: D	1.59E-07					
	1 Yr:		2.0E-09	4.6E-09	2.7E-09	1.4E-09	1.7E-09
	50 Yr:		2.0E-09	4.6E-09	2.7E-09	1.4E-09	1.7E-09
RB87	Class: D	5.51E-11					
	1 Yr:		3.5E-10	2.5E-09	1.4E-09	7.3E-10	7.9E-10
	50 Yr:		3.5E-10	2.5E-09	1.4E-09	7.3E-10	7.9E-10
RB88	Class: D	1.32E-06					
	1 Yr:		1.5E-10	1.8E-12	1.8E-12	1.4E-12	2.4E-11
	50 Yr:		1.5E-10	1.8E-12	1.8E-12	1.4E-12	2.4E-11
RB89	Class: D	3.73E-06					

	1 Yr:		7.0E-11	2.7E-12	2.2E-12	1.7E-12	1.2E-11
	50 Yr:		7.0E-11	2.7E-12	2.2E-12	1.7E-12	1.2E-11
SR85	Class: D	9.62E-07					
	1 Yr:		3.7E-10	9.8E-10	8.6E-10	2.9E-10	4.1E-10
	50 Yr:		3.7E-10	9.9E-10	8.7E-10	2.9E-10	4.2E-10
SR89	Class: O	4.77E-09					
	1 Yr:		1.7E-09	8.3E-09	5.2E-09	2.1E-10	1.5E-09
	50 Yr:		1.7E-09	8.3E-09	5.2E-09	2.1E-10	1.5E-09
SR90	Class: D	3.51E-10					
	1 Yr:		1.1E-09	7.3E-08	4.3E-08	3.4E-10	7.9E-09
	50 Yr:		1.1E-09	6.5E-07	2.9E-07	3.4E-10	5.5E-08
SR91	Class: O	1.17E-06					
	1 Yr:		9.0E-10	1.1E-10	1.1E-10	3.6E-11	2.6E-10
	50 Yr:		9.0E-10	1.1E-10	1.1E-10	3.6E-11	2.6E-10
SR92	Class: D	2.57E-06					
	1 Yr:		7.1E-10	3.1E-11	3.0E-11	2.0E-11	1.8E-10
	50 Yr:		7.1E-10	3.1E-11	3.0E-11	2.0E-11	1.8E-10
Y 90	Class: Y	1.27E-08					
	1 Yr:		9.7E-09	1.6E-11	1.6E-11	5.5E-13	2.4E-09
	50 Yr:		9.7E-09	1.6E-11	1.6E-11	5.5E-13	2.4E-09
Y 91M	Class: Y	1.10E-06					
	1 Yr:		7.0E-11	6.3E-13	8.0E-13	5.1E-13	9.8E-12
	50 Yr:		7.1E-11	6.3E-13	8.0E-13	5.1E-13	9.9E-12
Y 91	Class: Y	1.13E-08					
	1 Yr:		9.8E-08	3.2E-10	3.1E-10	8.5E-12	1.3E-08
	50 Yr:		9.9E-08	3.2E-10	3.1E-10	8.5E-12	1.3E-08
Y 92	Class: Y	5.09E-07					
	1 Yr:		1.3E-09	1.6E-12	2.3E-12	1.1E-12	2.2E-10
	50 Yr:		1.3E-09	1.6E-12	2.3E-12	1.1E-12	2.2E-10
Y 93	Class: Y	1.82E-07					
	1 Yr:		2.7E-09	3.4E-12	4.4E-12	9.6E-13	6.3E-10
	50 Yr:		2.7E-09	3.4E-12	4.4E-12	9.6E-13	6.3E-10
ZR93	Class: W	4.83E-13					
	1 Yr:		3.3E-09	1.1E-08	9.2E-10	2.8E-12	8.9E-10
	50 Yr:		3.3E-09	5.4E-07	4.4E-08	2.8E-12	2.2E-08
ZR95	Class: W	1.31E-06					
	1 Yr:		1.8E-08	2.2E-08	3.2E-09	7.7E-10	4.2E-09
	50 Yr:		1.8E-08	2.3E-08	3.3E-09	7.7E-10	4.2E-09
ZR97	Class: W	3.41E-07					
	1 Yr:		4.0E-09	1.3E-10	1.5E-10	3.8E-11	1.2E-09
	50 Yr:		4.0E-09	1.3E-10	1.5E-10	3.8E-11	1.2E-09
NB93M	Class: Y	2.94E-10					
	1 Yr:		1.9E-08	5.8E-11	2.4E-11	2.4E-12	2.4E-09
	50 Yr:		6.7E-08	2.2E-10	2.4E-11	2.4E-12	8.1E-09
NB94	Class: Y	2.62E-06					
	1 Yr:		1.5E-07	4.0E-09	4.7E-09	4.6E-09	2.2E-08
	50 Yr:		7.4E-07	1.6E-08	1.8E-08	1.8E-08	1.0E-07
NB95M	Class: Y	1.01E-07					
	1 Yr:		3.1E-09	6.4E-11	5.7E-11	3.7E-11	6.6E-10
	50 Yr:		3.1E-09	6.4E-11	5.7E-11	3.7E-11	6.6E-10
NB95	Class: Y	1.46E-06					
	1 Yr:		8.4E-09	5.2E-10	4.5E-10	3.6E-10	1.5E-09

	50 Yr:		8.4E-09	5.2E-10	4.5E-10	3.6E-10	1.5E-09
NB97M	Class: Y	1.13E-06					
	1 Yr:		2.4E-12	2.3E-14	3.1E-14	2.8E-14	3.5E-13
	50 Yr:		2.4E-12	2.3E-14	3.1E-14	2.8E-14	3.5E-13
NB97	Class: Y	1.17E-06					
	1 Yr:		1.6E-10	8.6E-13	1.2E-12	9.5E-13	2.3E-11
	50 Yr:		1.6E-10	8.6E-13	1.2E-12	9.5E-13	2.3E-11
M093	Class: D	1.42E-09					
	1 Yr:		6.4E-11	1.1E-09	2.2E-10	7.3E-11	2.6E-10
	50 Yr:		6.4E-11	1.1E-09	2.2E-10	7.3E-11	2.7E-10
M099	Class: D	2.48E-07					
	1 Yr:		1.1E-09	6.6E-10	4.1E-10	1.2E-10	5.4E-10
	50 Yr:		1.1E-09	6.6E-10	4.1E-10	1.2E-10	5.4E-10
TC99M	Class: W	1.63E-07					
	1 Yr:		3.1E-11	1.5E-12	2.5E-12	2.2E-11	7.5E-12
	50 Yr:		3.1E-11	1.5E-12	2.5E-12	2.2E-11	7.5E-12
TC99	Class: W	6.61E-11					
	1 Yr:		1.6E-08	2.1E-11	4.0E-11	4.5E-09	2.3E-09
	50 Yr:		1.6E-08	2.1E-11	4.0E-11	4.9E-09	2.3E-09
TC101	Class: W	6.97E-07					
	1 Yr:		3.1E-11	1.4E-13	1.9E-13	2.5E-12	4.1E-12
	50 Yr:		3.1E-11	1.4E-13	1.9E-13	2.5E-12	4.1E-12
RU103	Class: Y	9.40E-07					
	1 Yr:		1.6E-08	2.2E-10	3.1E-10	2.5E-10	2.5E-09
	50 Yr:		1.6E-08	2.2E-10	3.1E-10	2.5E-10	2.5E-09
RU105	Class: Y	1.40E-06					
	1 Yr:		7.0E-10	4.9E-12	8.5E-12	4.4E-12	1.6E-10
	50 Yr:		7.0E-10	4.9E-12	8.5E-12	4.4E-12	1.6E-10
RU106	Class: Y	4.15E-07					
	1 Yr:		6.6E-07	6.4E-10	1.1E-09	1.0E-09	8.4E-08
	50 Yr:		1.0E-06	6.4E-10	1.1E-09	1.0E-09	1.3E-07
RH103M	Class: Y	1.32E-09					
	1 Yr:		9.9E-12	2.6E-15	3.8E-15	1.6E-15	1.4E-12
	50 Yr:		9.9E-12	2.6E-15	3.8E-15	1.6E-15	1.4E-12
RH105	Class: Y	1.59E-07					
	1 Yr:		1.0E-09	3.9E-12	7.8E-12	3.1E-12	3.0E-10
	50 Yr:		1.0E-09	3.9E-12	7.8E-12	3.1E-12	3.0E-10
PD103	Class: Y	1.12E-08					
	1 Yr:		2.7E-09	4.7E-12	7.1E-12	1.5E-13	4.3E-10
	50 Yr:		2.7E-09	4.7E-12	7.1E-12	1.5E-13	4.3E-10
PD107	Class: Y	2.20E-14					
	1 Yr:		5.9E-09	3.7E-13	1.4E-13	2.6E-14	7.3E-10
	50 Yr:		2.9E-08	3.7E-13	1.4E-13	2.6E-14	3.5E-09
PD109	Class: Y	1.14E-08					
	1 Yr:		1.5E-09	1.0E-12	1.6E-12	2.2E-13	3.7E-10
	50 Yr:		1.5E-09	1.0E-12	1.6E-12	2.2E-13	3.7E-10
AG110M	Class: D	4.91E-06					
	1 Yr:		1.1E-08	3.3E-09	4.9E-09	3.1E-09	2.3E-08
	50 Yr:		1.1E-08	3.3E-09	4.9E-09	3.1E-09	2.3E-08
AG11M	Class: D	5.07E-08					
	1 Yr:		1.0E-09	5.1E-11	9.0E-11	7.5E-11	9.2E-10
	50 Yr:		1.0E-09	5.1E-11	9.0E-11	7.5E-11	9.2E-10

CD109	Class: D	1.04E-08						
	1 Yr:		6.0E-10	6.2E-10	1.3E-09	1.2E-09	1.3E-08	
	50 Yr:		7.8E-10	1.2E-09	2.7E-09	2.5E-09	3.0E-08	
CD113M	Class: D	4.10E-10						
	1 Yr:		5.8E-10	1.3E-09	2.6E-09	2.7E-09	3.1E-08	
	50 Yr:		5.8E-10	1.2E-08	2.9E-08	3.0E-08	4.0E-07	
CD115M	Class: D	4.47E-08						
	1 Yr:		1.9E-09	8.2E-10	1.6E-09	1.6E-09	1.9E-08	
	50 Yr:		1.9E-09	8.2E-10	1.6E-09	1.6E-09	1.9E-08	
CD115	Class: D	3.78E-07						
	1 Yr:		1.1E-09	9.0E-11	1.2E-10	8.7E-11	1.0E-09	
	50 Yr:		1.1E-09	9.0E-11	1.2E-10	8.7E-11	1.0E-09	
IN111	Class: D	5.53E-07						
	1 Yr:		1.9E-10	1.1E-10	9.8E-11	1.9E-11	1.5E-10	
	50 Yr:		1.9E-10	1.1E-10	9.8E-11	1.9E-11	1.5E-10	
IN114M	Class: D	2.07E-07						
	1 Yr:		2.8E-09	1.8E-08	6.1E-09	8.0E-11	1.2E-08	
	50 Yr:		2.8E-09	1.8E-08	6.1E-09	8.0E-11	1.2E-08	
IN115M	Class: D	3.09E-07						
	1 Yr:		1.3E-10	6.5E-12	5.1E-12	2.5E-12	3.3E-11	
	50 Yr:		1.3E-10	6.5E-12	5.1E-12	2.5E-12	3.3E-11	
SN117M	Class: W	1.72E-07						
	1 Yr:		6.2E-09	2.2E-09	2.7E-10	3.1E-11	1.3E-09	
	50 Yr:		6.2E-09	2.2E-09	2.7E-10	3.1E-11	1.3E-09	
SN119M	Class: W	7.15E-09						
	1 Yr:		1.1E-08	8.6E-10	3.6E-10	4.2E-11	1.6E-09	
	50 Yr:		1.1E-08	1.1E-09	4.7E-10	4.2E-11	1.7E-09	
SN121M	Class: W	0.00E+00						
	1 Yr:		2.0E-08	1.8E-09	7.0E-10	8.8E-11	2.9E-09	
	50 Yr:		2.0E-08	3.9E-09	1.5E-09	1.6E-10	3.1E-09	
SN121	Class: W	0.00E+00						
	1 Yr:		5.3E-10	8.5E-12	3.6E-12	8.8E-13	1.5E-10	
	50 Yr:		5.3E-10	8.5E-12	3.6E-12	8.8E-13	1.5E-10	
SN123	Class: W	1.48E-08						
	1 Yr:		6.1E-08	3.5E-09	1.3E-09	1.7E-10	9.0E-09	
	50 Yr:		6.1E-08	3.8E-09	1.4E-09	1.7E-10	9.0E-09	
SN125	Class: W	5.49E-07						
	1 Yr:		2.3E-08	9.8E-10	7.3E-10	7.7E-11	4.6E-09	
	50 Yr:		2.3E-08	1.1E-09	7.3E-10	7.7E-11	4.6E-09	
SN126	Class: W	4.62E-08						
	1 Yr:		1.5E-07	1.5E-08	8.3E-09	2.9E-09	2.4E-08	
	50 Yr:		1.5E-07	3.3E-08	1.7E-08	4.6E-09	2.7E-08	
SB124	Class: W	3.58E-06						
	1 Yr:		4.2E-08	1.3E-09	1.1E-09	6.8E-10	6.8E-09	
	50 Yr:		4.2E-08	1.3E-09	1.1E-09	6.8E-10	6.8E-09	
SB125	Class: W	8.41E-07						
	1 Yr:		2.2E-08	1.0E-09	5.2E-10	3.2E-10	3.3E-09	
	50 Yr:		2.2E-08	1.0E-09	5.2E-10	3.2E-10	3.3E-09	
SB126M	Class: W	2.90E-06						
	1 Yr:		5.8E-11	7.8E-13	9.6E-13	7.7E-13	8.0E-12	
	50 Yr:		5.8E-11	7.8E-13	9.6E-13	7.7E-13	8.0E-12	
SB126	Class: W	4.88E-06						

	1 Yr:		1.4E-08	7.0E-10	8.0E-10	4.8E-10	3.2E-09
	50 Yr:		1.4E-08	7.0E-10	8.0E-10	4.8E-10	3.2E-09
SB127	Class: W	1.20E-06					
	1 Yr:		6.9E-09	1.4E-10	1.6E-10	6.0E-11	1.6E-09
	50 Yr:		6.9E-09	1.4E-10	1.6E-10	6.0E-11	1.6E-09
TE123M	Class: W	1.63E-07					
	1 Yr:		1.3E-08	2.1E-08	2.1E-09	1.4E-10	2.8E-09
	50 Yr:		1.3E-08	2.4E-08	2.4E-09	1.4E-10	2.9E-09
TE125M	Class: W	2.39E-08					
	1 Yr:		1.0E-08	1.2E-08	1.2E-09	4.0E-11	2.0E-09
	50 Yr:		1.0E-08	1.2E-08	1.2E-09	4.0E-11	2.0E-09
TE127M	Class: W	7.52E-09					
	1 Yr:		3.3E-08	1.9E-08	4.8E-09	1.0E-10	5.8E-09
	50 Yr:		3.3E-08	2.1E-08	5.4E-09	1.0E-10	5.9E-09
TE127	Class: W	1.13E-08					
	1 Yr:		4.3E-10	5.1E-12	5.8E-12	1.9E-12	9.7E-11
	50 Yr:		4.3E-10	5.1E-12	5.8E-12	1.9E-12	9.7E-11
TE129M	Class: W	5.88E-08					
	1 Yr:		3.9E-08	7.1E-09	3.1E-09	3.1E-11	1.3E-07
	50 Yr:		3.9E-08	7.1E-09	3.1E-09	3.1E-11	1.3E-07
TE129	Class: W	1.11E-07					
	1 Yr:		1.6E-10	9.8E-13	1.0E-12	8.6E-14	4.2E-11
	50 Yr:		1.6E-10	9.8E-13	1.0E-12	8.6E-14	4.2E-11
TE131M	Class: W	2.61E-06					
	1 Yr:		2.2E-09	2.5E-10	1.4E-10	3.2E-08	3.2E-09
	50 Yr:		2.2E-09	2.5E-10	1.4E-10	3.2E-08	3.2E-09
TE131	Class: W	7.33E-07					
	1 Yr:		8.0E-11	4.9E-13	5.9E-13	5.7E-10	3.4E-11
	50 Yr:		8.0E-11	4.9E-13	5.9E-13	5.7E-10	3.4E-11
TE132	Class: W	3.75E-07					
	1 Yr:		1.4E-09	4.4E-10	8.6E-11	4.3E-08	3.4E-09
	50 Yr:		1.4E-09	4.4E-10	8.6E-11	4.3E-08	3.4E-09
TE133M	Class: W	4.08E-06					
	1 Yr:		2.1E-10	3.1E-12	4.0E-12	2.2E-09	1.2E-10
	50 Yr:		2.1E-10	3.1E-12	4.0E-12	2.2E-09	1.2E-10
TE133	Class: W	1.79E-06					
	1 Yr:		4.8E-11	2.8E-13	3.7E-13	5.0E-10	2.4E-11
	50 Yr:		4.8E-11	2.8E-13	3.7E-13	5.0E-10	2.4E-11
TE134	Class: W	1.58E-06					
	1 Yr:		6.2E-11	1.2E-12	1.2E-12	3.6E-10	2.8E-11
	50 Yr:		6.2E-11	1.2E-12	1.2E-12	3.6E-10	2.8E-11
I 125	Class: D	2.78E-08					
	1 Yr:		1.1E-10	1.6E-10	1.2E-10	2.0E-07	6.1E-09
	50 Yr:		1.1E-10	1.6E-10	1.2E-10	2.0E-07	6.1E-09
I 129	Class: D	1.55E-08					
	1 Yr:		2.4E-10	7.0E-10	3.6E-10	1.2E-06	3.6E-08
	50 Yr:		2.4E-10	7.0E-10	3.6E-10	1.4E-06	4.1E-08
I 130	Class: D	3.74E-06					
	1 Yr:		6.2E-10	5.4E-10	1.9E-10	1.6E-08	6.6E-10
	50 Yr:		6.2E-10	5.4E-10	1.9E-10	1.6E-08	6.6E-10
I 131	Class: D	6.68E-07					
	1 Yr:		6.5E-10	2.3E-09	2.7E-10	2.7E-07	8.3E-09

	50 Yr:		6.5E-10	2.3E-09	2.7E-10	2.7E-07	8.3E-09
I 132	Class: D	4.16E-06					
	1 Yr:		2.8E-10	6.9E-11	7.0E-11	1.3E-09	1.1E-10
	50 Yr:		2.8E-10	6.9E-11	7.0E-11	1.3E-09	1.1E-10
I 133	Class: D	1.09E-06					
	1 Yr:		8.3E-10	2.9E-10	2.2E-10	4.3E-08	1.5E-09
	50 Yr:		8.3E-10	2.9E-10	2.2E-10	4.3E-08	1.5E-09
I 134	Class: D	4.67E-06					
	1 Yr:		1.5E-10	2.8E-11	2.8E-11	2.0E-10	3.8E-11
	50 Yr:		1.5E-10	2.8E-11	2.8E-11	2.0E-10	3.8E-11
I 135	Class: D	2.89E-06					
	1 Yr:		4.6E-10	1.8E-10	1.3E-10	6.8E-09	3.2E-10
	50 Yr:		4.6E-10	1.8E-10	1.3E-10	6.8E-09	3.2E-10
XE131M	NobleGas	1.38E-08					
	1 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
	50 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
XE133M	NobleGas	5.17E-08					
	1 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
	50 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
XE133	NobleGas	4.28E-08					
	1 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
	50 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
XE135M	NobleGas	7.86E-07					
	1 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
	50 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
XE135	NobleGas	4.02E-07					
	1 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
	50 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
XE137	NobleGas	4.34E-07					
	1 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
	50 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
XE138	NobleGas	2.21E-06					
	1 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
	50 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
CS134M	Class: D	3.37E-08					
	1 Yr:		6.5E-11	9.0E-13	1.8E-12	1.7E-12	1.0E-11
	50 Yr:		6.5E-11	9.0E-13	1.8E-12	1.7E-12	1.0E-11
CS134	Class: D	2.93E-06					
	1 Yr:		7.6E-09	7.7E-09	1.0E-08	1.0E-08	1.1E-08
	50 Yr:		8.1E-09	8.3E-09	1.1E-08	1.1E-08	1.2E-08
CS135	Class: D	2.36E-11					
	1 Yr:		2.1E-10	5.4E-10	1.1E-09	1.1E-09	9.7E-10
	50 Yr:		2.1E-10	6.0E-10	1.2E-09	1.2E-09	1.1E-09
CS136	Class: D	3.72E-06					
	1 Yr:		1.9E-09	6.8E-10	1.7E-09	1.9E-09	1.9E-09
	50 Yr:		1.9E-09	6.8E-10	1.7E-09	1.9E-09	1.9E-09
CS137	Class: D	9.84E-07					
	1 Yr:		3.7E-09	4.1E-09	6.3E-09	7.3E-09	7.2E-09
	50 Yr:		4.0E-09	4.5E-09	7.0E-09	8.1E-09	7.9E-09
CS138	Class: D	4.49E-06					
	1 Yr:		1.6E-10	2.4E-12	3.5E-12	3.8E-12	2.8E-11
	50 Yr:		1.6E-10	2.4E-12	3.5E-12	3.8E-12	2.8E-11

BA139	Class: D	5.45E-08					
	1 Yr:		2.6E-10	2.6E-12	2.9E-12	1.7E-12	5.1E-11
	50 Yr:		2.6E-10	2.6E-12	2.9E-12	1.7E-12	5.1E-11
BA140	Class: D	3.45E-07					
	1 Yr:		1.5E-09	2.3E-09	1.1E-09	1.2E-10	9.1E-10
	50 Yr:		1.5E-09	2.3E-09	1.1E-09	1.2E-10	9.1E-10
BA141	Class: D	1.55E-06					
	1 Yr:		1.2E-10	3.8E-12	1.8E-12	1.0E-12	2.3E-11
	50 Yr:		1.2E-10	3.8E-12	1.8E-12	1.0E-12	2.3E-11
BA142	Class: D	1.58E-06					
	1 Yr:		5.6E-11	1.2E-12	1.5E-12	1.0E-12	1.2E-11
	50 Yr:		5.6E-11	1.2E-12	1.5E-12	1.0E-12	1.2E-11
LA140	Class: D	4.05E-06					
	1 Yr:		1.7E-09	4.3E-10	4.8E-10	1.3E-10	9.5E-10
	50 Yr:		1.7E-09	4.3E-10	4.8E-10	1.3E-10	9.5E-10
LA141	Class: D	9.77E-08					
	1 Yr:		6.6E-10	1.3E-10	3.7E-11	1.0E-11	1.6E-10
	50 Yr:		6.6E-10	1.3E-10	3.7E-11	1.0E-11	1.6E-10
LA142	Class: D	5.20E-06					
	1 Yr:		3.2E-10	1.3E-11	1.6E-11	9.3E-12	7.4E-11
	50 Yr:		3.2E-10	1.3E-11	1.6E-11	9.3E-12	7.4E-11
CE141	Class: Y	9.44E-08					
	1 Yr:		1.6E-08	2.7E-10	9.0E-11	2.6E-11	2.3E-09
	50 Yr:		1.6E-08	2.7E-10	9.0E-11	2.6E-11	2.3E-09
CE143	Class: Y	4.05E-07					
	1 Yr:		4.0E-09	1.7E-11	3.1E-11	6.5E-12	9.5E-10
	50 Yr:		4.0E-09	1.7E-11	3.1E-11	6.5E-12	9.5E-10
CE144	Class: Y	2.42E-08					
	1 Yr:		5.6E-07	1.9E-09	1.2E-09	1.5E-10	7.1E-08
	50 Yr:		7.9E-07	4.1E-09	2.0E-09	1.5E-10	1.0E-07
PR143	Class: Y	1.34E-09					
	1 Yr:		1.3E-08	1.5E-11	1.5E-11	9.8E-14	2.2E-09
	50 Yr:		1.3E-08	1.5E-11	1.5E-11	9.8E-14	2.2E-09
PR144M	Class: Y	1.03E-08					
	1 Yr:		4.0E-11	1.5E-14	1.8E-14	8.7E-15	5.1E-12
	50 Yr:		4.0E-11	1.5E-14	1.8E-14	8.7E-15	5.1E-12
PR144	Class: Y	8.01E-08					
	1 Yr:		9.7E-11	2.1E-14	2.7E-14	1.8E-14	1.2E-11
	50 Yr:		9.7E-11	2.1E-14	2.7E-14	1.8E-14	1.2E-11
ND147	Class: Y	2.19E-07					
	1 Yr:		1.0E-08	1.2E-10	7.7E-11	1.9E-11	1.8E-09
	50 Yr:		1.0E-08	3.1E-10	7.7E-11	1.9E-11	1.8E-09
PM147	Class: Y	3.67E-11					
	1 Yr:		3.5E-08	1.8E-09	1.4E-10	5.2E-14	4.4E-09
	50 Yr:		7.8E-08	2.0E-08	1.5E-09	5.2E-14	1.1E-08
PM148M	Class: Y	3.75E-06					
	1 Yr:		3.6E-08	1.4E-09	1.4E-09	1.0E-09	6.0E-09
	50 Yr:		3.6E-08	1.4E-09	1.4E-09	1.0E-09	6.0E-09
PM148	Class: Y	1.09E-06					
	1 Yr:		1.4E-08	7.4E-11	1.1E-10	3.9E-11	3.0E-09
	50 Yr:		1.4E-08	7.4E-11	1.1E-10	3.9E-11	3.0E-09
PM149	Class: Y	1.92E-08					

	1 Yr:		3.2E-09	5.3E-12	5.8E-12	4.4E-13	8.2E-10
	50 Yr:		3.2E-09	5.3E-12	5.8E-12	4.4E-13	8.2E-10
PM151	Class: Y	5.84E-07					
	1 Yr:		1.7E-09	1.7E-11	2.8E-11	6.6E-12	4.9E-10
	50 Yr:		1.7E-09	1.7E-11	2.8E-11	6.6E-12	4.9E-10
SM147	Class: W	0.00E+00					
	1 Yr:		7.5E-06	2.2E-05	1.8E-06	4.0E-10	2.1E-06
	50 Yr:		7.6E-06	3.4E-04	2.8E-05	4.0E-10	2.0E-05
SM151	Class: W	8.04E-12					
	1 Yr:		3.3E-09	9.7E-09	7.8E-10	1.7E-13	9.8E-10
	50 Yr:		3.3E-09	1.4E-07	1.1E-08	1.7E-13	8.1E-09
SM153	Class: W	8.38E-08					
	1 Yr:		2.1E-09	1.6E-10	7.1E-11	2.9E-12	5.4E-10
	50 Yr:		2.1E-09	1.6E-10	7.1E-11	2.9E-12	5.4E-10
EU152	Class: W	2.07E-06					
	1 Yr:		3.5E-08	2.6E-08	9.3E-09	1.5E-09	1.0E-08
	50 Yr:		5.8E-08	2.4E-07	8.0E-08	8.0E-09	5.6E-08
EU154	Class: W	2.12E-06					
	1 Yr:		5.9E-08	6.7E-08	1.4E-08	1.6E-09	1.7E-08
	50 Yr:		7.9E-08	5.2E-07	1.1E-07	6.7E-09	7.4E-08
EU155	Class: W	7.19E-08					
	1 Yr:		1.1E-08	2.6E-08	2.6E-09	7.0E-11	3.2E-09
	50 Yr:		1.2E-08	1.5E-07	1.4E-08	1.3E-10	1.1E-08
EU156	Class: W	2.48E-06					
	1 Yr:		1.9E-08	2.8E-09	1.2E-09	2.3E-10	3.9E-09
	50 Yr:		1.9E-08	2.8E-09	1.2E-09	2.3E-10	3.9E-09
GD153	Class: D	1.22E-07					
	1 Yr:		9.9E-10	6.2E-08	7.3E-09	2.0E-10	4.3E-09
	50 Yr:		1.3E-09	9.2E-08	1.1E-08	2.6E-10	6.3E-09
TB160	Class: W	1.84E-06					
	1 Yr:		3.0E-08	2.4E-08	4.4E-09	6.5E-10	6.6E-09
	50 Yr:		3.0E-08	2.5E-08	4.5E-09	6.5E-10	6.7E-09
H0166M	Class: W	2.69E-06					
	1 Yr:		4.1E-08	5.9E-08	1.2E-08	2.5E-09	1.9E-08
	50 Yr:		1.1E-07	8.9E-07	1.6E-07	2.1E-08	2.0E-07
W 181	Class: D	3.30E-08					
	1 Yr:		5.4E-11	6.7E-11	5.0E-11	3.7E-12	4.1E-11
	50 Yr:		5.4E-11	7.3E-11	5.4E-11	3.9E-12	4.2E-11
W 187	Class: D	8.43E-07					
	1 Yr:		6.2E-10	1.1E-10	3.7E-11	1.6E-11	1.8E-10
	50 Yr:		6.2E-10	1.1E-10	3.7E-11	1.6E-11	1.8E-10
W 185	Class: D	2.14E-10					
	1 Yr:		3.9E-10	2.6E-10	9.0E-11	4.7E-12	2.1E-10
	50 Yr:		3.9E-10	2.7E-10	9.2E-11	4.7E-12	2.1E-10
RE187	Class: W	0.00E+00					
	1 Yr:		1.1E-10	1.3E-13	2.7E-13	6.9E-12	1.5E-11
	50 Yr:		1.1E-10	1.3E-13	2.7E-13	6.9E-12	1.5E-11
IR192	Class: Y	1.60E-06					
	1 Yr:		5.2E-08	6.8E-10	9.2E-10	6.4E-10	7.5E-09
	50 Yr:		5.3E-08	6.8E-10	9.2E-10	6.4E-10	7.6E-09
HG203	Class: D	3.19E-07					
	1 Yr:		6.6E-10	6.1E-10	9.3E-10	8.3E-10	1.5E-09

	50 Yr:		6.6E-10	6.1E-10	9.3E-10	8.3E-10	1.5E-09
RN222	NobleGas	3.28E-06					
	1 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
	50 Yr:		0.0E-00	0.0E-00	0.0E-00	0.0E-00	0.0E-00
TH227	Class: Y	1.68E-07					
	1 Yr:		3.6E-05	1.6E-06	1.3E-07	3.0E-09	4.4E-06
	50 Yr:		3.6E-05	1.6E-06	1.3E-07	3.0E-09	4.4E-06
TH228	Class: Y	2.51E-09					
	1 Yr:		3.3E-04	2.6E-05	2.1E-06	4.5E-08	4.1E-05
	50 Yr:		6.6E-04	2.2E-04	1.7E-05	4.5E-08	8.8E-05
TH229	Class: Y	1.01E-07					
	1 Yr:		3.8E-04	3.2E-05	2.6E-06	5.2E-08	4.7E-05
	50 Yr:		2.0E-03	5.7E-03	4.6E-04	5.2E-08	4.7E-04
TH230	Class: Y	5.11E-10					
	1 Yr:		6.0E-05	4.8E-06	4.0E-07	8.2E-09	7.4E-06
	50 Yr:		3.0E-04	8.5E-04	7.0E-05	8.2E-09	7.0E-05
TH231	Class: Y	1.43E-08					
	1 Yr:		7.9E-10	1.6E-11	3.7E-12	2.8E-13	2.1E-10
	50 Yr:		8.1E-10	2.9E-10	3.7E-12	2.8E-13	2.2E-10
TH232	Class: Y	3.49E-10					
	1 Yr:		5.1E-05	4.3E-06	3.5E-07	7.2E-09	6.3E-06
	50 Yr:		8.9E-04	4.7E-03	3.8E-04	7.2E-09	3.0E-04
TH234	Class: Y	3.87E-08					
	1 Yr:		6.4E-08	4.1E-10	2.4E-10	1.2E-11	9.5E-09
	50 Yr:		6.4E-08	4.1E-10	2.4E-10	1.2E-11	9.5E-09
RA223	Class: W	4.88E-07					
	1 Yr:		1.7E-05	9.0E-07	6.2E-08	9.5E-09	2.1E-06
	50 Yr:		1.7E-05	9.0E-07	6.2E-08	9.5E-09	2.1E-06
RA224	Class: W	1.72E-08					
	1 Yr:		6.2E-06	2.3E-07	1.9E-08	6.4E-09	7.7E-07
	50 Yr:		6.2E-06	2.3E-07	1.9E-08	6.4E-09	7.7E-07
RA225	Class: W	1.30E-08					
	1 Yr:		1.6E-05	1.3E-06	8.2E-08	2.4E-09	2.0E-06
	50 Yr:		1.6E-05	1.3E-06	8.2E-08	2.4E-09	2.0E-06
RA226	Class: W	6.55E-09					
	1 Yr:		1.6E-05	5.9E-07	6.2E-08	2.8E-09	1.9E-06
	50 Yr:		1.6E-05	7.0E-06	3.9E-07	2.8E-09	2.2E-06
RA228	Class: W	5.40E-14					
	1 Yr:		6.4E-06	2.6E-07	2.9E-08	1.1E-09	7.8E-07
	50 Yr:		6.7E-06	5.7E-06	5.5E-07	1.1E-09	1.0E-06
PB210	Class: O	2.16E-09					
	1 Yr:		4.3E-10	2.5E-06	2.0E-07	4.4E-08	3.1E-07
	50 Yr:		4.3E-10	5.4E-05	3.8E-06	3.2E-07	3.6E-06
PB212	Class: D	2.26E-07					
	1 Yr:		1.8E-07	3.9E-07	3.5E-08	3.4E-09	4.5E-08
	50 Yr:		1.8E-07	3.9E-07	3.5E-08	3.4E-09	4.5E-08
BI210	Class: W	2.13E-09					
	1 Yr:		4.3E-07	3.8E-11	6.7E-11	6.6E-11	5.3E-08
	50 Yr:		4.3E-07	3.8E-11	6.7E-11	6.6E-11	5.3E-08
BI212	Class: W	2.79E-06					
	1 Yr:		3.8E-08	2.4E-10	6.7E-11	5.0E-11	5.1E-09
	50 Yr:		3.8E-08	2.4E-10	6.7E-11	5.0E-11	5.1E-09

P0210	Class: W	1.55E-11					
	1 Yr:		1.3E-05	6.5E-08	1.3E-07	1.3E-07	2.3E-06
	50 Yr:		1.3E-05	6.5E-08	1.3E-07	1.3E-07	2.3E-06
U 232	Class: Y	4.89E-10					
	1 Yr:		1.2E-04	3.7E-08	3.4E-09	1.1E-09	1.4E-05
	50 Yr:		1.4E-03	5.0E-06	3.4E-09	1.1E-09	1.7E-04
U 233	Class: Y	4.17E-10					
	1 Yr:		6.2E-05	1.9E-08	1.5E-09	3.7E-10	7.4E-06
	50 Yr:		3.0E-04	1.9E-08	1.5E-09	3.7E-10	3.6E-05
U 234	Class: Y	3.56E-10					
	1 Yr:		6.2E-05	1.9E-08	1.5E-09	3.7E-10	7.4E-06
	50 Yr:		3.0E-04	1.9E-08	1.5E-09	3.7E-10	3.6E-05
U 235	Class: Y	1.67E-07					
	1 Yr:		5.7E-05	1.8E-08	2.1E-09	6.7E-10	6.8E-06
	50 Yr:		2.8E-04	1.8E-08	2.1E-09	6.7E-10	3.3E-05
U 236	Class: Y	2.75E-10					
	1 Yr:		5.8E-05	1.8E-08	1.4E-09	3.4E-10	7.0E-06
	50 Yr:		2.8E-04	1.8E-08	1.4E-09	3.4E-10	3.4E-05
U 237	Class: Y	2.08E-07					
	1 Yr:		4.9E-09	7.2E-11	5.5E-11	1.1E-11	9.8E-10
	50 Yr:		4.9E-09	7.2E-11	5.5E-11	1.1E-11	9.8E-10
U 238	Class: Y	2.43E-10					
	1 Yr:		5.5E-05	1.7E-08	1.5E-09	3.9E-10	6.6E-06
	50 Yr:		2.7E-04	1.7E-08	1.5E-09	3.9E-10	3.2E-05
U 240	Class: Y	6.45E-07					
	1 Yr:		2.3E-09	9.8E-12	1.2E-11	4.0E-12	6.1E-10
	50 Yr:		2.3E-09	9.8E-12	1.2E-11	4.0E-12	6.1E-10
PA231	Class: Y	5.54E-08					
	1 Yr:		6.8E-05	3.5E-06	2.8E-07	1.7E-10	8.3E-06
	50 Yr:		7.5E-04	3.6E-03	2.9E-04	1.7E-10	2.3E-04
PA233	Class: Y	3.98E-07					
	1 Yr:		1.7E-08	4.6E-10	1.6E-10	5.7E-11	2.6E-09
	50 Yr:		1.7E-08	4.6E-10	1.6E-10	5.7E-11	2.6E-09
PA234	Class: Y	3.44E-06					
	1 Yr:		9.2E-10	1.9E-11	2.9E-11	1.3E-11	2.3E-10
	50 Yr:		9.2E-10	1.9E-11	2.9E-11	1.3E-11	2.3E-10
AC225	Class: Y	4.49E-07					
	1 Yr:		1.8E-05	4.7E-07	3.8E-08	2.1E-10	2.2E-06
	50 Yr:		1.8E-05	4.7E-07	3.8E-08	2.1E-10	2.2E-06
AC227	Class: Y	2.05E-10					
	1 Yr:		3.6E-04	2.1E-05	1.7E-06	1.1E-09	4.4E-05
	50 Yr:		1.5E-03	2.9E-03	2.3E-04	1.1E-09	3.5E-04
AC228	Class: Y	1.70E-06					
	1 Yr:		1.2E-07	6.5E-09	5.4E-10	6.5E-12	1.5E-08
	50 Yr:		2.4E-07	5.6E-08	4.1E-09	6.5E-12	3.2E-08
FR223	Class: D	6.96E-08					
	1 Yr:		2.0E-09	6.1E-10	1.2E-09	1.2E-09	1.3E-09
	50 Yr:		2.0E-09	6.1E-10	1.2E-09	1.2E-09	1.3E-09
NP237	Class: W	2.45E-08					
	1 Yr:		1.6E-05	8.2E-05	6.6E-06	1.2E-09	5.6E-06
	50 Yr:		1.6E-05	3.9E-03	3.1E-04	1.2E-09	1.7E-04
NP238	Class: W	9.55E-07					

	1 Yr:		3.3E-09	6.4E-09	6.3E-10	2.4E-11	1.0E-09
	50 Yr:		3.3E-09	2.4E-07	1.9E-08	2.4E-11	1.1E-08
NP239	Class: W	2.62E-07					
	1 Yr:		2.3E-09	1.1E-09	1.4E-10	7.5E-12	6.3E-10
	50 Yr:		2.3E-09	2.2E-09	1.4E-10	7.5E-12	6.6E-10
PU236	Class: Y	3.25E-10					
	1 Yr:		6.4E-05	3.2E-06	2.6E-07	8.0E-11	7.9E-06
	50 Yr:		1.5E-04	4.8E-05	3.6E-06	8.0E-11	2.0E-05
PU237	Class: Y	6.98E-08					
	1 Yr:		3.4E-09	1.3E-10	7.1E-11	2.1E-11	4.9E-10
	50 Yr:		3.4E-09	1.3E-10	7.1E-11	2.1E-11	4.9E-10
PU238	Class: Y	2.72E-10					
	1 Yr:		7.0E-05	3.7E-06	3.0E-07	8.5E-11	8.6E-06
	50 Yr:		3.2E-04	7.3E-04	5.9E-05	8.5E-11	7.7E-05
PU239	Class: Y	1.82E-10					
	1 Yr:		6.4E-05	3.5E-06	2.7E-07	8.0E-11	7.9E-06
	50 Yr:		3.1E-04	8.5E-04	6.5E-05	8.0E-11	8.2E-05
PU240	Class: Y	2.62E-10					
	1 Yr:		6.4E-05	3.5E-06	2.7E-07	8.0E-11	7.9E-06
	50 Yr:		3.1E-04	8.5E-04	6.5E-05	8.0E-11	8.2E-05
PU241	Class: Y	6.50E-16					
	1 Yr:		5.6E-08	3.6E-09	2.8E-10	8.0E-14	6.9E-09
	50 Yr:		3.1E-06	1.8E-05	1.4E-06	8.0E-14	1.3E-06
PU242	Class: Y	2.18E-10					
	1 Yr:		6.0E-05	3.1E-06	2.5E-07	7.4E-11	7.4E-06
	50 Yr:		2.9E-04	7.2E-04	6.0E-05	7.4E-11	7.4E-05
PU243	Class: Y	2.40E-08					
	1 Yr:		1.9E-10	1.7E-12	6.3E-13	1.1E-13	3.5E-11
	50 Yr:		2.0E-10	5.8E-11	6.3E-13	1.1E-13	3.9E-11
PU244	Class: Y	1.82E-10					
	1 Yr:		5.9E-05	3.1E-06	2.5E-07	1.2E-09	7.3E-06
	50 Yr:		2.9E-04	7.3E-04	5.8E-05	1.2E-09	7.4E-05
AM241	Class: W	1.87E-08					
	1 Yr:		1.8E-05	5.6E-05	4.4E-06	1.0E-09	5.4E-06
	50 Yr:		1.8E-05	2.2E-03	1.7E-04	1.0E-09	1.2E-04
AM242M	Class: W	1.03E-09					
	1 Yr:		3.7E-06	2.6E-05	2.1E-06	1.2E-10	2.0E-06
	50 Yr:		3.8E-06	2.0E-03	1.7E-04	1.2E-10	1.1E-04
AM242	Class: W	2.03E-08					
	1 Yr:		4.7E-08	9.8E-08	8.0E-09	2.5E-12	1.2E-08
	50 Yr:		4.7E-08	1.6E-07	1.1E-08	2.5E-12	1.4E-08
AM243	Class: W	4.72E-08					
	1 Yr:		1.7E-05	5.2E-05	4.2E-06	1.2E-09	5.1E-06
	50 Yr:		1.7E-05	2.1E-03	1.7E-04	1.2E-09	1.1E-04
CM242	Class: W	2.67E-10					
	1 Yr:		1.4E-05	2.9E-05	2.4E-06	9.4E-10	3.4E-06
	50 Yr:		1.4E-05	4.7E-05	3.2E-06	9.4E-10	4.3E-06
CM243	Class: W	1.92E-07					
	1 Yr:		1.8E-05	5.6E-05	4.6E-06	1.2E-09	5.5E-06
	50 Yr:		1.8E-05	1.4E-03	1.2E-04	1.2E-09	8.0E-05
CM244	Class: W	2.35E-10					
	1 Yr:		1.8E-05	5.6E-05	4.5E-06	9.9E-10	5.4E-06

	50 Yr:		1.8E-05	1.1E-03	9.2E-05	9.9E-10	6.4E-05
CM245	Class: W	9.58E-08					
	1 Yr:		1.7E-05	5.2E-05	4.3E-06	1.1E-09	5.1E-06
	50 Yr:		1.7E-05	2.1E-03	1.7E-04	1.1E-09	1.2E-04
CM246	Class: W	2.09E-10					
	1 Yr:		1.7E-05	5.4E-05	4.3E-06	9.9E-10	5.2E-06
	50 Yr:		1.7E-05	2.2E-03	1.7E-04	9.9E-10	1.2E-04
CM247	Class: W	7.37E-07					
	1 Yr:		1.5E-05	5.0E-05	3.9E-06	1.4E-09	4.7E-06
	50 Yr:		1.5E-05	2.0E-03	1.6E-04	1.4E-09	1.1E-04
CM248	Class: W	1.69E-10					
	1 Yr:		6.2E-05	1.9E-04	1.5E-05	2.2E-08	1.9E-05
	50 Yr:		6.3E-05	7.8E-03	6.2E-04	2.2E-08	4.2E-04
CF252	Class: W	1.71E-10					
	1 Yr:		3.5E-05	1.5E-04	1.2E-05	1.1E-08	1.1E-05
	50 Yr:		3.5E-05	6.6E-04	5.3E-05	1.1E-08	3.5E-05

FACILITY.DAT:

Hanford Facility Source Terms eim / ris Nov. 26, 1990

Area - 200 WEST

Facility - 222-S Earthquake

Accident Description - 222-S
Earthquake

An earthquake (0.05 g) occurs causing bottled gases to leak into the tunnel and ignite.

The earthquake disables fire suppression systems.

Source Term

SR90	3.00E-02
Y 90	3.00E-02
CS137	2.40E-02
BA137M	2.27E-02
PU239	9.92E-04

Height of Release - 0. ft

xxx

Area - 200 WEST

Facility - 222-S Explosion in Hot Cell

Accident Description - 222-S
Explosion in Hot Cell

An explosion occurs in a 222-S Hot Cell from the improper use of flammable volatile substances.

Source Term

SR90	6.00E-03
Y 90	6.00E-03
CS137	9.00E-04
BA137M	8.51E-04

Height of Release - 0. ft

xxx

Area - 200 WEST

Facility - 222-S Loss of Confinement

Accident Description - 222-S
Loss of Confinement

Unfiltered venting of the storage and transfer tanks (in the 219-S Facility) occurs as the result of failure of the steam heater element, which saturates the HEPA with water vapor. This causes high differential pressure across the filter that ruptures the filter.

Source Term

SR90	1.37E-07
Y 90	1.37E-07
CS137	1.67E-07
BA137M	1.58E-07
PM147	6.57E-08
PU238	1.86E-12
PU239	7.25E-12
PU240	2.84E-12
PU241	1.57E-10
AM241	1.76E-09
CM244	5.88E-11

Height of Release - 0. ft

xxx

Area - 200 WEST

Facility - 224-T (TRUSAF) Drum Spill

Accident Description - 224-T (TRUSAF)
Drum Spill

A pallet with four drums is dropped while being moved by a forklift.
This results in the lid popping open and spilling the drum contents.

Source Term

PU238	4.27E-03
PU239	5.11E-03
PU240	2.83E-03
PU241	2.53E-01
PU242	4.33E-06

Height of Release - 0. ft

xxx

Area - 200 WEST

Facility - 2736-Z Vent Filter Failure

Accident Description - 2736-Z SUPPORT COMPLEX
Failure of Ventilation Filters

All three stages of HEPA filtration servicing the repackaging glovebox fail.
Open area ground level release.

Source Term

PU238	2.38E-03
PU239	2.85E-03
PU240	1.58E-03
PU241	1.41E-01
PU242	2.42E-06

Height of Release - 0. ft

xxx

Area - 200 WEST

Facility - 2736-Z Breach of Containment

Accident Description - 2736-Z SUPPORT COMPLEX
Breach of Containment

Complete oxidation of a 2-kg plutonium button in a can results in a volume expansion, causing the can to rupture.
Open area ground level release.

Source Term

PU238	1.42E-09
PU239	1.70E-09

PU240 9.40E-10
PU241 8.41E-08
PU242 1.44E-12

Height of Release - 0. ft

xxx

Area - 200 WEST

Facility - 2736-Z Criticality

Accident Description - 2736-Z SUPPORT COMPLEX
Criticality

A criticality occurs in Room 2 during the moving of Pu containers. An initial burst of $1\text{E}+18$ fissions occurs, followed by pulses of lesser magnitude over a period of 8 hours, resulting in a total of $1\text{E}+19$ fissions. Open area ground level release.

Source Term

KR83M 1.1E+02
KR85M 7.1E+01
KR85 8.1E-04
KR87 4.3E+02
KR88 2.3E+02
KR89 1.3E+04
I 131 2.8E+00
I 132 3.0E+02
I 133 4.0E+01
I 134 1.1E+03
I 135 1.1E+02
XE131M 1.0E-01
XE133M 2.2E+00
XE133 2.7E+01
XE135M 3.3E+03
XE135 4.1E+02
XE137 4.9E+04
XE138 1.1E+04

Height of Release - 0. ft

xxx

Area - 200 WEST

Facility - 224-U (UO3 PLANT) Breach of Containment

Accident Description - 224-U UO3 PLANT
Breach of Containment/Loss of Confinement Barriers

Breach of containment or a loss of confinement occurs at UO3 causing an

unintentional release of UO3.

Open area ground level release.

Source Term

U 238	8.86E-06
U 236	1.24E-06
U 235	4.74E-07
U 234	1.47E-05

Height of Release - 0. ft

xxx

Area - 200 WEST

Facility - 224-U (UO3 PLANT) Calciner Cell UO3 Release

Accident Description - 224-U UO3 PLANT
Release of UO3 in the Calciner Cell

A UO3 powder release occurs in the Calciner Cell due to a 30 gallon drum filled with 1,000 lbs of UO3 spilling.
Open area ground level release.

Source Term

U 238	8.86E-06
U 236	1.24E-06
U 235	4.74E-07
U 234	1.47E-05

Height of Release - 0. ft

xxx

Area - 200 WEST

Facility - 224-U (UO3 PLANT) Earthquake

Accident Description - 224-U UO3 PLANT
Earthquake

A 0.25 g magnitude earthquake occurs, and all UO3 Plant structures fail. All containment and confinement barriers also are breached, except for 90% of the T-Hoppers.
Open area ground level release.

Source Term

U 234	1.65E-01
-------	----------

U 235 5.29E-03
U 236 1.38E-02
U 238 9.76E-02

Height of Release - 0. ft

xxx

Area - 200 WEST

Facility - 224-U (U03 PLANT) High Wind

Accident Description - 224-U U03 PLANT
High Wind

The U03 Plant fails under high winds. All confinements and containment barriers are breached, except for 90% of the T-Hoppers.

Open area ground level release.

Source Term

U 234 2.11E-01
U 235 6.73E-03
U 236 1.77E-02
U 238 1.25E-01

Height of Release - 0. ft

xxx

Area - 200 WEST

Facility - Z-PLANT Propane Explosion

Accident Description - 234-5 Z (Z-PLANT)
Propane Explosion

An explosion occurs in a laboratory room. The explosion results in a major breach of the facility containment, in addition to breaching a glovebox which contains Pu.

Open area ground level release.

Source Term

PU238 6.41E-02
PU239 7.67E-02
PU240 4.25E-02
PU241 3.80E+00
PU242 6.00E-05

Height of Release - 0. ft

xxx

Area - 200 WEST

Facility - Z-PLANT Roof Fire

Accident Description - 234-5 Z (Z-PLANT)
Roof Fire

The 234-5Z Plant roof is ignited and the subsequent fire spreads to rooms below, ultimately involving one of the seven exhaust filter rooms.
Elevated (61 m) release.

Source Term

PU238	4.27E-03
PU239	5.11E-03
PU240	2.83E-03
PU241	2.53E-01
PU242	4.00E-06

Height of Release - 200. ft

xxx

Area - 200 WEST

Facility - Z-PLANT Processing Area Criticality

Accident Description - Z-PLANT
Criticality in Processing Area

A criticality occurs with a total of 1E+19 fissions.
Open area 61 m release.

Source Term

KR83M	1.1E+02
KR85M	7.1E+01
KR85	8.1E-04
KR87	4.3E+02
KR88	2.3E+02
KR89	1.3E+04
I 131	2.7E+00
I 132	3.0E+02
I 133	4.0E+01
I 134	1.1E+03
I 135	1.1E+02
XE131M	1.0E-01
XE133M	2.2E+00
XE133	2.7E+01
XE135M	3.3E+03

XE135 4.1E+02
XE137 4.9E+04
XE138 1.1E+04

Height of Release - 200. ft

xxx

Area - 200 WEST

Facility - Z-PLANT Red Oil Explosion

Accident Description - 234-5 Z Z-PLANT
Red Oil Explosion

"Red Oil" forms and results in an explosion in 236-Z cell. This causes portions of the south wall and/or door contained in the un-reinforced 1-ft wall of the concrete blocks, releasing contaminated cell atmosphere to the outside.

Open area ground level release.

Source Term

PU238 8.1E-02
PU239 9.7E-02
PU240 5.4E-02
PU241 4.8E+00
PU242 7.6E-05

Height of Release - 0. ft

xxx

Area - 200 WEST

Facility - Z-PLANT Earthquake

Accident Description - Z-PLANT
Earthquake

An earthquake occurs (0.05 g) with sufficient intensity to cause major damage to Z Plant, including collapse of 236-Z, and crushing of several E-4 containments within 234-5Z.

Open area ground level release.

Source Term

PU238 7.64E-01
PU239 9.15E-01
PU240 5.07E-01
PU241 4.55E+01
PU242 7.20E-04

Height of Release - 0. ft

xxx

Area - 200 WEST

Facility - Z-PLANT RMA Line HF Corrosion

Accident Description - 234-5 Z Z-PLANT
RMA Line HF Corrosion

The fiberglass portion of HEPA filters degrades due to reaction with HF. This leads to an eventual collapse from air pressure acting on the face of the filter. During and following the collapse, some portion of the entrained PuF4 articles are released up the 200 ft (61-m) stack.
61-m elevated release.

Source Term

PU238	1.28E-02
PU239	1.53E-02
PU240	8.49E-03
PU241	7.63E-01
PU242	1.20E-05

Height of Release - 200. ft

xxx

Area - 200 WEST

Facility - Z-PLANT RMA Line Fire

Accident Description - 234-5 Z Z-PLANT
RMA Line Fire

A major fire occurs in the RMA line involving gloveboxes.
61-m elevated release.

Source Term

PU238	5.55E-04
PU239	6.64E-04
PU240	3.68E-04
PU241	3.31E-02
PU242	5.20E-07

Height of Release - 200. ft

xxx

Area - 200 EAST

Facility - 225-B (WESF) Truck Port Fire

Accident Description - 225-B (WESF)
Fire in Truck Port

A truck leaks gasoline that subsequently ignites. The gas tank ruptures and 24 boxes with low-level waste are ignited and burn.

Source Term

SR90	1.44E+00
Y 90	1.44E+00
CS137	4.80E-01
BA137M	4.80E-01

Height of Release - 0. ft

xxx

Area - 200 EAST

Facility - 225-B (WESF) K-3 Filter Drop

Accident Description - 225-B (WESF)
K-3 Filter Dropped

A K-3 filter is dropped from 20 ft and ruptures.

Source Term

SR90	7.20E-01
Y 90	7.20E-01
CS137	8.00E-02
BA137M	8.00E-02

Height of Release - 0. ft

xxx

Area - 200 EAST

Facility - 225-B (WESF) Loaded K3 Filter Drop

Accident Description - 225-B (WESF)
Loaded K-3 Filter Dropped

All the duct contamination has impacted a K-3 filter, resulting in twenty times above normal loading. This K-3 filter is then ruptured because it is inadvertently dropped (from 20 ft above ground) as a crane is replacing it.

Source Term

SR90	14.4
Y 90	14.4
CS137	1.6
BA137M	1.6

Height of Release - 0. ft

xxx

Area - 200 EAST

Facility - 225-B (WESF) K-3 Filter Release

Accident Description - 225-B (WESF)
Release to K-3 Filter

All duct contamination is released to an already radioactively loaded K-3 filter and 1 E-06 of the activity is released to the environment.

Source Term

SR90	1.4E-02
Y 90	1.4E-02
CS137	1.6E-03
BA137M	1.6E-03

Height of Release - 0. ft

xxx

Area - 200 EAST

Facility - 221-B (B PLANT) Seismic Event

Accident Description - 221-B B Plant
Seismic Event

An earthquake occurs > 0.125 g.
The stack breaks and falls on some exhaust HEPAS, causing them to fail.
The roof and some parts of canyon walls collapse, resulting in a series of events leading to releases.
Open area ground level release.

Source Term

SR90	335.
CS137	1.4

Height of Release - 0. ft

xxx

Area - 200 EAST

Facility - PUREX PuOxide Production Criticality

Accident Description - 202-A PUREX
Criticality in Pu Oxide Production Facility

A criticality occurs in an unshielded process area of the PUREX plant. The cause is an undetected accumulation of plutonium oxalate on the calciner glovebox floor.
Open area ground level release.

Source Term

KR83M	1.1E+02
KR85	8.1E-04
KR85M	7.1E+01
KR87	4.3E+02
KR88	2.3E+02
KR89	1.3E+04
XE131M	1.0E-01
XE133	2.7E+01
XE133M	2.2E+00
XE135	4.1E+02
XE135M	3.3E+03
XE137	4.9E+04
XE138	1.1E+04
I 131	2.8E+00
I 132	3.0E+02
I 133	4.0E+01
I 134	1.1E+03
I 135	1.1E+02

Height of Release - 0. ft

xxx

Area - 200 EAST

Facility - PUREX U Metal Fire in Dissolver

Accident Description - 202-A PUREX
Uranium Metal Fire in Dissolver

Fire results from irradiated N Reactor Fuel elements being exposed to air in one of three PUREX Plant fuel dissolvers because of a failure to add adequate water to the dissolver.
61-m stack release.

Source Term

KR85	4.1E+03
SR89	3.2E+00
SR90	3.4E-01
Y 90	3.4E-01
Y 91	4.8E+00
ZR95	6.2E+00
NB95	1.1E+01
RU103	1.3E+01
RU106	7.5E+00
SB125	2.0E-02
TE127M	3.8E-03
TE127	3.7E-02
TE129M	4.1E-02
TE129	2.6E-02
I 129	4.6E-04
I 131	3.4E-02
XE131M	2.5E+00
RH103M	1.3E+01
RH106	7.5E+00
BA137M	3.4E+00
NB95M	5.1E-02
TE125M	4.3E-03
PR144M	8.3E-02
EU155	3.6E-03
CS134	1.9E-01
CS137	3.5E+00
CE141	1.2E+00
CE144	6.9E+00
PR144	6.9E+00
PM148M	1.4E-02
PM147	1.2E+00
U 234	3.1E-05
U 235	1.6E-06
U 236	3.7E-06
U 238	3.1E-05
PU238	4.1E-05
PU239	5.7E-03
PU240	1.4E-03
PU241	7.0E-02
PU242	8.9E-08
AM241	6.2E-05

Height of Release - 200. ft

xxx

Area - 200 EAST

Facility - PUREX Silver Reactor Explosion

Accident Description - PUREX
Silver Reactor Explosion

An explosion in the DOG silver reactor occurs during fuel dissolution at the PUREX Plant.
61-m stack release.

Source Term

SR89	3.7E-11
SR90	4.0E-02
Y 90	4.0E-02
Y 91	1.3E-09
ZR95	9.8E-09
NB95	2.2E-08
RU103	2.9E-14
RU106	6.8E-03
SB125	1.1E-03
TE127M	1.4E-07
TE127	1.4E-07
TE129M	6.2E-18
TE129	3.9E-18
I 129	1.4E-00
I 131	2.7E-02
NB95M	8.0E-11
RU103M	2.9E-14
RH106	6.8E-03
AG110M	1.3E-05
SN123	3.5E-07
TE125M	2.6E-04
CS134	1.6E-03
BA137M	4.3E-02
CS137	4.5E-02
CE141	4.8E-17
CE144	1.5E-02
PR144	1.5E-02
PM147	4.8E-02
PM148	1.5E-16
PM148M	3.2E-15
SM151	1.2E-04
EU154	3.7E-04
EU155	2.0E-04
PU238	1.7E-04
PU239	5.9E-04
PU240	3.3E-04
PU241	2.7E-02
PU242	1.2E-07
AM241	2.2E-04

Height of Release - 200. ft

xxx

Area - 200 EAST

Facility - PUREX P&O Gallery 6% Pu Release

Accident Description - PUREX

Plutonium Release via the P&O Gallery

A pipe leak occurs and releases Pu (6% of Pu-240) and some fission products through the P&O Gallery and White Room Ventilation systems.
Open area ground level release.

Source Term

SR89	5.4E-04
SR90	5.5E-05
Y 90	5.5E-05
Y 91	8.2E-04
ZR95	1.0E-03
NB95	1.9E-03
NB95M	8.3E-06
RH103M	2.2E-04
RU103	2.2E-04
RH106	1.1E-04
RU106	1.1E-04
SB125	3.1E-06
TE125M	7.6E-07
TE127	6.1E-06
TE127M	6.2E-06
TE129	7.1E-06
TE129M	7.2E-06
I 129	7.8E-11
I 131	7.9E-09
CS134	2.4E-06
BA137M	5.4E-05
CS137	5.7E-05
CE141	2.1E-04
CE144	1.1E-03
PR144	1.1E-03
PM147	2.0E-04
U 234	6.5E-10
U 235	4.4E-11
U 236	8.0E-11
U 238	6.5E-10
PU238	2.2E-04
PU239	4.1E-03
PU240	8.2E-04
PU241	3.4E-02
PU242	3.6E-08
AM241	6.3E-09

Height of Release - 0. ft

xxx

Area - 200 EAST

Facility - PUREX P&O Gallery 12% Pu Release

Accident Description - PUREX

Plutonium Release via the P&O Gallery

A pipe leak occurs and releases Pu (12% of Pu-240) and some fission products through the P&O Gallery and White Room Ventilation systems.

Open area ground level release.

Source Term

SR89	5.2E-07
SR90	1.5E-04
Y 90	1.5E-04
Y 91	1.9E-06
ZR95	5.4E-06
NB95	1.3E-05
NB95M	4.5E-08
RH103M	2.5E-08
RU103	2.5E-08
RH106	1.8E-04
RU106	1.8E-04
SB125	7.8E-06
TE125M	1.9E-06
TE127	5.1E-07
TE127M	6.3E-07
TE129	7.9E-11
TE129M	1.1E-10
I 129	2.6E-10
CS134	1.5E-06
BA137M	1.5E-04
CS137	1.6E-04
CE141	2.3E-09
CE144	7.4E-04
PR144	7.4E-04
PM147	3.6E-04
U 234	6.5E-10
U 235	3.4E-11
U 236	1.3E-10
U 238	6.5E-10
PU238	1.1E-03
PU239	3.7E-03
PU240	2.1E-03
PU241	1.9E-01
PU242	7.5E-07
AM241	3.8E-07

Height of Release - 0. ft

xxx

Area - 200 EAST

Facility - PUREX Oxide Line Fire

Accident Description - PUREX
Oxide Line Fire

A solvent fire occurs in PUREX N Cell resulting in a release of Pu to the environment. The PUREX Pu nitrate solution is converted to Pu Oxide in the N Cell.

Open area ground level release.

Source Term

PU238	2.7E-02
PU239	8.4E-02
PU240	4.8E-02
PU241	4.6E+00
PU242	1.7E-05

Height of Release - 0. ft

xxx

Area - 200 WASTE

Facility - 241-A Db1 Shell Tank Dome Collapse

Accident Description - 241-A DOUBLE-SHELL TANK FARM FACILITY
Dome Collapse

A 5% mixture of H₂ ignites above the crust. The top 1-foot of the crust is dry and of a reactive mixture, and consequently also ignites.

Source Term

SR90	7.70E+00
Y 90	7.70E+00
TC99	1.30E+00
CS137	4.02E+02
SM151	1.29E+01
U 235	3.00E-04
NP237	8.00E-03
U 238	5.00E-03
PU238	1.00E-03
PU239	1.00E-02
PU240	3.00E-03
PU241	6.50E-02
AM241	2.00E-02
PU242	1.20E-07

CM242 2.00E-04

Height of Release - 0. ft

xxx

Area - 200 WASTE

Facility - 241-A Db1 Shell Tank Filter Failure

Accident Description - 241-AP DOUBLE-SHELL TANK FARM FACILITY
Filter Failure

A mixture of hydrogen ignites above the crust, but the crust does not react.
The dome does not collapse, however, the HEPAs fail.

Source Term

SR90	3.80E-01
Y 90	4.00E-01
TC99	6.00E-02
CS137	1.98E+01
SM151	6.40E-01
U 235	1.00E-05
NP237	4.00E-04
U 238	2.00E-04
PU238	5.00E-05
PU239	5.00E-04
PU240	1.00E-04
PU241	3.20E-03
AM241	1.00E-03

Height of Release - 0. ft

xxx

Area - 200 WASTE

Facility - A-350 LIFT STATION (241-A Tank Farms)

Accident Description - A-350 LIFT STATION
Breach of Pump Pit and Receiver Tank

During removal or replacement of pump pit cover blocks, crane failure allows
a cover block to fall. The block penetrates the pump pit floor and ruptures
the receiver tank.

Open area ground level release.

Source Term

CS137	1.6E-03
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SR90 3.2E-05
PU239 1.2E-08

Height of Release - 0. ft

xxx

Area - 200 WASTE

Facility - 242-A EVAP/CRYSTALLIZER Loss of Confinement

Accident Description - 242-A EVAPORATOR/CRYSTALLIZER
Loss of Confinement Scenario

The heater steam coil (that raises the temperature of the airstream to above the dew point of water) fails, saturating the filter media and dissolving the accumulated activity. A simultaneous failure in the interlock system (that would otherwise shut-down the vessel vent fan) allows it to continue running such that the solubilized activity is drawn through the filters and released. Open area ground level release.

Source Term

SR90 1.7E-03
CS137 1.2E-02
PU239 9.3E-07
AM241 1.9E-05

Height of Release - 0. ft

xxx

Area - 200 WASTE

Facility - 242-A EVAP/CRYSTALLIZER Tornado

Accident Description - 242-A EVAPORATOR/CRYSTALLIZER
Tornado

A tornado with 120 mi/hr total horizontal winds occurs, generating missiles and negative pressure transients that cause the loading dock door to fail. This leads to a resuspension of radioactive material from contaminated surfaces. The K1 ventilation system HEPA filter housing is destroyed, releasing activity accumulated on the filters and deposited in the ductwork.

Source Term

SR90 6.7E-02
CS137 4.7E-01
PU239 3.6E-05
AM241 7.4E-04

Height of Release - 0. ft

xxx

Area - 200 WASTE

Facility - 241&244 SaltWellWasteRec. Earthquake

Accident Description - 244-A, 244-BX, 241-AN-101, 244-S, 244-TX, AND 244-U
SALT WELL WASTE RECEIVER FACILITIES
Earthquake

This is the worst case accident scenario. A 0.25-g earthquake occurs which damages the 244-CR facility, its exhaust ventilation and the 15,000 gallon 003-CR tank, which is filled with salt well liquor.
Open area ground level release

Source Term

CS137	7.6E+00
SR90	1.5E-01
PU239	6.1E-04

Height of Release - 0. ft

xxx

Area - 200 WASTE

Facility - 241&244 SaltWellWasteRec. Vent Failur

Accident Description - 244-A, 244-BX, 241-AN-101, 244-S, 244-TX, AND 244-U
SALT WELL WASTE RECEIVER FACILITIES
Failure of Ventilation System

Both stages of HEPA filters on the exhaust ventilation system fail. In addition the stack radiation monitor fails so that the failure is not detected for 8 hours.
Open area ground level release.

Source Term

CS137	6.9E-01
SR90	1.0E-02
PU239	5.6E-04

Height of Release - 0. ft

xxx

Area - 200 WASTE

Facility - 241&244 Salt Well Waste Pump Pit&Tank

Accident Description - 244-A, 244-BX, 241-AN-101, 244-S, 244-TX, AND 244-U
SALT WELL WASTE RECEIVER FACILITIES
Breach of Pump Pit and Primary Tank

During removal or replacement of the pump pit cover blocks, a crane failure allows a cover block to fall. The block penetrates the pump pit floor and ruptures the primary tank resulting in a release of radioactive mist.
Open area ground level release.

Source Term

CS137	1.5E-02
SR90	3.0E-04
PU239	1.2E-05

Height of Release - 0. ft

xxx

Area - 200 WASTE

Facility - NONSTABILIZED SINGLE SHELL TANKS

Accident Description - NONSTABILIZED SINGLE SHELL TANKS
Loss of Seal Loop Fluid

An unfiltered airborne release occurs from a loss of fluid in the seal loop.
Open area ground level release.

Source Term

C 14	8.24E-06
NI63	2.35E-05
SR90	2.35E-02
Y 90	2.35E-02
TC99	2.35E-05
RU106	7.05E-08
RH106	7.05E-08
SN126	7.05E-08
SB126M	7.05E-08
CS135	1.18E-07
CS137	2.35E-02
BA137M	2.22E-02
SM151	8.24E-05
U 233	7.05E-13
U 234	1.18E-14
U 235	3.53E-13
NP237	4.70E-08
PU238	1.18E-09
PU239	3.53E-12

PU240	9.36E-11
PU241	9.36E-12
AM241	3.53E-05
AM242M	5.87E-08
AM242	5.84E-08
AM243	2.35E-08
NP239	2.35E-08
CM242	4.70E-08
CM244	2.35E-07
CM245	8.24E-12
U 238	9.36E-12

Height of Release - 0. ft

xxx

Area - 200 WASTE

Facility - STABILIZED SINGLE-SHELL TANK

Accident Description - STABILIZED SINGLE-SHELL TANK
Exhaust System Breach

A breach occurs in a mechanically exhausted system in which the tank dome atmosphere is exhausted directly to the atmosphere by continued fan operation.

Source Term

SR90	1.84E-01
CS137	9.20E-03
PU238	9.20E-07
PU239	5.60E-05
PU240	9.20E-06
PU241	9.20E-05
AM241	9.20E-05

Height of Release - 0. ft

xxx

Area - 200 WASTE

Facility - Solid Waste Burial: Truck Accident

Accident Description - ACTIVE AND RETIRED RADIOACTIVE SOLID WASTE
BURIAL GROUNDS
Waste Truck Accident

A truck containing 100 containers, half containing ^{137}Cs - ^{90}Sr and half containing ^{239}Pu has an accident in the burial grounds. The waste containers are exposed to heat from a fire resulting from the accident and burn for 30

minutes. - Open area ground level release.

Source Term

SR90	4.0E-01
CS137	4.0E-01
PU239	1.0E-03

Height of Release - 0. ft

xxx

Area - 200 WASTE

Facility - Solid Waste Burial Grounds: Fire

Accident Description - ACTIVE AND RETIRED RADIOACTIVE SOLID WASTE
BURIAL GROUNDS
Fire

A fire is started (via chemical interactions, lightning or sparks) in a cardboard box containing non-TRU contaminated plastics, fabrics and rubber. Other boxes in the trench ignite and the fire burns for 2 hours before being extinguished. - Open area ground level release.

Source Term

SR90	2.0E+00
CS137	1.0E+00

Height of Release - 0. ft

xxx

Area - 400/300

Facility - FFTF Loss of Cooling in IEM Cell

Accident Description - FFTF
Loss of Cooling in IEM Cell

A loss of off-site and emergency electrical power occurs. The loss of argon circulation over 2 bare subassemblies causes cladding failure within 15 minutes and partial cladding meltdown 2 hrs later.
Open area ground level release.

Source Term

KR85	6.8E+01
RB86	4.0E+01
SR89	1.1E+02
SR90	4.2E+00

SR91	1.4E-10
Y 90	4.2E+00
Y 91M	9.0E-11
Y 91	1.5E+02
ZR95	2.8E+02
ZR97	6.0E-05
NB95	2.8E+02
MO99	9.2E+00
TC99M	8.6E+00
RU103	3.8E+02
RU106	1.5E+02
RH105	2.8E-01
SB125	2.8E+00
SB126	3.2E-01
SB127	2.4E+00
TE127M	4.4E+00
TE127	6.6E+00
TE129M	1.9E+01
TE129	1.2E+01
TE131M	7.2E-03
TE132	1.5E+01
I 129	1.2E-04
I 131	2.2E+03
I 132	3.8E+02
I 133	4.1E-02
I 135	3.9E-14
XE133	9.4E+03
XE135	5.0E-08
CS134	2.2E+02
CS136	6.3E+02
CS137	5.7E+02
BA140	1.9E+02
LA140	2.2E+02
CE141	3.0E+02
CE143	1.2E-01
CE144	1.5E+02
PR143	1.9E+02
PR144	1.5E+02
ND147	6.8E+01
PU238	6.5E-04
PU239	2.0E-03
PU240	1.5E-03
PU241	5.5E-02
AM241	7.0E-04
CM242	4.1E-02

Height of Release - 0. ft

xxx

Area - 400/300

Facility - FFTF Cover GasSample System Pipe Fail

Accident Description - FFTF

Cover Gas Sampling System Pipe Failure

The gas sampling line of the reactor cover gas fails. The reactor is operating with 1% failed fuel. The argon feed and bleed controls continue to supply fresh argon at max capacity, causing a purge of the cover gas through the line break.

Open area ground level release.

Source Term

KR83M	6.9E+02
KR85M	1.9E+03
KR85	3.3E-01
KR87	1.6E+03
KR88	3.2E+03
XE131M	1.3E+01
XE133M	3.0E+02
XE133	6.3E+03
XE135	2.2E+04

Height of Release - 0. ft

xxx

Area - 400/300

Facility - FFTF Surge & Delay Tank & CAPS Fail

Accident Description - FFTF

Surge and Delay Tank and CAPS Failure

The surge and delay tank is ruptured while containing the maximum radioactivity and CAPS fails.

Open area ground level release.

Source Term

AR41	5.4E+00
KR83M	7.3E+02
KR85M	7.9E+02
KR85	1.0E+00
KR87	5.7E+02
KR88	2.0E+03
XE131M	5.3E+01
XE133M	1.0E+03
XE133	2.5E+04
XE135	3.7E+04

Height of Release - 0. ft

xxx

Area - 400/300

Facility - FFTF Sodium Spill

Accident Description - FFTF
Sodium Spill

867 lbs of sodium is released to the pipe-way and 53.7 lb of the total release burns to form an airborne oxide.

Open area ground level release.

Source Term

NA22	2.2E-02
NA24	6.3E+02
I 131	5.9E+00
I 133	1.2E+01
I 135	1.2E+01
CS134	5.9E-02
CS136	4.1E-01
CS137	1.8E-01
TA182	2.4E-02

Height of Release - 0. ft

xxx

Area - 400/300

Facility - FFTF Earthquake

Accident Description - FFTF
Earthquake

An earthquake causes a power failure, resulting in: loss of forced cooling in IEM cell (assuming no containment and rate-limited IEM Cell leakage), reactor cover gas sampling system pipe failure, and accidental sodium release from sodium and argon sampling pipe-way.

Source Term

NA22	2.2E-02
NA24	6.3E+02
KR83M	6.9E+02
KR85M	1.9E+03
KR85	6.8E+01
KR87	1.6E+03
KR88	3.2E+03
RB86	4.0E+01
SR89	1.1E+02

SR90	4.2E+00
Y 90	4.2E+00
Y 91	1.5E+02
ZR95	2.8E+02
NB95	2.8E+02
M099	9.2E+00
TC99M	8.6E+00
RU103	3.8E+02
RH105	2.8E-01
RU106	1.5E+02
SB125	2.8E+00
SB126	3.2E-01
SB127	2.4E+00
TE127M	4.4E+00
TE127	6.6E+00
TE129	1.2E+01
TE129M	1.9E+01
TE132	1.5E+01
I 131	2.2E+03
I 132	3.8E+02
I 133	1.2E+01
I 135	1.2E+01
XE131M	1.3E+01
XE133M	3.0E+02
XE133	1.6E+04
XE135	2.2E+04
CS134	2.2E+02
CS136	6.3E+02
CS137	5.7E+02
BA140	1.9E+02
LA140	2.2E+02
CE141	3.0E+02
CE143	1.2E-01
PR143	1.9E+02
CE144	1.5E+02
PR144	1.5E+02
ND147	6.8E+01
TA182	2.4E-02
PU238	6.5E-04
PU239	2.0E-03
PU240	1.5E-03
PU241	5.5E-02
AM241	7.0E-04
CM242	4.1E-02

Height of Release - 0. ft

xxx

Area - 400/300

Facility - FFTF Tornado

Accident Description - FFTF
Tornado

Tornado causes power failure and blockage of containment isolation valves.
Radioactivity is released from containment in 4 hours at containment
ventilation rate.

Source Term

KR83M	5.6E+02
KR85M	1.7E+03
KR85	3.5E-00
KR87	1.2E+03
KR88	2.8E+03
XE131M	1.5E+01
XE133M	2.9E+02
XE133	6.2E+03
XE135	2.2E+04

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 306-W Criticality

Accident Description - 306-W FACILITY, DIVERSIFIED METALWORKING,
CERAMICS LABORATORY, SNM STORAGE AREA,
AND SUPPORT LABORATORIES
Criticality

Source Term

KR83M	2.61E+01
KR85M	1.13E+02
KR85	1.08E-03
KR87	7.00E+02
KR88	4.55E+02
KR89	2.89E+04
KR90	1.09E+05
KR91	4.57E+05
I 131	1.28E+00
I 132	4.69E+00
I 133	2.45E+01
I 134	3.36E+02
I 135	8.54E+01
XE131M	2.67E-03
XE133M	3.85E-01
XE133	9.10E+00
XE135M	7.70E+00

XE135	1.11E+02
XE137	2.66E+04
XE138	8.40E+03
XE139	9.66E+04
XE140	2.98E+05

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 306-W Sintering Furnance Explosion

Accident Description - 306-W FACILITY, DIVERSIFIED METALWORKING,
CERAMICS LABORATORY, SNM STORAGE AREA,
AND SUPPORT LABORATORIES
Sintering Furnance Explosion

A hydrogen explosion occurs in the Hydrogen Sintering Furnaces located in the Ceramic Laboratory.
Open area ground level release.

Source Term

U 234	4.92E-03
U 235	6.07E-04
U 236	1.70E-03
U 238	2.51E-02

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 306-E Pu Capsule Breach

Accident Description - 306-E, DEVELOPMENT, FABRICATION AND TESTING LABORATORY
Pu Capsule Breach

All capsules are assumed to be breached by some undefined major disruptive event (such as an explosion). The entire permitted inventory is assumed to be present at one time.

Open area ground level release.

Source Term

TC99	1.0E-01
I 129	1.0E-03
ND147	1.0E-01
U 234	7.6E-04

U 235	6.6E-06
U 236	1.2E-03
U 238	1.6E-07
NP237	1.0E-04
PU236	1.0E-03
PU239	1.0E-04
AM243	1.0E-04
CM244	1.0E-04
CM246	1.0E-04
CM248	1.0E-05
CF252	1.0E-03

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 308 Criticalty: Massive Glovebox Fail

Accident Description - 308 FACILITY, THE FUELS DEVELOPMENT LABORATORY
Criticality in Glovebox, Massive Glovebox Failure

An initial excursion of $1\text{E}+18$ fissions occurs, followed by pulses of $1.9\text{E}+17$ fissions at ten-min intervals for 8 hours, for a total of $1\text{E}+19$ fissions. Since the glovebox ventilation system is assumed to be severed, fission products are released into the room and exhausted through the main building ventilation system, producing some radioactive decay during holdup. Open area ground level release.

Source Term

KR83M	9.2E+01
KR85M	6.6E+01
KR85	8.1E-04
KR87	3.4E+02
KR88	2.0E+02
KR89	1.7E+03
XE131M	1.0E-01
XE133M	2.2E+00
XE133	2.7E+01
XE135M	1.4E+03
XE135	3.9E+02
XE137	7.5E+03
XE138	4.5E+03
I 131	2.8E+00
I 132	2.6E+02
I 133	3.9E+01
I 134	7.9E+02
I 135	1.0E+02

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 308 Criticalty: Partial Glovebox Fail

Accident Description - 308 FACILITY, THE FUELS DEVELOPMENT LABORATORY
Criticality in Glovebox, Partial Glovebox Failure

An initial excursion of $1\text{E}+18$ fissions occurs, followed by pulses of $1.9\text{E}+17$ fissions at ten-min intervals for 8 hours, for a total of $1\text{E}+19$ fissions. Since the glovebox ventilation system is assumed to remain intact, there is almost no holdup or decay time in the building.
Open area ground level release.

Source Term

KR83M	$1.1\text{E}+02$
KR85M	$7.1\text{E}+01$
KR85	$8.1\text{E}-04$
KR87	$4.3\text{E}+02$
KR88	$2.3\text{E}+02$
KR89	$1.3\text{E}+04$
XE131M	$1.0\text{E}-01$
XE133M	$2.2\text{E}+00$
XE133	$2.7\text{E}+01$
XE135M	$3.3\text{E}+03$
XE135	$4.1\text{E}+02$
XE137	$4.9\text{E}+04$
XE138	$1.1\text{E}+04$
I 131	$2.8\text{E}+00$
I 132	$3.0\text{E}+02$
I 133	$4.0\text{E}+01$
I 134	$1.1\text{E}+03$
I 135	$1.1\text{E}+02$

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 308 Pu Oxide Spill

Accident Description - 308 FACILITY, THE FUELS DEVELOPMENT LABORATORY
Plutonium Oxide Spill

A Plutonium spill occurs in Room 113 which is large enough to saturate the room air. This corresponds to an air concentration of 100 mg PuO₂ per cubic meter.
Open area ground level release.

Source Term

PU238	1.03E-05
PU239	4.50E-06
PU240	4.50E-06
PU241	7.25E-04
PU242	7.50E-09

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 308 Severe Earthquake

Accident Description - 308 FACILITY, THE FUELS DEVELOPMENT LABORATORY
Severe Earthquake

A seismic event having a 0.2 g horizontal ground acceleration occurs. 1% of 6 kg of pellets in the glovebox and 10% of 225 g of pellets at the cleaning station were assumed to be crushed.
Open area ground level release.

Source Term

PU238	1.64E-03
PU239	3.37E-03
PU240	1.89E-03
PU241	1.32E-01

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 324 One pin release

Accident Description - 324 FACILITY, THE CHEMICAL AND MATERIALS
ENGINEERING LABORATORY
One pin release

A pin is dropped or impacted with equipment while being moved. Reactive Fuel, no iodine filtration case.
46-m release height.

Source Term

I 131	5.27E+01
KR85	4.86E+00
XE131M	6.56E+00

XE133M	8.98E-02
XE133	1.08E+02
SE79	2.84E-10
AS76	6.12E-16
RB86	5.08E-06
RB87	1.20E-14
CD113M	1.36E-07
CD115M	2.01E-06
CD115	4.98E-09
CS134	4.79E-05
CS135	1.53E-09
CS136	6.04E-05
CS137	1.02E-04
SR89	1.70E-05
SR90	7.74E-07
Y 90	7.74E-07
Y 91	2.35E-05
ZR93	4.00E-11
ZR95	4.36E-05
ZR97	1.02E-17
NB93M	1.81E-12
NB95M	5.53E-07
NB95	5.06E-05
NB97M	8.78E-18
NB97	1.10E-17
MO99	4.83E-08
TC99M	4.59E-08
RU103	5.65E-05
RU106	2.61E-05
RH103M	5.65E-05
RH105	7.03E-11
RH106	2.61E-05
PD107	4.19E-12
AG110	9.53E-07
AG111	3.39E-07
IN114M	2.21E-11
IN114	2.14E-11
IN115M	1.09E-10
SN117M	1.50E-10
SN119M	1.38E-08
SN121M	2.50E-11
SN123	4.93E-07
SN125	1.81E-07
SN126	2.45E-12
SB124	3.32E-08
SB125	5.23E-07
SB126M	2.45E-12
SB126	3.00E-08
SB127	3.30E-08
TE123M	2.87E-10
TE125M	1.03E-07
TE127M	7.61E-07

TE127	7.76E-07
TE129M	2.66E-06
TE129	1.69E-06
TE131M	5.47E-13
TE131	9.98E-14
TE132	1.32E-07
BA137M	1.93E-06
BA140	1.62E-05
LA140	1.87E-05
CE141	4.21E-05
CE143	1.87E-11
CE144	2.60E-05
PR143	1.65E-05
PR144	2.60E-05
ND147	5.04E-06
PM147	6.27E-06
PM148M	9.45E-07
PM148	1.03E-07
PM149	1.88E-09
PM151	3.16E-13
SM151	8.18E-08
SM153	1.62E-10
EU152	3.23E-10
EU154	4.50E-08
EU155	3.54E-07
EU156	7.40E-07
GD153	7.01E-11
TB160	5.89E-08
HO166M	4.01E-13
PU239	5.60E-08
PU240	5.52E-08
PU241	8.65E-06

Height of Release - 151. ft

xxx

Area - 400/300

Facility - 324 200 pin release

Accident Description - 324 FACILITY, THE CHEMICAL AND MATERIALS
ENGINEERING LABORATORY
200 pin release

A load from the three-ton in-cell crane drops onto the in-cell storage unit and all the pins are breached. Reactive Fuel, no iodine filtration case. 46-m release height.

Source Term

I 131 2.01E+02

KR85	7.73E+02
XE131M	1.04E+03
XE133M	1.43E+01
XE133	1.72E+04
SE79	1.06E-06
RB87	4.47E-11
CD113M	4.41E-04
CD115M	4.87E-10
CS134	6.70E-02
CS135	5.70E-06
CS137	3.56E-01
SR89	4.31E-08
SR90	2.68E-03
Y 90	2.68E-03
Y 91	2.96E-07
ZR93	1.49E-07
ZR95	2.06E-06
NB95M	2.62E-08
NB95	4.45E-06
RU103	1.68E-09
RU106	1.31E-02
RH103M	1.68E-09
RH106	1.31E-02
PD107	1.56E-08
AG110	1.90E-04
IN114M	2.76E-14
IN114	2.66E-14
SN119M	2.52E-06
SN121M	8.92E-08
SN123	5.99E-06
SN126	9.08E-09
SB124	5.82E-10
SB125	9.29E-04
SB126M	9.08E-09
SB126	1.27E-09
TE123M	2.24E-09
TE125M	2.27E-04
TE127M	3.23E-06
TE127	3.17E-06
TE129M	2.49E-12
TE129	1.58E-12
BA137M	6.72E-03
CE141	2.18E-11
CE144	7.19E-03
PR144	7.19E-03
PM147	1.08E-02
PM148M	6.07E-11
PM148	4.18E-12
SM151	2.97E-04
EU152	1.03E-06
EU154	1.32E-04
EU155	8.63E-04

GD153	1.21E-08
TB160	8.05E-09
H0166M	1.49E-09
PU239	1.12E-05
PU240	1.10E-05
PU241	1.73E-03

Height of Release - 151. ft

xxx

Area - 400/300

Facility - 324 Safeguards Vault&Lab Criticality

Accident Description - 324 FACILITY, THE CHEMICAL AND MATERIALS
ENGINEERING LABORATORY
Safeguards Vault & Laboratory Criticality

A criticality occurs in the vault because of considerable overbatching, arrangement of containers in an improper configuration with water moderation and reflection. A total of 1E+19 fissions occur. No charcoal filtration, but HEPA filtration remains in place. - 46-m release height.

Source Term

KR83M	1.1E+02
KR85M	7.1E+01
KR85	8.1E-04
KR87	4.3E+02
KR88	2.3E+02
KR89	1.3E+04
XE131M	1.0E-01
XE133M	2.2E+00
XE133	2.7E+01
XE135M	3.3E+03
XE135	4.1E+02
XE137	4.9E+04
XE138	1.1E+04
I 131	2.8E+00
I 132	3.0E+02
I 133	4.0E+01
I 134	1.1E+03
I 135	1.1E+02
PU238	1.5E-09
PU239	6.8E-11
PU240	1.5E-10
PU241	4.5E-08
PU242	1.1E-12
AM241	6.0E-11

Height of Release - 151. ft

xxx

Area - 400/300

Facility - 324 Vault Criticality: Filters In Place

Accident Description - 324 FACILITY, THE CHEMICAL AND MATERIALS
ENGINEERING LABORATORY
Vault Criticality with Filter In Place

A criticality occurs in the vault because of considerable overbatching, arrangement of containers in an improper configuration with water moderation and reflection. A total of $1\text{E}+19$ fissions occur. HEPA and charcoal filtration remain in place. - 46-m release height.

Source Term

KR83M	1.1E+02
KR85M	7.1E+01
KR85	8.1E-04
KR87	4.3E+02
KR88	2.3E+02
KR89	1.3E+04
XE131M	1.0E-01
XE133M	2.2E-00
XE133	2.7E+01
XE135M	3.3E+03
XE135	4.1E+02
XE137	4.9E+04
XE138	1.1E+04
I 131	1.4E-01
I 132	1.5E+01
I 133	2.0E-00
I 134	5.4E+01
I 135	5.6E-00

Height of Release - 151. ft

xxx

Area - 400/300

Facility - 324 Plutonium Oxide Spill

Accident Description - 324 FACILITY, THE CHEMICAL AND MATERIALS
ENGINEERING LABORATORY
Plutonium Oxide Spill

High exposure PuO₂ is spilled in Room 3K. The spill is large enough to saturate the air, corresponding to an air concentration of 100 mg PuO₂ per m³.
46-m release height.

Source Term

PU238	2.29E-06
PU239	1.04E-06
PU240	1.03E-06
PU241	1.61E-04
PU242	1.70E-09

Height of Release - 151. ft

xxx

Area - 400/300

Facility - 325 Criticality

Accident Description - 325 RADIOCHEMISTRY BUILDING
Criticality

Criticality excursion involving $5E+17$ fissions.

Source Term

KR83M	5.5E-00
KR85M	3.6E-00
KR85	4.1E-05
KR87	2.2E+01
KR88	1.2E+01
KR89	6.5E+02
XE131M	5.0E-03
XE133M	1.1E-01
XE133	1.4E-00
XE135M	1.7E+02
XE135	2.1E+01
XE137	2.5E+03
XE138	5.5E+02
I 131	1.4E-01
I 132	1.5E+01
I 133	2.0E-00
I 134	5.4E+01
I 135	5.6E-00

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 325 Earthquake

Accident Description - 325 RADIOCHEMISTRY BUILDING
Earthquake

An earthquake having a magnitude of 0.25 g occurs. The CEP0D gloveboxes suffer a 10% loss of containment, while all 325 Facility engineered reduction and removal mechanisms for radionuclides are lost.
Open area ground level release.

Source Term

PU239 7.29E-04
PU240 1.70E-04

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 325 Ion-Exchange Explosion

Accident Description - 325 RADIOCHEMISTRY BUILDING
Ion-Exchange Explosion

The Pu purification column in the glovebox explodes. The explosion destroys the glovebox window and exhaust filter and sprays liquid into the room.
Open area ground level release.

Source Term

PU239 4.32E-08
PU240 9.99E-09

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 327 Bldg: PIN BREACH

Accident Description - 327, POSTIRRADIATION TESTING LABORATORY
Pin Shear during Transfer, Reactive Fuel Case:

Irradiated pins containing the maximum permissible radionuclide inventory are sheared open in a handling accident in the canyon.
Open area ground level release.

Source Term

I 129 7.99E+00
KR85 1.51E+02
XE131M 2.04E+02
XE133M 2.79E+00

XE133	3.36E+03
SE79	4.25E-05
RB87	1.79E-09
CD113M	1.77E-02
CD115M	1.95E-08
CS134	2.69E+00
CS135	2.29E-04
CS137	1.42E+01
SR89	1.73E-06
SR90	1.07E-01
Y 90	1.07E-01
Y 91	1.19E-05
ZR93	5.96E-06
ZR95	8.27E-05
NB95M	1.05E-06
NB95	1.78E-04
RU103	6.74E-08
RU106	5.25E-01
RH103M	6.74E-08
RH106	5.25E-01
PD107	6.27E-07
AG110	7.60E-03
IN114M	1.11E-12
IN114	1.07E-12
SN119M	1.01E-04
SN121M	3.58E-06
SN123	2.40E-04
SN126	3.65E-07
SB124	2.34E-08
SB125	3.73E-02
SB126M	3.65E-07
SB126	5.10E-08
TE123M	8.98E-08
TE125M	9.09E-03
TE127M	1.30E-04
TE127	1.27E-04
TE129M	1.00E-10
TE129	6.35E-11
BA137M	2.70E-01
CE141	8.74E-10
CE144	2.89E-01
PR144	2.89E-01
PM147	4.35E-01
PM148M	2.43E-09
PM148	1.68E-10
SM151	1.19E-02
EU152	4.12E-05
EU154	5.29E-03
EU155	3.46E-02
GD153	4.86E-07
TB160	3.23E-07
H0166M	5.96E-08

PU239 5.60E-04
PU240 5.52E-04
PU241 8.65E-02

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 327 Fire in Hot Cell

Accident Description - 327, POSTIRRADIATION TESTING LABORATORY
Fire in Hot Cell

Fuel pins are ruptured in a hot cell and are then involved in a fire.
Open area ground level release.

Source Term

I 129 7.99E+00
KR85 1.51E+02
XE131M 2.04E+02
XE133M 2.79E+00
XE133 3.36E+03
SE79 4.25E-05
RB87 1.79E-09
CD113M 1.77E-02
CD115M 1.95E-08
CS134 2.69E+00
CS135 2.29E-04
CS137 1.42E+01
SR89 1.73E-06
SR90 1.07E-01
Y 90 1.07E-01
Y 91 1.19E-05
ZR93 5.96E-06
ZR95 8.27E-05
NB95M 1.05E-06
NB95 1.78E-04
RU103 6.74E-08
RU106 5.25E-01
RH103M 6.74E-08
RH106 5.25E-01
PD107 6.27E-07
AG110 7.60E-03
IN114M 1.11E-12
IN114 1.07E-12
SN119M 1.01E-04
SN121M 3.58E-06
SN123 2.40E-04
SN126 3.65E-07

SB124	2.34E-08
SB125	3.73E-02
SB126M	3.65E-07
SB126	5.10E-08
TE123M	8.98E-08
TE125M	9.09E-03
TE127M	1.30E-04
TE127	1.27E-04
TE129M	1.00E-10
TE129	6.35E-11
BA137M	2.70E-01
CE141	8.74E-10
CE144	2.89E-01
PR144	2.89E-01
PM147	4.35E-01
PM148M	2.43E-09
PM148	1.68E-10
SM151	1.19E-02
EU152	4.12E-05
EU154	5.29E-03
EU155	3.46E-02
GD153	4.86E-07
TB160	3.23E-07
HO166M	5.96E-08
PU239	5.60E-04
PU240	5.52E-04
PU241	8.65E-02

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 327 Hot Cell Criticality

Accident Description - 327, POSTIRRADIATION TESTING LABORATORY
Criticality in Hot Cell

Criticality results from the accumulation of fissile material in a compact pile in the tray of the shielded cell, followed by flooding of the tray. A total of $1\text{E}+18$ fissions occur. Halogens pass through a charcoal filter. Open area ground level release.

Source Term

KR83M	1.1E+01
KR85M	7.1E+00
KR85	8.1E-05
KR87	4.3E+01
KR88	2.3E+01
KR89	1.3E+03

XE131M	1.0E-02
XE133M	2.2E-01
XE133	2.7E+00
XE135M	3.3E+02
XE135	4.1E+01
XE137	4.9E+03
XE138	1.1E+03
I 131	2.8E-03
I 132	3.0E-01
I 133	4.0E-02
I 134	1.1E+00
I 135	1.1E-01
PU238	3.0E-08
PU239	1.4E-09
PU240	2.9E-09
PU241	9.0E-07
PU242	2.2E-11
AM241	1.2E-09

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 327 Cask Drop and Fuel Pin Rupture

Accident Description - 327, POSTIRRADIATION TESTING LABORATORY
Cask Drop and Fuel Pin Rupture

The crane, rigging or cask lifting yoke fails while a cask is being suspended directly above a storage array.

Source Term

I 129	9.01E+00
KR85	1.69E+02
XE131M	2.27E+02
XE133M	3.11E+00
XE133	3.75E+03
SE79	3.15E-06
RB87	1.33E-10
CD113M	1.31E-03
CD115M	1.44E-09
CS134	1.99E-01
CS135	1.70E-05
CS137	1.05E+00
SR89	6.39E-06
SR90	3.97E-01
Y 90	3.97E-01
Y 91	4.39E-05
ZR93	2.20E-05

ZR95	3.06E-04
NB95M	3.89E-06
NB95	6.60E-04
RU103	2.49E-07
RU106	1.94E+00
RH103M	2.49E-07
RH106	1.99E+00
PD107	2.32E-06
AG110	2.81E-02
IN114M	4.09E-12
IN114	3.94E-12
SN119M	3.74E-04
SN121M	1.32E-05
SN123	8.89E-04
SN126	1.35E-06
SB124	8.64E-08
SB125	1.38E-01
SB126M	1.35E-06
SB126	1.88E-07
TE123M	3.32E-07
TE125M	3.36E-02
TE127M	4.80E-04
TE127	4.70E-04
TE129M	3.70E-10
TE129	2.35E-10
BA137M	9.98E-01
CE141	3.23E-09
CE144	1.07E+00
PR144	1.07E+00
PM147	1.61E+00
PM148M	9.00E-09
PM148	6.21E-10
SM151	4.41E-02
EU152	1.52E-04
EU154	1.96E-02
EU155	1.28E-01
GD153	1.80E-06
TB160	1.19E-06
HO166M	2.20E-07
PU239	1.34E-02
PU240	1.33E-02
PU241	2.08E+00

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 329 Bldg Criticality

Accident Description - 329 BUILDING NEUTRON MULTIPLIER FACILITY

Criticality

Source Term

KR83M	1.2E-00
KR85M	5.3E-00
KR85	5.0E-05
KR87	3.1E+01
KR88	2.1E+01
XE131M	1.2E-04
XE133M	2.0E-02
XE133	4.0E-01
XE135	5.3E-00
I 129	1.3E-11
I 131	6.0E-02
I 132	2.1E-01
I 133	1.1E-01
I 134	1.5E+01
I 135	3.7E-00

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 331 Bldg Fire

Accident Description - 331 BUILDING, LIFE SCIENCES LABORATORY
Fire

A one-gallon bottle of toluene-base liquid scintillation cocktail is broken and subsequently ignited in Room 175. The fire involves the entire inventory in Room 175. Two stages of HEPA Filtration remains intact.

Open area ground level release.

Source Term

H 3	6.5E-07
C 14	1.0E-08
NA22	5.0E-09
CR51	5.0E-08
NI63	4.0E-06
AS73	5.0E-08
SE75	1.0E-08
SR90	1.0E-11
I 125	3.0E-07
CS134	3.0E-07
PM147	5.0E-12
EU152	2.5E-08

GD153	5.0E-11
YB169	5.0E-08
TL204	1.0E-07
PB210	2.5E-07
PA231	1.0E-09
PA233	1.0E-10
U 233	2.5E-09
NP235	1.5E-09
PU238	3.0E-06
PU239	3.5E-10
AM241	1.5E-06
AM243	1.0E-07
CM244	5.0E-12

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 340 Bldg Solid Waste Fire, No Filters

Accident Description - 340 BUILDING, WASTE HANDLING FACILITY
Solid Waste Fire, No HEPA filtration

This is the worst case scenario for 340 (assuming the maximum allowable inventory is involved). A fire, involving solid waste, occurs in the truck lock. The fire starts in the non-transuranic waste packaged in cardboard waste cartons, stored inside the waste truck.
Open area ground level release.

Source Term

SR90	5.0E-02
PU238	6.1E-07
PU239	2.8E-07
PU240	6.5E-04
PU241	4.3E-05
PU242	4.7E-10

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 340 Bldg Solid Waste Fire, Filters OK

Accident Description - 340 BUILDING, WASTE HANDLING FACILITY
Solid Waste Fire Source Term, with HEPA Filtration
Intact

A fire, involving solid waste, occurs in the truck lock. The fire starts in the non-transuranic waste packaged in cardboard waste cartons, stored inside the waste truck.

Open area ground level release.

Source Term

SR90	2.5E-05
PU238	3.1E-10
PU239	1.4E-10
PU240	3.3E-07
PU241	2.2E-08
PU242	2.4E-13

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 340 BUILDING, I-131 Release

Accident Description - 340 BUILDING, WASTE HANDLING FACILITY
I-131 Release

1.2 Curies of 131I are released from solution in 340 waste tanks.

Open area ground level release.

Source Term

I 131 1.2

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 3730 Bldg: Explosion, No Filters

Accident Description - 3730 BUILDING, GAMMA IRRADIATION FACILITY,
IRRADIATED SPECIMEN in GENERAL PURPOSE LABORATORY
Explosion in the Shielded Handling Cell (No filtration)

The most serious accident that can occur within the Specimen Handling Facility is an explosion in the Shielded Handling Cell. This results in a release of highly radioactive TEM disks and associated contamination from the cell.

Open area ground level release.

Source Term

MN54	3.6E-01
TA182	6.1E-02
C058	3.9E-01
C060	1.7E-01
FE59	2.4E-03
CR51	1.1E-02

Height of Release - 0. ft

xxx

Area - 400/300

Facility - 3730 Bldg: Explosion, Filters OK

Accident Description - 3730 BUILDING, GAMMA IRRADIATION FACILITY,
IRRADIATED SPECIMEN in GENERAL PURPOSE LABORATORY
Explosion in the Shielded Handling Cell (with filtration)

An explosion occurs in the Shielded Handling Cell. This results in a release of highly radioactive TEM disks and associated contamination from the cell. Filters remain effective.
Open area ground level release.

Source Term

MN54	9.0E-07
TA182	1.5E-07
C058	9.8E-07
C060	4.3E-07
FE59	6.0E-09
CR51	2.8E-08

Height of Release - 0. ft

xxx

Area - 000

Facility - ENDOFILE
^Z

APPENDIX C

HUDU VERIFICATION TESTS

APPENDIX C. HUDU VERIFICATION TESTS

This appendix describes the results of HUDU benchmark and accuracy testing. This testing was conducted using a Software Test Plan established in accordance with Pacific Northwest Laboratory (PNL) Software Control Procedure SCP-70-315, Conversion Testing, Verification, and/or Validation of Software. A summary of the test cases is included as Attachment 1.

OBJECTIVE

The objective of the HUDU benchmark testing was to demonstrate acceptable accuracy and reproducibility of the code's atmospheric dispersion and radiation dose calculation capabilities.

METHODS

To accomplish the testing objective, HUDU calculation results were compared to results from the GENII computer code (Napier et al. 1988). GENII was developed using PNL and NQA-1 (ASME 1986) quality assurance procedures, has general acceptance for use in environmental dose calculations (NRC 1989), and has been accepted for use at Hanford by the Hanford Dose Overview Panel.

Ten test cases were selected to evaluate HUDU capabilities. Five of these cases were HUDU default scenarios involving releases of preselected radionuclide mixtures from predetermined stack heights. The other five cases involved the input of specific radionuclides and activities. Descriptions of the 10 HUDU benchmark test cases are presented in Attachment 2. A variety of scenarios were chosen so that atmospheric dispersion calculations could be evaluated from both stack and ground-level releases, using a number of different stability classes and wind speeds. Six of the cases were ground-level releases, involving six different stability classes and five different wind speeds. The remaining four cases were 89-m stack releases, using three different stability classes and four different wind speeds.

Atmospheric dispersion calculations were evaluated by comparing HUDU and GENII calculation of E/Q values. Calculation of E/Q was evaluated at three different distances for nine test cases; one test case had only two distances. Radiation dose calculations were evaluated for effective dose equivalent, air submersion dose, lung dose, thyroid dose, and either bone surface or red bone marrow dose; HUDU provided outputs for only the higher of the two bone compartments. Comparisons were made at each of the test case distances. Acceptance criteria for both E/Q and dose equivalent values were established at 1 1/2 significant figures.

RESULTS

Atmospheric Dispersion

All test cases met the established acceptance criteria, where GENII and HUDU results were within 1 1/2 significant figures. In eight of the ten test cases, HUDU and GENII E/Q values were identical to 2 significant figures.

Evaluation of atmospheric dispersion calculations was not without difficulty, however. Special joint frequency tables had to be created for GENII to allow a direct comparison between calculated GENII and HUDU E/Qs. Several tests were run to determine the effect of various inputs on HUDU's plume rise calculation subroutine, so that GENII and HUDU input would indeed be identical.

The effort to make a direct comparison with GENII to one of HUDU's unique features resulted in the discovery of a small error in GENII Version 1.436. HUDU requires that all wind-speed input information be measured at the 10-m height. GENII normally uses wind-speed input data taken at the release height. In making the adjustment of using a 10-m wind speed for the 89-m stack height for unstable stability categories, it was determined that GENII was incorrectly profiling the wind speed at the stack height. The difference was inconsequential for all ground-level releases, and stack releases under neutral and stable categories. The error in GENII was noted

and corrected in Version 1.446. Version 1.446 was then used for comparison to HUDU in test cases 3 and 10.

Radiation Doses

Acceptance criteria were met in all cases where HUDU presented doses with at least two significant figures. In the majority of these cases, doses were identical to two significant figures or very nearly identical.

For very low doses (less than 1 mrem), HUDU presents only a general description, such as "< 1 mrem" or "< .1 mrem". GENII was compared to HUDU only to verify the order-of-magnitude correctness. Because of the relatively large inherent modeling errors at these levels and the potentially insignificant effects to a dose receptor, these results were judged acceptable.

There were also a number of instances where HUDU presented dose results with only one significant figure. In every case, these were instances of single mrem doses (1 to 9 mrem). In these cases, the compared results were identical to one significant figure. It is possible that these comparisons were also able to meet the acceptance criteria of 1 1/2 significant figures, but this could not be verified because of the HUDU reporting truncation. Because of the low dose values and the apparent closeness of the results (at least 1 significant figure) these results were judged acceptable.

CONCLUSION

When compared to GENII Version 1.436 and Version 1.440, HUDU demonstrates acceptable accuracy in both atmospheric dispersion and radiation dose calculations.

DOCUMENTATION

Documentation for the HUDU Benchmark Testing, in addition to this report, consists of HUDU and GENII output reports for each of the 10 test

cases and a summary sheet for each test case. The result summaries for the 10 tests are presented in Attachment 2.

REFERENCES

American Society of Mechanical Engineers (ASME). 1986. Quality Assurance Program Requirements for Nuclear Facilities. ANSI/ASME NQA-1, American National Standards Institute, New York.

Napier, B. A., R. A. Peloquin, D. L. Strenge, and J. V. Ramsdell. 1988. HANFORD ENVIRONMENTAL DOSIMETRY UPGRADE PROJECT. GENII - The Hanford Environmental Radiation Dosimetry Software System. Volume 1: Conceptual Representation; Volume 2: User's Manual; Volume 3: Code Maintenance Manual. PNL-6584, Vols. 1, 2, and 3, Pacific Northwest Laboratory, Richland, Washington.

U.S. Nuclear Regulatory Commission (NRC). 1989. Background Information for the Development of a Low-Level Performance Assessment Methodology. Volume 3: Selection and Integration of Models; Volume 4: Identification and Recommendation of Computer Codes. NUREG/CR-5453, SAND89-2509, U.S. Nuclear Regulatory Commission, Washington, D.C.

ATTACHMENT 1

DESCRIPTION OF HUDU BENCHMARK TEST CASES

Test Case 1: PUREX Oxide Line Fire

HUDU default scenario for 200 Area; noble gases, Sr, Cs, Pu; ground level release. Stability class A, 4 m/s wind speed; distances of 200 m, 1600 m, 13000 m.

Test Case 2: Nonstabilized Single Shell Tanks

HUDU default scenario for 200 Area; MFP, Pu, Am; ground level release. Stability class C, 3 m/s wind speed; distances of 100 m, 3200 m, 51000 m.

Test Case 3: Z-Plant Processing Area Criticality

HUDU default scenario for 200 Area; noble gases and iodines; 89 m stack release. Stability class A, 3 m/s wind speed; distances of 400 m, 3200 m, 51000 m.

Test Case 4: 308 Building Criticality; Massive Glovebox Failure

HUDU default scenario for 300 Area; noble gases and iodines; ground level release. Stability class B, 5 m/s wind speed; distances of 430 m, 800 m, 30000 m.

Test Case 5: 340 Building Solid Waste Fire; No Filters

HUDU default scenario for 300 Area; Sr and Pu; ground level release. Stability class E, 2 m/s wind speed. Distances of 290 m, 800 m, 50000 m.

Test Case 6: 10 Ci of Pu-239

Ground level release, stability class D, 4 m/s wind speed. Distances of 610 m, 8000 m. Two HUDU cases: January and July, differences in temperature and mixing heights.

Test Case 7: 10 Ci each of Sr-90 and Ru-106

89 m stack release, stability class D, 4 m/s wind speed. Distances of 620 m, 8000 m, 50000 m.

Test Case 8: 10 Ci of Cs-137

Ground level release, stability class F, 1 m/s wind speed. Distances of 100 m, 652 m, 8000 m.

Test Case 9: 10000 Ci each of H-3 and I-131

89 m stack release, stability class F, 1 m/s wind speed. Distances of 8000 m and 50000 m.

Test Case 10: 100 Ci each of U-234 , U-235, and U-238

89 m stack release, stability class A, 6 m/s wind speed. Distances of 620 m, 8000 m, 50000 m.

Summary: 6 ground level releases, 6 stability classes (A-F), 5 wind speeds

4 89 m stack releases, 3 stability classes (A,D,F), 4 wind speeds

ATTACHMENT 2
SUMMARY OF RESULTS OF HUDU BENCHMARK TESTS

HUDU BENCHMARK TEST
(Version 1.21, 14-March-90)

TEST CASE 1: PUREX Oxide Line Fire
ground level release
A stability class, 4 m/s
Distances: 200 m, 1600 m, 13000 m
1 HUDU case: 1) 1000 m mixing height, ground level release
HUDU file: 1: TEST1A
Comparison Code: GENII (Version 1.436, 29-Jan-90)
GENII files: TST1G1 (200 m); TST1G2 (1600 m); TST1G3 (13000 m)

SUMMARY OF TEST RESULTS:

Atmospheric Dispersion

E/Q values: between 1½ and 2 significant figures

Radiation Doses

EDE: identical to 2 significant figures

Lung: identical to 2 significant figures

Bone Surface: between 1½ and 2 significant figures

Thyroid: negligible

Air Submersion Dose: identical to 2 significant figures (13000 m case negligible)

SUMMARY:

E/Q values were between 1½ and 2 significant figures for A stability, ground level release. Small differences may be attributed to differences in the rounding or truncation algorithm.

Compared dose values were identical to 2 significant figures for EDE, lung, and external dose. Bone surface dose was nearly 2 s.f., thyroid dose was not comparable because of very low values.

J. L. Shember 18 April 90
preparer date

HUDU BENCHMARK TEST
(Version 1.21, 14-March-90)

TEST CASE 2: Nonstabilized Single Shell Tanks
ground level release
C stability class, 3 m/s
Distances: 100 m, 3200 m, 51000 m
1 HUDU case: 1) 1000 m mixing height, ground level release
HUDU file: 1: TEST2C
Comparison Code: GENII (Version 1.436, 29-Jan-90)
GENII files: TST2G1 (100 m); TST2G2 (3200 m); TST2G3 (51000 m)

SUMMARY OF TEST RESULTS:

Atmospheric Dispersion

E/Q values: between 1½ and 2 significant figures

Radiation Doses

Radiation doses were checked only at the 100 m distance.

EDE: identical to 1 significant figure; only 1 s.f. reported by HUDU
Lung: identical to 1 significant figure; only 1 s.f. reported by HUDU
Bone Surface: identical to 2 significant figures
Thyroid: negligible
Air Submersion Dose: negligible

SUMMARY:

E/Q values were between 1½ and 2 significant figures for C stability, ground level release. Small differences may be attributed to differences in the rounding or truncation algorithm.

Dose values were compared for 3 cases at 100 m; bone surface dose was identical to 2 s.f.; EDE and lung dose were identical to 1 s.f. HUDU reported only 1 significant figure for these cases, which were single mrem values. Low dose differences may be attributed to rounding or truncation differences.

18 April 90
preparer date

HUDU BENCHMARK TEST
(Version 1.21, 14-March-90)

TEST CASE 3: Z-Plant processing area criticality

89 m stack release

A stability class, 3 m/s

Distances: 400 m, 3200 m, 51000 m

1 HUDU case: 1) 1000 m mixing height, 89 m effective stack ht. input

HUDU file: 1: TEST3_2

*** Comparison Code: GENII (Version 1.446, 17-Apr-90)

GENII files: TST3G1 (400 m); TST3G2 (3200 m); TST3G3 (51000 m)

SUMMARY OF TEST RESULTS:

Atmospheric Dispersion

E/Q values: identical to 2 significant figures

Radiation Doses

Radiation doses were checked only at the 400 m distance.

EDE: identical to 1 significant figure; HUDU reported only 1 s.f.

Lung: identical to 1 significant figure; HUDU reported only 1 s.f.

Bone Surface: negligible

Thyroid: identical to 2 significant figures

Air Submersion Dose: identical to 2 significant figures

SUMMARY:

E/Q values were identical to 2 significant figures for A stability, 89 m stack release.

Dose values were identical to 2 s.f. for thyroid and external dose; identical to 1 s.f. for EDE and lung, where HUDU reported only 1 s.f. Bone surface dose was negligible (< 1 mrem).

preparer

18 April 90
date

HUDU BENCHMARK TEST
(Version 1.21, 14-March-90)

TEST CASE 4: 308 criticality: massive glovebox failure
ground level release
B stability class, 5 m/s
Distances: 430 m, 800 m, 30000 m
1 HUDU case: 1) 1000 mixing height, open area ground level release
HUDU file: 1: TEST4B
Comparison Code: GENII (Version 1.436, 29-Jan-90)
GENII files: TST4G1 (430 m); TST4G2 (800 m); TST4G3 (30000 m)

SUMMARY OF TEST RESULTS:

Atmospheric Dispersion

E/Q values: identical to 2 significant figures

Radiation Doses

EDE: identical to 1 s.f.; only 1 s.f. reported by HUDU; (30000 m negligible)

Lung: identical to 1 s.f.; only 1 s.f. reported by HUDU; (30000 m negligible)

Bone Surface: identical to 1 s.f.; only 1 s.f. reported by HUDU; (30000 m negligible)

Thyroid: between 1½ and 2 significant figures; (30000 m negligible)

Air Submersion Dose: between 1½ and 2 significant figures; (30000 m negligible)

SUMMARY:

E/Q values identical to 2 significant figures for B stability, ground level release.

Compared dose values were between 1½ and 2 significant figures for thyroid and external dose. Other cases were identical to 1 s.f., where HUDU reported only 1 significant figure; these were single mrem values. Low dose differences may be attributed to rounding or truncation differences.

J. G. Shenberg 17 April 90
preparer date

HUDU BENCHMARK TEST
(Version 1.21, 14-March-90)

TEST CASE 5: 340 Bldg Solid Waste Fire, No Filters
ground level release
E stability class, 2 m/s
Distances: 290 m, 800 m, 50000 m
1 HUDU case: 1) 1000 mixing height, open area ground level release
HUDU file: 1: TESTSE
Comparison Code: GENII (Version 1.436, 29-Jan-90)
GENII files: TST5G1 (290 m); TST5G2 (800 m); TST5G3 (50000 m)

SUMMARY OF TEST RESULTS:

Atmospheric Dispersion

E/Q values: identical to 2 significant figures

Radiation Doses

EDE: between 1 $\frac{1}{2}$ and 2 significant figures; (50000 m case negligible)

Lung: between 1 $\frac{1}{2}$ and 2 significant figures; (50000 m case negligible)

Bone Surface: between 1 $\frac{1}{2}$ and 2 significant figures; (50000 m case negligible)

Thyroid: negligible

Air Submersion Dose: negligible

SUMMARY:

E/Q values identical to 2 significant figures for E stability, ground level release.

Compared dose values were between 1 $\frac{1}{2}$ and 2 significant figures. Small differences at low doses may be attributed to differences in the rounding or truncation algorithms.

preparer

17 April 90
date

HUDU BENCHMARK TEST
(Version 1.21, 14-March-90)

TEST CASE 6: 10 Ci of Pu-239

ground level release

D stability class, 4 m/s

Distances: 610 m, 8000 m

2 HUDU cases: 1) Jan, 3 °C, 200 m mixing height

7) July, 29 °C, 500 m mixing height

HUDU files: TEST6D1 (january) TEST6D7 (july)

Comparison Code: GENII (Version 1.436, 29-Jan-90)

GENII file: TEST6GEN 2 runs, at 610 m & 8000 m

SUMMARY OF TEST RESULTS:

Slight difference in HUDU cases. Bone surface dose is 15 rem for january (TEST6D1), 14 rem for july (TEST6D7).

Atmospheric Dispersion

E/Q values: identical to 2 significant figures

Radiation Doses

EDE: between 1½ and 2 significant figures

Lung: identical to 2 significant figures

Bone Surface: between 1½ and 2 significant figures

Thyroid: negligible

Air Submersion

Dose: negligible

SUMMARY:

E/Q values identical to 2 significant figures for D stability, ground level release.

Compared dose values were between 1½ and 2 significant figures. Small differences at low doses may be attributed to differences in the rounding or truncation algorithms.

preparer

17 April 90
date

HUDU BENCHMARK TEST
(Version 1.21, 14-March-90)

TEST CASE 7: 10 Ci each of Sr-90, Ru-106

 89 m stack release

 D stability class, 4 m/s

 Distances: 620 m, 8000 m, 50000 m

 1 HUDU case: 1000 m mixing height, input effective stack height

HUDU files: TEST7DZ used for GENII comparison

Comparison Code: GENII (Version 1.436, 29-Jan-90)

GENII files: TST11G1 (620 m); TST11G2 (8000 m); TST11G3 (50000 m)

SUMMARY OF TEST RESULTS:

Atmospheric Dispersion

E/Q values: identical to 2 significant figures

Radiation Doses

EDE: between 1 $\frac{1}{2}$ and 2 significant figures

Lung: between 1 $\frac{1}{2}$ and 2 significant figures

Bone Surface: between 1 $\frac{1}{2}$ and 2 significant figures

Thyroid: identical to 1 s.f., only 1 s.f. reported by HUDU; evaluated only at 8000 m

Air Submersion negligible
Dose:

SUMMARY:

E/Q vlaues were identical to 2 significant figures for D stability, 89 m release height.

Compared dose values were between 1 $\frac{1}{2}$ and 2 significant figures for EDE, lung, and bone surface. HUDU reported only 1 significant figure for thyroid, which was a single mrem value. Low dose differences may be attributed to rounding or truncation differences.

J.A. Shenberg 18 April 90
preparer date

HUDU BENCHMARK TEST
(Version 1.21, 14-March-90)

TEST CASE B: 10 Ci of Cs-137
ground level release
F stability class, 1 m/s
Distances: 100 m 652 m, 8000 m

2 HUDU cases: 1) Jan, 3 °C, 200 m mixing height
7) July, 29 °C, 500 m mixing height

HUDU files: TEST801 (January) TEST807 (July)
Comparison Code: GENII (Version 1.436, 29-Jan-90)
GENII files: TST8G1 (100 m); TST8G2 (652 m); TST8G3 (8000 m)

SUMMARY OF TEST RESULTS:

Atmospheric Dispersion

E/Q values: identical to 2 significant figures

Radiation Doses

EDE: between 1½ and 2 significant figures

Lung: between 1½ and 2 significant figures

Red Marrow: between 1½ and 2 significant figures

Thyroid: identical to 2 significant figures for near 2 cases; only 1 s.f. reported by HUDU at furthest distance

Air Submersion Dose: negligible

SUMMARY:

E/Q values identical to 2 significant figures for F stability, ground level release.

Compared dose values were between 1½ and 2 significant figures. Small differences at low doses may be attributed to differences in the rounding or truncation algorithms.

preparer

date

17 April 90

HUDU BENCHMARK TEST
(Version 1.21, 14-March-90)

TEST CASE 9: 1000 Ci each of H-3, I-131

89 m stack release

F stability class, 1 m/s

Distances: 620 m, 8000 m, 50000 m

1 HUUU case: 1) 1000 mixing height, input effective stack height

HUUU file: TEST9F used for GENII comparison

Comparison Code: GENII (Version 1.436, 29-Jan-90)

GENII files: TST12G2 (8000 m); TST12G3 (50000 m)

SUMMARY OF TEST RESULTS:

Atmospheric Dispersion

E/Q values: identical to 2 significant figures

Radiation Doses

EDE:	identical to 2 significant figures
Lung:	identical to 1 s.f.; only 1 s.f. reported by HUDU
Bone Surface:	between 1½ and 2 significant figures
Thyroid:	identical to 2 significant figures
Air Submersion Dose:	negligible

SUMMARY:

E/Q values were identical to 2 significant figures for F stability, 89 m release height.

Compared dose values were identical to 2 significant figures for EDE and thyroid; between 1 $\frac{1}{2}$ and 2 significant figures for bone surface. HUDU reported only 1 significant figure for lung, which was a single mrem value. Low dose differences may be attributed to rounding or truncation differences.

J.R. Henberg 18 April 90
preparer date

HUDU BENCHMARK TEST
(Version 1.21, 14-March-90)

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TEST CASE 10:      100 Ci each of U-234, U-235, U-238

                   89 m stack release

                   A stability class, 6 m/s

                   Distances:  620 m, 8000 m, 50000 m

                   1 HUDU case:      1) 1000 mixing height, input effective stack height

HUDU file:      1: TEST10A8 [ also TEST10A4 (U-234), TEST10A5 (U-235), TEST10A8 (U-238)]

*** Comparison Code:      GENII (Version 1.446, 17-Apr-90)

GENII files:  TST10G1 (620 m); TST10G2 (8000 m); TST10G3 (50000 m)

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SUMMARY OF TEST RESULTS:

Atmospheric Dispersion

E/Q values: identical to 2 significant figures

Radiation Doses

EDE: between 14 and 2 significant figures

Lung: between 1½ and 2 significant figures

June Surface: identical to 2 s.f. for 620 m case; negligible in other cases

Thyroid: negligible

Air Submersion negligible
Dose:

SUMMARY:

E/O values are identical to 2 significant figures for A stability, 89 m stack.

Compared dose values were between 1 $\frac{1}{2}$ and 2 significant figures for EDE and lung; identical to 2 s.f. for thyroid near case (620 m). Other cases negligible.

I. L. Skenberg 18 April 90
preparer date

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