
See also ‘readme.txt’ file with each distribution

**New, applies to all 4.xx versions**

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**Revised for v. 4.02**

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Addition:

*New section to be added to the end of Section 4. Applies to all 4.xx versions.*

### 4.5 Effluent Concentration Limit Ratios

MILDOS-AREA calculates the ratios of the air concentrations of each radionuclide at each receptor location with the effluent air concentration limits (ECLs) as defined in Table 2 (Column 1) of Appendix B to NRC’s *Standards for Protection against Radiation* (10 CFR Part 20).

In the case of Rn-222, the calculated ratio involves consideration of the radon daughter products. The Rn-222 ECL ratio ($ECL_{Rn-222}$) is calculated as:

$$ECL_{Rn-222} = \frac{C_{air}(Rn222, x, t_j)}{1 \times 10^8} \left(1 - E_{222\_eq}\right) + \frac{C_{air}(Rn222, x, t_j)}{1 \times 10^{10}} E_{222\_eq}, \quad (4.20)$$

where

$$C_{air}(Rn222, x, t_j) = \text{air concentration of Rn-222 during time step } t_j \text{ at distance } x \text{ (Ci/m}^3\text{)} \quad [\text{calculated by substituting Equation 4.12 in Equation 3.26 or 3.28}],$$

$$E_{222\_eq} = \text{equilibrium fraction of radon daughters with Rn-222 in air at the receptor location (unitless) [Equation 4.21]},$$

$$1 \times 10^{-8} = \text{the 10 CFR Part 20 Appendix B Table 2 air concentration value for Rn-222 without daughters \(\mu\text{Ci/cm}^3 \equiv \text{Ci/m}^3\)}, \text{ and}$$

$$1 \times 10^{-10} = \text{the 10 CFR Part 20 Appendix B Table 2 air concentration value for Rn-222 with daughters \(\mu\text{Ci/cm}^3 \equiv \text{Ci/m}^3\)}.$$

The Rn-222 equilibrium fraction is calculated as:

$$E_{222\_eq} = F_{in} E_{222\_in\_eq} + F_{out} E_{222\_out\_eq}, \quad (4.21)$$

where

$$F_{in}, F_{out} = \text{indoor and outdoor occupancy fractions, respectively (unitless),}$$

$$E_{222\_in\_eq} = \text{equilibrium fraction of radon daughters with Rn-222 in indoor air (unitless),}$$

$$E_{222\_out\_eq} = \text{equilibrium fraction of radon daughters with Rn-222 in outdoor air [user specified or calculated according to Equation 5.5] (unitless),}$$

The Rn-220 ECL ratio is calculated by dividing the Rn-220 air concentration at the receptor location by the 10 CFR Part 20 Appendix B Table 2 air concentration value for Rn-220 with
daughters ($3 \times 10^{-11} \, \mu\text{Ci}/\text{cm}^3$). ECL ratios for radon daughters are not calculated on an individual basis.

A demonstration of compliance with 10 CFR 20.1301 using the method in Part 20.1302(b)(2)(i) should be based on annual average effluent concentrations calculated at the boundary of the unrestricted area; and that adjustment of the effluent concentration values in Appendix B for purposes of demonstrating compliance requires prior NRC approval.
Revision:

Revised map interface showing updated map toolbar and added option for mouse coordinate display. Update of Section 6.9

Figure 6-15 Main Program Window with the “Map” Tab Selected
Revision:

New map options.  Update of Section 6.9.2.1

6.9.2.1 Rudimentary Functions

Working with the map interface involves using the tools on the map toolbar, which is shown in Figure 6-16.

Zoom-In tool  When selected, the Zoom-In tool will cause the map view to zoom in (decrease the amount of area shown in the map window) a certain percentage with a mouse click on the map.  You can also click and drag the mouse using the Zoom-In tool to highlight a section of the map that will then be expanded.

Zoom-Out tool  When clicked on the map, the Zoom-Out tool causes the map view to zoom out (increase the amount of area shown in the map window) a certain percentage.

Position tool  When clicked and dragged, the map Position tool will cause the entire map view to shift in the direction of the mouse drag.

Pointer tool  The map Pointer tool is used to reposition sources and receptors on the map.  Its operation is discussed in the next section.

Max Extents tool  Clicking the mouse on the Max(imum) Extents tool will cause the map to be sized so that the maximum (outer) extent of all map layers are visible within the map view.

Reverse tool  Clicking the mouse on the Reverse tool will cause the map view to reverse the last map action and revert back to its previous state.

Ruler tool  With the Ruler tool selected, the first click of the mouse on the map will set the start point for distance measurement.  The second click will set the end point and result in a display of the distance between the two points in meters or kilometers depending on the distance.  Subsequent clicks will provide the distance between the last two points and cumulative distance from the beginning.  A double-click will end the measurement.

Area tool  With the Area tool selected, successive clicks of the mouse at different locations will result in the display of area within the defined polygon.  A double-click will end the measurement.  The units displayed will be in square meters, hectares (ha) (1 ha = 10,000 m²) or square kilometers, depending the size of the area selected.
Figure 6-16 Map Toolbar

When the map control has the input focus and one of the first four or last two tools is selected (Zoom-In, Zoom-Out, Position, Pointer, Ruler, or Area), there is another way to cause the map view to zoom in or out: by rolling the mouse scroll wheel (or its equivalent).
Revision:

New map options. Update of Section 6.9.3

6.9.3 Managing Map Layers

Data are displayed in the map control in layers. Each layer corresponds to data displayed as either raster or vector data. Bitmap and TIFF files are examples of raster data, for which information is presented in a matrix of cells (images such as digital pictures or a scanned map). Shapefiles, originally introduced by ESRI, are examples of vector data for which the information can be stored as points, lines, or polygons as a collection of coordinated points (in which lines and polygons are drawn as a series of connected points and are thus independent of the resolution of a display device).

The MILDOS-AREA map is used to provide an underlying view, if desired, and establishes the coordinate system. Receptors, point sources, area sources, and the scale bar are all represented by in-memory shapefile layers that are not directly accessible by the user and are automatically drawn on top of any layers loaded by the user. The “Edit Map” button in the “Map Settings” group (lower right of Figure 6-15), when clicked, will bring up the “Edit Map” form (Figure 6-17), which allows users to control whether local coordinates are used without additional map information or to load their own UTM coordinate map layers.

Figure 6-17 Edit Map Input Form

6.9.3.1 Map Coordinate Selection

In the “Map Information” group, the “Local” and “UTM” radio buttons control whether or not local coordinates are used. If the setting is changed from “UTM” to “Local,” all currently associated user layers will be deleted from the map, and the coordinates for all receptors and sources will be adjusted to correspond with the first emission source at (0,0). The same function can be
performed by pressing the “New Map” button at the bottom of the form and can be used if the “Local” radiobutton is already selected. Using the “New Map” button will reset the coordinates of the first source to (0,0) if it had been moved or deleted and a different source is now the listed first source. Resetting the coordinates in this case is not necessary but does give the user a recognizable point of reference. If the radiobutton setting is changed from “Local” to “UTM,” the user will be asked to select the desired UTM zone from the UTM selection drop-down list control before adding a map data layer (by pressing the “Add Layer” button) that should be in the specified coordinate system.

Because of the complexities associated with verifying the true coordinate system for map data from different sources, MILDOS-AREA does not perform any type of enforcement in this area other than to notify the user of the projection of the specified data to be loaded if that information can be determined. It is up to the user to make sure that the data are appropriate for the settings used. Once the UTM zone is specified, the map will use that as the underlying coordinate system. If a scenario had been previously set-up using local coordinates, the “Recenter” button and associated x and y UTM coordinate inputs at the bottom of the “Edit Map” form allows the user to move the first source position to the proper location on the newly added map image. All receptors and other sources will maintain their position relative to the first source during this operation.

6.9.3.2 Raster Data

Generally, only one image raster map layer can be used, because such layers are opaque and would obscure any layers placed beneath them. However, if each raster map layer constitutes a tile in a series of tiles (i.e., image blocks arranged side by side to form a larger image), the tiles may be loaded at the same time and displayed concurrently. The “Add Tiles” button allows the selection of such a series of tiles. These images should have the same map projection for proper display. It is assumed that the projection characteristics of the first tile are representative of the remaining tiles selected. Each tile will be rendered as a separate layer. This situation can be cumbersome, when it comes to layer management, if a large number of tiles is involved. All tiles loaded at the same time will be treated as a single layer if the “VRT for multi-tile” checkbox is checked in the “Raster / Reprojection” group.

The types of GIS formats that MILDOS-AREA supports are listed in Table 6-3, along with the file extension typically used for that format (and expected by MILDOS-AREA). All types listed are raster data types with the exception of the shapefile (vector data). A second file that provides additional spatial data that may include georeferenced coordinates or projection information (e.g., .tfw or .jpw “world” files in the case of TIFF and JPEG data) is often associated with the primary GIS data file. This second file should be in the same directory as that of the primary data file in order for MILDOS-AREA to properly load the map layer.

If needed, MILDOS-AREA has the capability to re-project the data in the layer into the UTM projection selected for the map. For raster data, the image is first re-projected to the map’s UTM projection as a GeoTIFF file without compression. Because of the amount of data required to render an image, most raster data types are by their nature a compressed format or can incorporate varying degrees of compression. The second stage of re-projection in MILDOS-AREA is to take the re-projected image and save it as a compressed GeoTIFF or JPEG2000 file. This second step also checks to see if a fourth data band is present and asks the user if it should be removed. Color GIS data is displayed in three bands (R,G,B). The fourth band is often referred to as the alpha band that normally contains near infrared data which will degrade the overall image if displayed with the normal color bands in MILDOS-AREA.
Table 6-3  GIS File Types Supported by MILDOS-AREA

<table>
<thead>
<tr>
<th>File Type</th>
<th>File Extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitmap</td>
<td>.bmp</td>
</tr>
<tr>
<td>Graphics Interchange Format (GIF)</td>
<td>.gif</td>
</tr>
<tr>
<td>Joint Photographic Experts Group (JPEG) and JPEG2000</td>
<td>.jpg, .jp2</td>
</tr>
<tr>
<td>Portable Network Graphics (PNG)</td>
<td>.png</td>
</tr>
<tr>
<td>Multiresolution Seamless Image Database (MrSID)</td>
<td>.sid</td>
</tr>
<tr>
<td>Shapefile</td>
<td>.shp</td>
</tr>
<tr>
<td>Tagged Image File Format (TIFF)</td>
<td>.tif</td>
</tr>
<tr>
<td>Geodata Data Abstraction Library (GDAL) Virtual TIFF</td>
<td>.vrt</td>
</tr>
</tbody>
</table>

The final output file type and amount of compression is specified by the user in the “Raster / Reprojection” group on the “Edit Map” form (Figure 6-17). While MILDOS-AREA can read many raster formats, it can only create new files with either TIFF or JPEG2000 formats. The “Compressed Size (%)” selection determines the amount of compression to use. A value of 100 on a scale of 1 to 100 indicates that no additional compression is requested. Decreasing values selected will result in more compression and a smaller final file size. A value of 25 represents the largest amount of compression, smallest final file size, allowed by the code. The final compressed file size will also depend on the complexity of the imagery displayed. The compression formats used here will result in some data loss (higher compression, more loss), although the differences are not easily observed by eye.

6.9.3.3  Vector Data

Many data are available in shapefile format that use decimal degree coordinates. When MILDOS-AREA loads a specified shapefile and determines that it is not in the proper UTM format, it will save the re-projected data in a new file and then load the new file (if the user does not cancel the operation).

Rudimentary editing functions that control the display of shapefile data are available in the “Shapefile Information” group, as shown in Figure 6-17. Users may control the point sizes and line widths of point and line shapefiles, respectively, as well as set a color for all items in the shapefile. For polygon shapefiles, the transparency of the polygon fill can also be adjusted from clear to opaque (so as to not cover, partially cover, or completely cover any underlying layers) by using the slide bar.

6.9.3.4  Layer Manipulation and Map Settings

Note that MILDOS-AREA does not store the actual map data in the user file but rather only the associated filename. If such files are subsequently moved or deleted on the user’s computer, the program will not be able to load them into the map when the user file is loaded.

In the “Layer Information” group (Figure 6-17), the user may view what map layers are loaded by using the “Layer” drop-down list. The user may also modify the position of the display order of the loaded map layers, if there are two or more, by clicking the up and down arrows to move the currently selected layer. Remember that the map layers with the lower index will be
displayed first and may be covered by layers with a higher index, depending on the type of layer (raster or vector) and the areal extents of the layer coverage. The “Layer Name” text input enables the user to give the layer a more intuitive name that will be saved with the map information for later use. The user may also render a particular layer invisible or visible at any given time without deleting or adding the layer by unchecking or checking the “Layer Visible” checkbox.

The “Save Map” button in the “Map Settings” group (lower right in Figure 6-15) is used to save the current map settings (the current view and layers loaded). Once the map is saved, the user file must also be saved to preserve those settings for the next time that the user file is loaded.