Parameter Discussion Paper

Development of Mass Loading Distribution

The dose and risk results calculated using mathematical models such as RESRAD are determined by the formulation of the model and by a large number of numerical inputs that represent the physical, temporal, physiological and behavioral properties of the source, pathway and receptor (the person receiving the dose). The source is represented by such factors as contaminant concentration in soil, or area and depth of contamination, all physical parameters. The pathway may be represented in terms of mass loading in the atmosphere, wind speed, soil density, vegetative uptake, root depth, or gamma shielding factor, again mostly physical parameters. The receptor is represented in such parameters as ingestion rate, inhalation rate, time on site, fraction of time indoors, or age-specific dose conversion factors, typically a mix of temporal, physiological and behavioral parameters. The assignment of physical parameters is generally influenced the greatest by site specific conditions; physiological parameters, by information derived from laboratory and epidemiological studies; and temporal and behavioral parameters by the assumptions driving the scenario, tempered by observational data and studies in the literature.

Mass loading, the subject of this discussion, is a physical input parameter. However, the values that must be used in the model cannot be directly measured in the atmosphere today. The scenarios being modeled are predictive scenarios, and must be represented by physical conditions that may exist at the time the dose is being received by the receptor, some time in the future. Since site conditions are assumed to change from those presently existing, for various reasons, the mass loading must be calculated using a group of reasonable, but somewhat conservative assumptions about those future conditions. In addition, because of the formulation of the model itself, the mass loading must be calculated as though the entire volume of air in the vicinity of the site contains that same mass loading. The loading cannot be attributable only to a small perturbed source area lying in a larger unperturbed field.

The mass loading has been calculated using information derived from site observations, a compendium of air concentration data from across Colorado, guidance contained in various publications, and from scenario-specific field measurements at the Site. Types of information considered include:

- average annual mass loading measured at five locations around the Site over the past few years, serving as a benchmark but not used in the calculation;
- average annual mass loading measured at all locations across Colorado, from the AIRS database, providing both a baseline median value to use in the mass loading distribution calculation, and a benchmark distribution to compare with the calculated result;
- EPA Publication AP-42, providing guidance regarding the manner in which to account for precipitation events when predicting mass loading;
- various literature regarding drought and its behavior;
- site-specific data regarding typical annual and monthly rainfall patterns;
- scenario and site-specific data derived from wind-tunnel tests performed at RFETS following a controlled burn in a vegetated area typical of the soils in the industrial area and majority of the buffer zone.

ADMIN RECORD

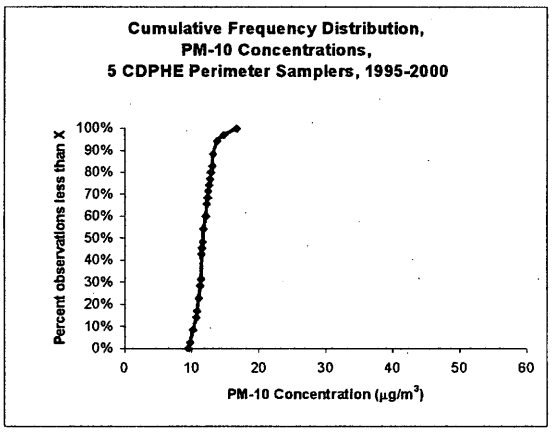
The information has been used to develop an estimated statistical distribution of annual mass loadings that would result from a variety of site conditions. The conditions modeled range from normal rainfall and no wildfires to moderate drought conditions with wildfire, the wildfire occurring either in the spring or fall with different consequences due to the impact of the season on vegetative regrowth.

Because of inherent limitations in RESRAD, the empirical distribution was limited to eight frequency data points, two of which were used to establish the minimum and maximum of the possible range of mass loading conditions that would be modeled, the remaining six represent the frequency of occurrence of intermediate conditions.

The graphics and discussions that follow illustrate the progression of the mass loading calculation:

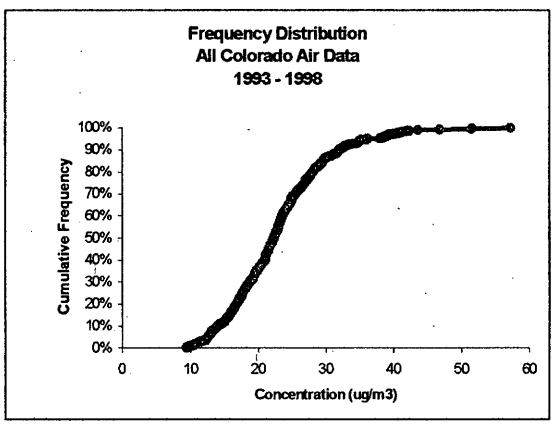
Present site conditions:

These data represent current annual PM-10 mass loading conditions at RFETS. The observations range from a low of about 9.4 to a high of 16.6, with a median value of 11.6 $\mu g/m^3$. Under conditions similar to present site conditions, this median value could be used to seed a mass distribution calculation. Such conditions would represent wildlife worker or open space user scenarios. The working group chose to use a more conservative starting value, however.



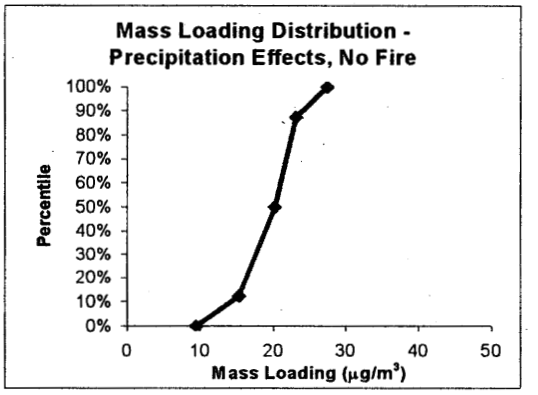
Present statewide conditions:

Statewide conditions are assumed to be more representative of potential mass loadings that could occur at RFETS in the future, given present growth trends. The statewide data represent the conditions that are observed in both pristine rural areas and in developed industrial and agricultural settings. As such, these data are assumed to be a good cross-section of mass loading conditions that would likely exist under rural residential and office worker scenarios. The median PM-10 concentration, 20.2 ug/m3 was used to "seed" the distribution estimates shown below.



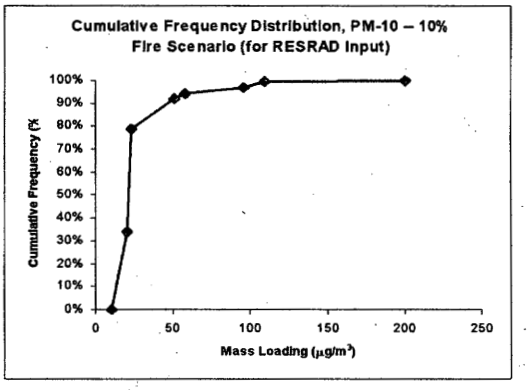
Estimated distribution using median statewide mass loading as input "seed", without fire:

Precipitation has a relatively small influence on the mass loading distribution, about 14% increase in dust load is estimated for the more extreme dry periods that have been observed at Rocky Flats over the past 37 years for which meteorological records exist. These conditions do not replicate the "dust bowl" conditions observed in Kansas in the '30s but are thought to be representative of conditions likely to occur in this locale. This graphic is used only for illustration.



Estimated distribution, same input "seed", with fire in both spring and fall:

The addition of post-fire wind erosion of partially denuded grassy areas results in additional mass loading for the years in which the fire occurs and potentially to some extent for several years following, as thatch builds up again. Annual mass loading is estimated to increase with a multiplier of about 2.5 after an extensive spring fire that includes a contaminated area. A fall fire results in a multiplier of about 4.7 for the year following.



The probability of a fire is assigned as 10%, representing the most frequent occurrence projected from the use of controlled burns as a prairie resource-management tool. Wildfires would occur with much lower frequency.