GUIDELINES FOR EVALUATING THE AIR QUALITY IMPACTS OF TOXIC POLLUTANTS IN NORTH CAROLINA

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North Carolina Department of Environment and Natural Resources
Division of Air Quality
Permitting Section
Air Quality Analysis Branch

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1.0 NC MODELING GUIDANCE

1.1 Introduction

The purpose of these guidelines is to assist facility owners and air quality specialists in demonstrating to the Air Quality Analysis Branch (AQAB) of the North Carolina Division of Air Quality (NCDAQ) that any regulated toxic air pollutant emitted from the facility and listed in 15A NCAC 2Q[1] Section .0711 of the Toxic Air Pollutant Guidelines, will not result in ambient concentrations in excess of the Acceptable Ambient Levels (AALs) listed in 15A NCAC 2D Section .1104. In addition, the owner of any facility subject to Prevention of Significant Deterioration (PSD) is required by the NCDAQ to perform dispersion modeling for air toxics as part of the Best Available Control Technology (BACT) analysis. These guidelines should be followed for performing the dispersion modeling analysis.

All guidance discussed in this document adheres to EPA guidance[2] (documentation and policies) for determining the impact of any pollutant. The guidelines presented in this document may change at any time as new guidance or new air quality modeling techniques become available. For the latest changes in AQAB guidance, refer to the “Alerts Page” located on the NCDAQ web site, which can be found at: http://daq.state.nc.us/permits.

1.2 Modeling Policy-General

The applicant is required to conduct dispersion modeling when the total facility-wide emissions of a regulated air toxic exceed the emission rates listed in NCAC 2Q .0711 as a result of the addition of a new source or modification of an existing source. The modeling must demonstrate that the ambient concentrations of the affected air toxics will not exceed the applicable AALs, listed in NCAC 2D .1104.

The applicant is encouraged to submit a modeling protocol to the AQAB prior to conducting and submitting a modeling analysis and permit application, which is discussed in the following section. As an alternative, the applicant may choose to complete the North Carolina Toxics Modeling Protocol Checklist (Appendix A.1) and submit it with the analysis and permit application.

Applicants may request that the AQAB conduct the modeling for them to determine compliance, but are encouraged to contact the AQAB before doing so. In order to perform requested modeling, the AQAB will require the completion of all facility information in the D3 modeling worksheet (Appendix A.2) and specified facility drawings. This information will be used by the AQAB modelers to conduct a screening analysis, and if necessary and where possible, refined modeling. If the model results indicate that compliance with the AALs will not be demonstrated for one or more pollutants at the requested emission rates, the applicant will be notified and will be required to perform a complete compliance demonstration.

1.3 Modeling Policy – Specific Industry

In response to air quality issues associated with certain industrial operations, the AQAB has established specific modeling approaches to protocols to be used for that industry to evaluate facility-wide pollutant emissions. In addition, the AQAB has also conducted modeling to establish operating thresholds for a limited number of industrial operations that will define when additional or more refined modeling is needed to establish compliance with the applicable AALs. These operating/capacity thresholds can be used in lieu of modeling.

1.3.1 Concrete Batch Plants

The AQAB has developed a database for two types of concrete facilities: truck-mix concrete facilities with controls on the truck load-out operation and central-mix concrete facilities. The resultant database of production rates and property line distances, along with information provided from the attached facility questionnaire (Appendix D), can now be used to exempt above specified concrete facilities from modeling and to establish, as needed, a maximum annual concrete production rate limit to assure compliance. The AQAB will conduct refined level modeling for truck-mix facilities located in mountainous regions, provided these facilities use truck load-out controls. The AQAB will evaluate facility mountain region applicability on a case-by-case basis.

1.3.2 Landfills

As a result of an AQAB study, it was concluded that most, if not all landfills may be screened from future modeling requirements. A landfill data spreadsheet was developed that summarizes the relevant emission and modeling variables. For future landfill submittals, the applicant must supply the following information to potentially screen formal modeling submittal requirements: location of landfill (city, county), emission sources by type (e.g., area, point, flare, etc.), pollutant emission rates for each source, and a site map identifying emission sources and property boundaries. Once the information is received, the AQAB will compare the data with the landfill spreadsheet and draft an appropriate response.

1.3.3 North Carolina Quarries

The Director of the Division of Air Quality of North Carolina instructed that all new quarries and existing quarries proposing modifications to the primary crusher will be required to submit dispersion modeling to demonstrate compliance with the National Ambient Air Quality Standards (NAAQs). Primary crusher modifications are those that increase the capability of that unit to produce comparable size and quality material. This modeling requirement may, however, be waived for quarries that qualify under the recently developed DAQ/AQAB quarry modeling exemption strategy. The modeling exemption strategy is based on specific quarry characteristics and operating scenarios; details on the exemption can be seen on the following webpage: http://daq.state.nc.us/permits/quarry_forms.shtml. Contact the appropriate DAQ regional office for further details.

If modeling is required, the applicant is expected to use the quarry specific modeling guidance detailed at http://daq.state.nc.us/permits/mets/quarry1.pdf.

As additional industrial specific modeling protocols/policies are developed, they will be added to this guidance and posted on the AQAB web page.

2.0 MODELING PROTOCOL

Any permit application that requires a modeling compliance demonstration must be preceded by a modeling plan or protocol. As an alternative, the North Carolina Toxics Modeling Protocol Checklist may be completed and submitted with the modeling analysis. A detailed modeling plan gives the AQAB the opportunity to review and comment on the proposed project and modeling methodology before the analysis is begun, and ensures that the final modeling analysis will be conducted in accordance with existing NC regulations and modeling requirements. An approved plan will minimize overall modeling efforts, which will result in shorter total permit review times. The protocol must be approved by the AQAB before the final modeling analysis is submitted. The information listed below should be discussed in the modeling protocol, and submitted with the modeling analysis:

a) A general discussion of plant processes and the types of emission sources under consideration;

b) A certified plat, signed survey, or copy of the deed from the County Register of Deeds Office, in that order of preference, of the industrial site clearly locating all property boundaries;

c) A detailed site map showing locations of property boundaries, emission sources (existing and proposed), existing and proposed facility buildings or structures [the map must show the dimensions (height, width, length) of all buildings and structures], and any public right-of-ways traversing the property (e.g. roads, railroad tracks, rivers, etc.). The site diagram should also provide a scale and true north indicator and should show UTM coordinates or the latitude/longitude of at least one point (e.g. source or building corner). If known, indicate the format or projection of the UTM coordinates (e.g. NAD27 or NAD83);

d) A preliminary list of all the facility toxic air pollutants, their emission rates, and their respective NC toxic permitting emission rate (TPER) as listed in 15A NCAC 2Q .0711. Use NC Form 2 (Appendix A.4) or an equivalent form;

e) A list or table of stack parameters for all existing and proposed sources. Use NC Form 3, 3A, and 3V, (Appendix A.5, A.6, A.7) or an equivalent form. If multiple stacks are merged, identify the merged stack and include all "M" factor calculations. List area or volume sources separately and include a short discussion on why these sources are represented as area or volume sources. All fugitive emissions should be identified and quantified;

f) A preliminary Good Engineering Practice (GEP) analysis using NC Form 1 (Appendix A.3) or an equivalent form. All individual or combined structures (those

Within 1L of each other) with a region of influence (5L) extending to one or more sources must be included in the GEP analysis. As necessary, discuss techniques for calculating GEP stack height for each structure. (Also, please note that refined BPIP modeling output is generally accepted as a GEP analysis);

g) All emission calculations used to derive source parameters (e.g. σ_y and σ_z calculations);

h) A short discussion of the proposed meteorological data (e.g. stations and years selected), if applicable;

i) A short discussion of proposed receptor locations, resolution, and terrain considerations (from USGS elevation data). Note: Any changes made to the topography, due to excavating, etc. should be reflected in the analysis for review;

j) A USGS map highlighting the location of the facility, including property boundary identification, which includes a scale and contour interval;

k) A short discussion of cavity impact evaluation. All structures with a region of influence (5L) extending to one or more sources and any cavity regions extending off-property must be evaluated for off-site or ambient air (e.g. railroad tracks on property-excluding spurs, public highways, rivers, etc.) cavity impacts;

l) A short discussion of urban/rural considerations;

m) A short discussion of model(s) selection and version of model used;

n) A table summarizing modeling results, comparing them with the appropriate AALs.

If the submitted modeling plan discussion is limited to screening modeling, and refined modeling becomes necessary to determine compliance, the modeling plan must be revised and resubmitted to the AQAB for approval prior to submitting the refined modeling analysis.

A modeling protocol is valid for a period of 90 days from the date of the approval to ensure that any changes made in response to advancements made in the science of air quality dispersion modeling are valid. However, previously approved modeling protocols may be substituted for a new submittal if they are less than one year old, and a letter is submitted that requests that a previously approved protocol be used (specifying date of previous submittal). The letter should discuss in detail the proposed facility modifications, and any proposed changes to the methodologies (including model updates, etc.). If the modeling analysis will not be submitted prior to the modeling plan expiration date, a protocol "approval extension request," or a revised protocol should be submitted to the AQAB before the modeling analysis is submitted.

Generic modeling protocols for “multi-location” modeling will not be accepted (e.g. large “multi-site” industries submitting one protocol to model more than one facility at the same time). For proposed “multi-facility” evaluations, each individual facility must have an approved protocol, which is unique to that facility. The discussion of the facility (sources, buildings, receptors, terrain, etc.) should include every aspect of the “individual” facility; generalizations will not be accepted.

3.0 <u>GENERAL MODELING INFORMATION</u>

New facilities are required to identify and evaluate emissions of air toxics from all sources. Existing facilities making modifications are required to identify and evaluate all sources of new air toxics and all existing sources that show a facility-wide "net" increase of air toxics as a result of the modifications.

Total facility emissions of the air toxics, those toxics listed in 15A NCAC 2Q .0711, must be compared to the applicable toxic emission rates also listed in 2Q .0711. If the facility's total emissions exceed these values for any of the North Carolina air toxics, those toxics must be modeled to show compliance with the applicable AALs listed in 15A NCAC 2D .1104. **Note: Any changes in source characteristics previously modeled to show compliance may require a new modeling compliance demonstration.** Modeling requirements for proposed modifications that *do not* result in a facility-wide "net" increase of air toxic emissions will be evaluated by the NCDAQ on a case-by-case basis.

Questions or comments regarding stack testing, mass balance calculations, or toxic emission factors should be directed to a NCDAQ air quality engineer.

3.1 Source Types

This guideline document refers almost exclusively to point sources, since these are the most common continuous toxic emission sources. Other source types should be used where applicable.

Industrial pollutant emissions can be characterized in four different ways:

<u>Point or Flare sources</u>: examples include stacks, chimneys, exhaust fans, vents, or flares.
These sources can be modeled with most dispersion models including AERSCREEN and AERMOD, which are able to evaluate building downwash.

Area sources: examples include ponds, puddles, storage piles, and open pits. These sources can also be modeled with most dispersion models including AERSCREEN and AERMOD.

Volume sources: examples include open buildings and open storage tanks, building roof vents, and conveyor belts. These sources can also be modeled with most dispersion models including AERSCREEN and AERMOD. The model accounts for downwash using the entered horizontal and vertical dispersion parameters (σ_y and σ_z) of the influencing structure, where:

> σ_y = length of side / 4.3
> σ_z = vertical dimension of source / 2.15 (for surface-based source)
> σ_z = building height / 2.15 (for elevated source on or adjacent to a building)
> σ_z = vertical dimension of source / 4.3 (for elevated source not on or adjacent to a building)
> To determine the lateral side for σ_y calculations, the correct method is to use volumes with square area footprints and use the side of the square. A non-square footprint should be divided up into two or more square ones. AQAB will accept, as an alternative method, using the side of an equal area square footprint. In other words, use the square root of the total footprint area of the volume source. To prevent delays and reworks, confer with the AQAB prior to completing the analysis, in order to reach agreement of volume source parameters.
> The release height is generally equal to 50% of the source height.

Line sources: examples include roadways and streets (motor vehicle sources) or lines of roof vents or stacks. These sources generally require special application models such as the point, area, line, source (PAL), buoyant line and point source (BLP), and CALPUFF models. The AERMOD model can simulate line source emissions as multiple volume sources. Contact the AQAB before choosing this type of source.

3.2 Good Engineering Practice (GEP) Calculations

The atmospheric flow and turbulence around buildings and other obstacles determines how pollutants are dispersed. The height above the ground of undisturbed atmospheric flow, H_g, is called the *good engineering practice (GEP) height.* Determining the GEP height is the initial phase of the air quality modeling analysis. GEP stack height is defined as the height necessary to ensure that emissions from the stack will not result in excessive concentrations of any air pollutant in the immediate vicinity of the sources as a result of atmospheric downwash, eddies, or wakes, which may be created by the source itself, nearby structures, or nearby terrain obstacles.

Using the Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations)[3], a GEP analysis should be conducted for all structures, combinations of structures (those within 1L of each other,) and terrain features that have a region of influence (5L) extending to one or more emission sources. These obstacles (buildings, structures, or terrain features) should not be limited to only those on the facility property; any off-site structures should be evaluated if their region of influence encompasses one or more facility sources. Assessment of terrain elevations is on a case-by-case basis. Contact the AQAB for more information.

GEP stack height is calculated by using the following equation:

$H_g = H + 1.5L$

Where,

H_g = good engineering practice stack height;

H = height of the adjacent structure or nearby structure;

L = lesser dimension (height or maximum projected width of the adjacent or nearby structure or terrain feature height).

The obstacle resulting in the largest GEP stack height (H_g) for each source is identified as the critical structure for that source. The critical structure dimensions are used by the AERSCREEN model to assess cavity impacts and wake effects for each source modeled. On-site and off-site structures that are not identified as the critical structure, but which are close (within 3L) to the property boundaries and have a region of influence (5L) extending to one or more sources, should also be evaluated for cavity impacts.

Refined models, such as AERMOD, use direction-specific building dimension data, which can be obtained from the EPA Building Profile Input Program (BPIP-PRIME) or several vendor GEP-BPIP programs. For tiered structures, start with the largest "footprint" using the height of the shortest tier, and work down to the smallest "footprint" that has the tallest tier. More detailed information regarding combinations of structures (e.g. tiered or complex structures) can be obtained from the EPA GEP guidelines referenced above. Refined BPIP modeling output is generally accepted by the NCDAQ as an acceptable GEP analysis which limits the need for a detailed discussion of GEP rules and regulations. Also, unless otherwise exempted, a stack greater than GEP should be modeled at a calculated GEP height.

3.3 Merged Sources

A single representative stack may be used to represent several sources that are identified as "similar". "Similar" stacks are those that are located less than 100 m apart, emit the same pollutants, and have stack heights and gas exit velocities differing by less than 20 percent. The procedure of merging sources identifies one (1) worst case representative stack from which all of the emissions from the sources involved are modeled. The merged stack is typically located at the closest location, of all the stacks involved, to the property line. This location, if all other parameters were the same, would result in the maximum modeled off-site concentrations. Dissimilar stacks may also be merged, but the merged source technique will result in conservatively high off-site concentrations. Therefore, merging dissimilar stacks should be done with caution. To determine which stack should be used as the representative stack, compute the parameter, M, for each stack, using the following equation:

$M = (H_s\ V\ T_s) / Q$

Where,

M = parameter accounting for the relative influence of stack height, plume rise, and emission rate on concentrations;

H_s = stack height (m);

$V = (\pi/4)\ v^2 d^2$, where V = stack gas volume flow rate parameter;

Note: Since it is possible for two stacks to have the same flow rate (V) and "M" value, while still having a large difference in momentum flux, and predicted ambient concentrations, the stack exit velocity (v) is squared when calculating the stack flow rate (V). This is consistent with the algorithms used by the SCREEN3 model to calculate momentum flux and will ensure a conservative emission point is used as the representative stack.

d = stack exit diameter (m);

v = stack gas exit velocity (m/s);

T_s = stack gas exit temperature (K); and

Q = pollutant emission rate (g/s).

The stack with the lowest "M" value is used as the representative stack. The sum of the emissions from all merged stacks is assumed to be emitted from the representative stack; i.e. the merged source is characterized by H_{s1}, V_{s1}, T_{s1}, and Q, where subscript 1 indicates the representative stack and $Q = Q_1 + Q_2 + \ldots + Q_n$ (the combined emissions). The location of the representative stack is at the actual stack location closest to the property line.

To conservatively estimate ambient impacts using SCREEN3, the worst-case stack is determined using the lowest "M" factor calculated assuming a "Q" value of 1. The stack with the lowest "M" factor is then used as the representative stack. The sum of the facility-wide emissions and the parameters for the worst-case stack are then input into the model.

Merging stacks in a refined modeling analysis is generally not recommended. Since refined modeling uses actual hourly meteorological data, the representative stack closest to the property line may not necessarily result in the highest ambient concentrations. Similar stacks which are located close to one another and are a considerable distance from the property boundary may be merged; however, the user should discuss the proposed source merging with the AQAB and in the required modeling protocol.

3.4 Receptors

Receptors are points, defined by the modeler, that represent physical locations at which the air dispersion models will predict ambient pollutant concentrations. Groups of Cartesian or polar receptors are usually defined as "receptor grids". Deciding which type to use is largely a function of the type of modeling being performed (screening or refined), the size and number of emission sources, or the site location (including topography), and should be selected to provide the best "coverage" for the facility being modeled.

A Cartesian receptor grid consists of receptors identified by their x (east -west) and y (north-south) coordinates and is generally the easiest to work with. A polar receptor grid consists of receptors identified by their distance and direction (angle) from a user defined origin (e.g. main boiler stack). Discrete receptors are used to identify specific locations of interest (e.g. school, church, etc.) and can be expressed in Cartesian or polar coordinates. All types of receptors may include terrain heights (z) for evaluation of terrain.

A modeling receptor grid may consist of any combination of discrete, polar, or Cartesian receptors, but must provide sufficient detail and resolution to identify the maximum impact. Additional comments regarding receptor types, placement, and terrain considerations are given in the screening and refined modeling sections.

3.5 Land Use Classification

Land use classification determines the type of area to be modeled. The different classifications, urban or rural, incorporate distinct pollutant dispersion characteristics and will affect the estimation of downwind concentrations when used in the model. With few exceptions, (e.g. downtown areas of large cities such as Raleigh, Charlotte, Greensboro, etc.), all of North Carolina should be considered rural. If additional clarification is warranted or desired, contact the AQAB.

3.6 Recommended Models

The dispersion models recommended in this guidance are consistent with the EPA model recommendations given in the EPA Guidelines, Supplement C, dated November 2005. Although there are a number of technical and non-technical factors a modeler will consider when deciding which dispersion models should be used, model selection can generally be defined based on terrain (simple or complex) and level of modeling desired (screening or refined). A modeling exercise may be limited to a specific model or may require more than one model. Table 1 summarizes the more commonly used models and are those recommended by the AQAB.

TABLE 1
Recommended Models

Model Application	Screening Models	Refined Models
Flat/Rolling Terrain[a]	AERSCREEN	AERMOD
Complex Terrain[a]	AERSCREEN, CTSCREEN	AERMOD

[a] CALPUFF may be used on a case-by-case basis;
however, prior approval from DAQ must be obtained.

The models listed in Table 1 and other EPA Guideline models can be downloaded from the EPA Technology Transfer Network (TTN), SCRAM web site. Addresses for EPA and SCRAM, as well as other useful sites are listed below:

-US EPA – http://www.epa.gov/

-Support Center for Regulatory Air Models (SCRAM) - http://www.epa.gov/scram001/

-Atmospheric Sciences Modeling Division – http://www.epa.gov/docs/asmdnerl/index.html

-Region 4 (Atlanta) – http://www.epa.gov/region4/

-NCDAQ/Permits Section (contains a link to AQAB) – http://www.daq.state.nc.us/permits/

3.7 Modeling Reporting Requirements

The modeling reports submitted to the AQAB should be complete and include an introduction and detailed discussion of the modeling compliance demonstration. Although the length and complexity of the modeling report will be dictated by the complexity of the modeling, each report should contain the following items:

a) A general discussion of plant processes and the types of emission sources under consideration;

b) A certified plat, signed survey, or copy of the deed from the County Register of Deeds Office, in that order of preference, of the industrial site clearly locating all property boundaries;

c) A detailed site map showing locations of property boundaries, emission sources (existing and proposed), existing and proposed facility buildings or structures [the map must show the dimensions (height, width, length) of all buildings and structures], and any public right-of-ways traversing the property (e.g. roads, railroad tracks, rivers, etc.). The site diagram should also provide a scale and true north indicator and should show UTM coordinates or the latitude/longitude of at least one point (e.g. source or building corner). If known, indicate the format or projection of the UTM coordinates (e.g. NAD27 or NAD83);

d) A list of all the facility toxic air pollutants, their emission rates, and their respective NC air toxic emission rate as listed in 15A NCAC 2Q .0711. Use NC Form 2 (A.4) or an equivalent form;

e) A list or table of stack parameters for all existing and proposed sources. Use NC Forms 3, 3A, and 3V, (A.5, A.6, A.7) or an equivalent form. If multiple stacks are merged, identify the merged stack and include all "M" factor calculations. List area or volume sources separately and include a short discussion on why these sources are represented as area or volume sources. All fugitive emissions should be identified and quantified;

f) A Good Engineering Practice (GEP) analysis using NC Form 1 (A.3) or an equivalent form. All individual or combined structures (those within 1L of each other) with a region of influence (5L) extending to one or more sources must be included in the GEP analysis. As necessary, discuss techniques for calculating GEP stack height for each structure. Refined BPIP modeling output is generally accepted by the AQAB as an acceptable GEP analysis which limits the need for a detailed discussion of GEP rules and regulations.

g) All emission calculations used to derive source parameters (e.g. σ_y and σ_z calculations);

h) A short discussion of the proposed meteorological data (e.g. stations and years selected), if applicable;

i) A short discussion of proposed receptor locations, resolution, and terrain considerations (from the USGS topographic map). Note: Any changes in topography due to excavating, etc. should be reflected in modeling analysis for review;

j) A USGS map highlighting the location of the facility, including property boundary identification, which includes a scale and contour interval;

k) A short discussion of cavity impact evaluation. All structures with a region of influence (5L) extending to one or more sources and any cavity regions extending off-property must be evaluated for off-site or ambient air (e.g. railroad tracks on property-excluding spurs, public highways, rivers, etc.) cavity impacts;

l) A short discussion of urban/rural considerations;

m) A short discussion of model(s) selection and version of model used;

n) A table summarizing modeling results, comparing them with the appropriate standards.

The forms referenced below and shown in Appendix A may be photocopied and used in the modeling report. The applicant is free to develop and use alternate forms, but all information must be included. The appropriate forms or combination of forms to be submitted to the AQAB will depend on the complexity of the modeling compliance demonstration. The following forms are recommended for submission for a simple screening or refined modeling analysis.

Form 1 – GEP Analysis

Form 2 – Pollutant Emission Rates

Form 3 (3A and 3V as needed) – Emission Source Parameters

Form 4 – Screen Terrain Calculations

Form S5 – Screening Model Results

Form R5 – Refined Model Results (if applicable)

4.0 SCREENING MODELING

Applicants proposing to modify an existing facility or construct a new facility in North Carolina are required to identify and evaluate the new air toxic emissions or net increases in existing toxics at their facility. If the applicant is required to perform dispersion modeling to demonstrate compliance with the applicable Acceptable Ambient Levels (AALs) for identified regulated toxics, the AQAB recommends the use of screening models as a first approach to the compliance demonstration. The latest screening models available will estimate pollutant concentrations in cavity regions, and simple, rolling, and complex terrain environments. These screening models are also generally faster and easier to use because they require less detailed data than refined models. They are also preferred because they are designed to provide conservative estimates of pollutant concentrations. The following discussion will mainly reference the EPA AERSCREEN model since this is now the AQAB preferred screening model. AQAB modeling staff can be contacted for guidance on use on the previously preferred SCREEN3 model, if required.

4.1 AERSCREEN

AERSCREEN is a screening-level model based on AERMOD. While not as simple to use as the previously preferred SCREEN3 model, AERSCREEN includes state-of-the-art dispersion science, enhanced terrain capabilities, and is expected to provide more realistic concentration estimations. The model provides an output concentration for various averaging periods using conversion factors that are built into the model; therefore, it is not necessary to multiply the 1-hour output concentration by the applicable conversion factors as was required with SCREEN3. The data input requirements for AERSCREEN are source-specific and are described in detail in the AERSCREEN User's Guide [4], EPA-454/B-11-001. This document can be downloaded from the EPA SCRAM web site.

The data required to perform simple point source screening modeling are: stack height, exit velocity, diameter, exit temperature, individual pollutant emission rates for each stack, distances from stacks to the property/fence line, and detailed information about any structure within one half (1/2) mile of each stack. For facilities located in elevated and rolling terrain, a National Elevation Dataset (NED) file for the area surrounding the source can be obtained from the Multi-Resolution Land Characteristics Consortium (MRLC) at: http://www.mrlc.gov/viewerjs/.

The following are the recommended model options:

a) Stack exit velocity: If the stack has a non-vertical exit, the following equation should be used to calculate an appropriate exit velocity:
$V_s = V_{s0}$ sin(angle of stack from horizontal)
Where;
V_s = exit velocity to input to model,
V_{s0} = exit velocity as reported
The greater of V_s or 0.01m/s should be used in the dispersion model. In cases where there are fugitive emissions, stacks with rain caps (china hats), and horizontal or downward-pointing exits, use 0.01 m/s.

b) Receptor height (flag pole) = 0 m, unless considering impacts on nearby buildings, balconies, highway overpasses, etc. The distance to flag pole receptors should be identified using the discrete receptor option (i.e. do not use the automated distance receptor array for flag pole receptor heights).

c) Urban/rural options (described in Section 3.5): Choose rural except when a source is located in urbanized areas (e.g. near downtown areas of Raleigh, Charlotte, Greensboro, etc.)

d) Building downwash: For building downwash effects, the user can use a use either a pre-existing BPIP file or enter certain information about nearby buildings directly. The parameters required if entering the building information directly into the model are: 1) building height, 2) maximum horizontal building dimension, 3) minimum horizontal building dimension, 4) the maximum horizontal building dimension angle from true north (0-179 degrees), 5) direction of the stack from the building center (0-360 degrees), 6) distance between the stack and building center. If several buildings exist within the vicinity of the modeled source and a pre-existing GEP file is not used, the buildings should be evaluated through a GEP analysis to determine the controlling structure to be used for model input.

e) Terrain heights should generally be included for all sources and terrain configurations.

f) Discrete or flagpole receptors may be entered for any particular areas of interest in the analysis.

g) The source location can be entered in either Lat/Lon or UTM coordinates.

h) When using NED elevation data files (recommended), select the NAD 1983 dataset option.

i) Automated receptor array: Recommended and must begin at the nearest location of <u>contiguous property line</u> from the source. It should extend far enough to ensure that the maximum concentration is calculated, usually 2000 m. Extend the receptor array out to 20 km for taller stacks (height greater than 50 m). If the terrain heights within 5 km (~3 miles) of the modeled stack exceed the stack base elevation, include terrain features.

j) Discrete receptors: Use at nearby critical locations, including residences, schools, rest homes, businesses, etc., on property not owned by the facility, and on public right-of-ways (e.g. train tracks, highways, rivers, etc.) which traverse the facility property. **Note: Annual and 24-hour toxics modeling demonstrations do not require receptors to be located on public right-of-ways traversing facility property boundaries.**

4.2 Cavity Effects

AERSCREEN incorporates algorithms that include the calculation of pollutant concentrations within building cavity zones and, therefore, a separate cavity analysis is not required as it was with SCREEN3.

4.3 Acceptable Ambient Levels (AALs)

After modeling is completed, sum the predicted concentrations for each source for each pollutant. Compare the maximum predicted concentrations for each averaging period to the AALs listed in 15A NCAC 2D .1104 "Toxic Air Pollutant Guidelines". Use the following when comparing to the AALs to determine compliance:

a) If the 1-hour modeled concentrations are greater than 95% of the appropriate AAL, refined modeling (see Section 5) must be conducted to demonstrate compliance. Alternatively, the applicant may choose to apply additional controls, make source modifications, or consider permit restrictions to reduce the modeled concentrations to 95% or less of the appropriate AAL.

b) If the total predicted 24-hour and annual concentrations are less than the AALs, no further modeling is necessary.

c) If pollutant concentrations in the cavity region of any structure are in excess of the appropriate AALs and the cavity region extends off property or to any applicable receptor, the applicant may elect to apply additional controls, modify sources, include permit restrictions, or perform a second level cavity analysis, as described in the refined modeling section.

5.0 <u>REFINED MODELING</u>

If the screening modeling evaluation results in pollutant concentrations that exceed 95% of the 1-hour AAL, and source modifications or permit restrictions are not acceptable alternatives, the source emissions can be modeled using an acceptable refined dispersion model. The refined model is more complex than the screening model and will require more extensive computer hardware and software resources, more detailed input data, and a greater level of modeling proficiency. However, the refined model is more accurate and will generally predict lower ambient pollutant concentrations. The guidance in this section is intended to provide an introduction to refined modeling techniques. The user may wish to review the material in the individual refined model user's guides and the <u>EPA Guideline on Air Quality Models</u> - Supplement C.

Use of the ISCST3 or CALPUFF model for refined modeling is allowed only for special cases and on a very limited basis. Please contact the AQAB prior to using.

5.1 AERMOD

The AERMOD model is a refined model designed to estimate average pollutant concentrations for multiple sources, at one or more receptor locations over the averaging period(s) of concern using actual hourly meteorological data, and is the refined model most preferred by the AQAB.

The AERMOD model is capable of evaluating ambient impacts at receptors in all types of terrain (i.e. flat, rolling, and complex). AERMOD may be executed with complex and intermediate terrain receptors in the same manner as with simple terrain receptors. For each source evaluated, the AERMOD model will determine the appropriate terrain classification (i.e. simple, intermediate, or complex) for all receptors and apply the appropriate algorithm.

The following settings should be used when running the AERMOD model:

a) The model should be executed with all regulatory default options unless otherwise approved by the AQAB.

b) For stacks with raincaps or with horizontal discharge, use 0.01 m/s for the exit velocity. Stacks with an angled alignment may calculate an effective exit velocity based on trigonometry. See the Screening section for calculation formula.

c) Use 293 degrees Kelvin for discharges at ambient temperature.

d) All facility buildings, including separate tiers, should be modeled in the analysis.

e) Always use the highest impact concentration for comparison to the AAL. Any other arrangement must be approved by the AQAB.

f) The urban dispersion option should only be used as approved by the AQAB.

The data input requirements for AERMOD are source-specific and are described in detail in the User's Guide for the AMS/EPA Regulatory Model - AERMOD[5], EPA-454/B-03-001. This document can be downloaded from the EPA SCRAM web site.

5.2 Cavity Effects

The AERMOD model evaluates cavity concentrations. However, if maximum impacts are believed to be primarily the result of excessive building downwash calculations, a field study or fluid modeling demonstration may be performed to demonstrate compliance with the AALs. If such options are pursued, the AQAB must give prior approval on the study plan and methodology.

5.3 Receptor Grids

The AERMOD model uses a combination of coarse and refined receptor grids to determine the maximum concentration for each pollutant and pollutant averaging period evaluated. The number and placement of these receptors will vary depending on the modeling scenario, but in all cases should provide sufficient resolution to identify the maximum pollutant impact.

In designing the receptor grid, emphasis should be placed on resolution and location and not on the total number of receptors. For most facility modeling, the receptor grids should extend out to 5-10 km; generally, taller stacks (>50 meters) require larger receptor grids. The receptor grid should also include terrain elevations when terrain heights exceed source base elevations. Terrain elevations should be processed from USGS National Elevation Dataset (NED) data by the AERMAP program.

Although coarse and refined receptor grids can be used in the same model run, the coarse receptor grid is generally used to identify the general area of maximum impact for each pollutant for each averaging period. The refined receptor grid is then developed and centered on the coarse grid maximum impact and used to identify the maximum pollutant concentrations.

5.3.1 Coarse Grid Array

The coarse receptor grid can be discrete, Cartesian, polar, or any combination thereof, and is used to identify the general area of maximum impact for each pollutant for each averaging period. The polar receptor grid consists of 36 radials extending out from a centralized location with receptors placed along each radial at selected distances from the origin. Due to the nature of the polar grid, receptor resolution quickly diminishes as radial distance increases. This characteristic can often result in a receptor grid that provides insufficient detail to define the area of maximum impact. For this reason, the AQAB discourages the use of polar receptor grids and strongly recommends the use of Cartesian and/or discrete receptor grids.

The coarse Cartesian receptor grid is a rectangular pattern of receptors with a resolution greater than 100 meters but less than 1000 meters. The exact receptor placement will vary from one modeling scenario to another. If the minimum source to property distance is less than 100 meters, discrete receptors are placed at 25-meter intervals along the property boundary near the source(s) identified. For toxic pollutants, discrete receptors along the public right-of-ways traversing the facility property are required only for the 1-hour averaging period evaluation. Discrete receptors are also placed at nearby residences and in other critical or sensitive areas such as hospitals, schools, and nearby residences.

5.3.2 Refined Grid Array

The refined receptor grid is used to ensure the maximum impact for each pollutant for each averaging period has been identified. The refined grid is a Cartesian and/or discrete receptor grid and can be developed based on the coarse receptor grid analysis, or can be developed and used in lieu of the coarse receptor grid.

If the coarse receptor grid is initially used to identify the area of maximum impact, the refined receptor grid with 100 meter resolution is centered on the coarse grid receptor of maximum impact for each pollutant for each averaging period. The refined grid should be of sufficient size to ensure that the refined receptor indicating the maximum predicted concentration has at least one receptor on all sides showing a lower concentration. The location of maximum coarse grid impact may vary depending on the pollutant and averaging period; subsequently, the refined modeling analyses may require more than one refined receptor grid.

5.4 AERMAP

Terrain elevations for receptors should be processed from USGS National Elevation Dataset (NED) data by the AERMAP program. The NED data can currently be retrieved from the Multi-Resolution Land Use Characteristics Consortium website at: http://www.mrlc.gov.

Use of the old DEM quads is strongly discouraged because of documented problems with some of the data and lack of updates; the NED data is improved, maintained, and updated. AQAB can provide assistance on retrieving and using this data. AERMAP should also be used to assign initial base elevations for sources and structures from the same NED data. These onsite elevations, whether from NED or another source, may need to be adjusted manually to account for grading and to ensure that the data values are consistent with surrounding receptor elevations. Different sources of elevation data may have different absolute values for the same point.

The data input requirements for AERMAP are described in detail in the User's Guide for the AERMOD Terrain Preprocessor (AERMAP)[6], EPA-454/B-03-003. This document can be downloaded from the EPA SCRAM web site.

5.5 Meteorological Data/AERMET

Refined models, such as AERMOD use actual meteorological data, hourly or averaged, collected from a pre-determined, representative, National Weather Service (NWS) station, or as part of an on-site data collection program, and can use up to five (5) years of data. In some cases, with AQAB approval, data collected at local universities, FAA sites, military bases, industries, or pollution control agencies may be used. Meteorological data should be selected based on climatological representativeness and the ability of the data to accurately characterize atmospheric transport and dispersion in the location of the facility. Appendix B contains a list of recommended NWS meteorological data sets to be used for refined modeling for each county in NC.

When using AERMOD, the AQAB will provide five year meteorological .sfc and .pfl data sets pre-processed by AERMET. The parameters of albedo, bowen ratio, and surface roughness have been determined by the AQAB and are available upon request. Use the table in Appendix B for the recommended NWS meteorological data set for you county.

Any use of on-site or other meteorological data that has not been processed by the AQAB will require prior approval. The AQAB will assist in the selection of surface characteristics to be used in the AERMET meteorological data processing. The data input requirements for AERMET are described in detail in the User's Guide for the AERMOD Meteorological Preprocessor (AERMET)[7], EPA-454/B-03-002. This document can be downloaded from the EPA SCRAM web site.

5.6 Elevated / Mountainous Terrain

AERMOD, and CALPUFF[8] models can be used to perform refined modeling in elevated terrain. However, most of these models require extensive data collection that cannot be summarized in this document. Before using any of these models in an elevated terrain setting, discuss with AQAB personnel.

5.7 Comparison to AAL

The maximum modeled concentrations for each pollutant are compared to the applicable AAL for each appropriate averaging period. No further modeling is necessary if the most recent year of meteorological data is used and the modeling results are below 50% of the applicable AAL. If the predicted concentrations exceed 50% of the applicable AAL, but are less than 100%, the latest five years of appropriate meteorological data must be used. If the modeling results indicate that ambient concentrations exceed the applicable AAL, permit restrictions and/or source modifications and remodeling will be required to demonstrate compliance.

6.0 REFERENCES

1. "North Carolina Administrative Code, Title 15A, Department of Environment, Health, and Natural Resources, Chapter 2, Environmental Management", Environmental Management Commission, Raleigh, NC, amended March 8, 1994.

2. U.S. Environmental Protection Agency, Guidelines on Air Quality Models – Appendix W to Part 51, U.S. EPA, Research Triangle Park, NC, 2005.

3. U.S. Environmental Protection Agency, Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations) (Revised), EPA 450/4-80-023R, U.S. EPA, Research Triangle Park, NC, 1985.

4. U.S. Environmental Protection Agency, SCREEN3 Model User's Guide, EPA 454/B-95-004, U.S. EPA, Research Triangle Park, NC, 1995.

5. U.S. Environmental Protection Agency, User's Guide for the AMS/EPA Regulatory Model – AERMOD EPA 454/B-03-001, U.S. EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, September 2004.

6. U.S. Environmental Protection Agency, User's Guide for the AERMOD Terrain Preprocessor (AERMAP) EPA 454/B-03-003, U.S. EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, October 2004.

7. U.S. Environmental Protection Agency, User's Guide for the AERMOD Meteorological Preprocessor (AERMET) EPA 454/B-03-002, U.S. EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, November 2004.

8. Scire, Joseph S., David G. Strimaitis, & Robert J. Yamartino, A User's Guide for the CALPUFF Dispersion Model, Earth Tech, Inc., Concord, MA, 2000.

Appendix A

Modeling Report Forms

(Click the product name below to open)

A.1 Toxics Protocol Checklist

A.2 Modeling Request D3 Form

A.3 GEP Analysis Form

A.4 Pollutant Emission Rates Table

A.5 Point Source Parameters Table

A.6 Area Source Parameters Table

A.7 Volume Source Parameters Table

A.8 Screen Terrain Calculations Table

A.9 Screening Model Results

A.10 Refined Model Results Table

Appendix B

NWS Data Sets for Use with AERMOD

(Click here to open document)

http://www.ncair.org/permits/
mets/Metdata.pdf

Appendix C

Definitions and Terms

DEFINITIONS AND TERMS

AAL: Acceptable Ambient Level

AQAB: Air Quality Analysis Branch

Area source: Source that has initial lateral dimension, such as a pond, rock pile, parking lot, or open pit

Cartesian receptor grid: Receptors identified by their x (east- west) and y (north- south) coordinates

Cavity region: Recirculation zone around buildings

Complex terrain: All terrain above stack top

Discrete receptors: Receptors used to identify specific locatio ns of interest such as schools, churches, etc., and can be expressed in cartesian or polar coordinates

Flat terrain: Terrain at the same elevation as stack base

GEP stack height: The height necessary to ensure that emissions from the stack will not result in excessive concentrations of any air pollutant in the immediate vicinity of the sources as a result of atmospheric downwash, eddies, or wakes which may be created by the source itself, nearby structures, or nearby terrain obstacles: $H_g = H + 1.5L$, where L is the lesser dimension of the height of the source or maximum projected width of the adjacent or nearby structure or terrain feature height

Intermediate terrain: Terrain at elevations between stack top and plume centerline

NCDAQ: North Carolina Division of Air Quality

Polar receptor grid: Receptors identified by their distance and direction (angle) from a user defined origin

PSD: Prevention of Significant Deterioration

Simple elevated terrain: Terrain at elevations lower than stack top

TAP: Toxic air pollutant

USEPA: United States Environmental Protection Agency

Volume source: Source that has lateral and vertical dimensions such as a building with vents, tanks, conveyor belts, flanges and valves

Appendix D

Concrete Facility Questionnaire

(Click here to open document)