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

May 2018

North Carolina Department of Environmental Quality

Division of Air Quality

Permitting Section

Air Quality Analysis Branch

Table of Contents

List of Tables

Appendices

1.0   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 02Q[1] Section .0711 of the Toxic Air Pollutant Procedures will not result in ambient concentrations exceeding the Acceptable Ambient Levels (AALs) listed in 15A NCAC 02D Section .1104. Note: Section .0711 includes two separate lists of facility-wide emission rates requiring an air toxics modeling demonstration. The first list, Section .0711(a), specifies more conservative emission rates where one or more facility emission release points are obstructed or non-vertically oriented. The second list, Section .0711(b), specifies less conservative emission rates where all facility emission release points are unobstructed and vertically oriented.

Additionally, the owner of any facility subject to Prevention of Significant Deterioration (PSD) may be required by the NCDAQ to perform dispersion modeling for air toxics. AQAB recommends that air toxics be discussed and addressed during the PSD pre-application meeting for any PSD project to prevent potential delays in review of permit applications and accompanying modeling materials.

These guidelines should be followed for performing the dispersion modeling analysis demonstrating compliance with AALs listed in 15A NCAC 02D Section .1104.

All modeling guidance discussed in this document adheres to appropriate EPA guidance[2] (documentation and policies) for determining the impact of any air 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://deq.nc.gov/about/divisions/air-quality/air-quality-permits/modeling-meteorology/alerts.

Any further questions, clarifications, and concerns regarding proper application of current modeling guidelines and alternative modeling techniques should be addressed directly in consultation with the AQAB.

1.1   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 15A NCAC 02Q .0711 as a result of the addition of a new source or modification of an existing source, unless exempted under 15A NCAC 02Q .0702. The modeling must demonstrate that the ambient concentrations of the affected air toxics will not exceed the applicable AALs, listed in 15A NCAC 02D .1104.

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 because of the modifications.

Total facility emissions of the air toxics (those toxics listed in 15A NCAC 02Q .0711) must be compared to the applicable toxic emission rates also listed in 02Q .0711. If the facility's total emissions exceed those 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 02D .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.

Facility-wide and source-by-source toxics emission limits may be based on a variety of conservative dispersion modeling methodologies provided ambient impacts model below the applicable AALs. Applicants may propose emission limits based on potential and/or actual emission rates that model below the applicable AAL. Optimized emission limits may be proposed that are based on modeled emissions impacts scaled to an acceptable percentage of the applicable AAL. Further optimized emission limits can be made in terms of facility-wide impacts based on individual source contributions, facility-wide impacts based on one or more worst-case stacks, or a combination thereof. The applicant is encouraged to contact the AQAB to discuss any uncertainties in proposed emission limits that rely on anything other than facility-wide impacts based on individual emission source contributions.

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. Note: modeling protocol approvals are valid for a period of 90 days from the date of approval. Approvals may be extended by submitting a written request to AQAB.

Applicants may request that the AQAB conduct the modeling for them to determine compliance, but are encouraged to contact the AQAB before doing so. To perform requested modeling, the AQAB will require the completion of all facility information in the D3 modeling worksheet (Appendix A.2) and provide the specified facility drawings. This information will be used by the AQAB modelers to conduct a screening analysis. Refined analyses are not generally conducted as part of the modeling request option. 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.

The AQAB may request updated or refined modeling for toxics pollutants where proposed or existing permitted emission limits are based upon previous model versions, techniques, or methodologies that would have a significant impact on predicted model concentrations. Therefore, development of a modeling protocol and early communications with AQAB prior to commencing a project will significantly improve the efficiency of modeling efforts on the part of the applicant and the subsequent review and approval by the AQAB.

1.2 Modeling Policy – Specific Industry

In response to air quality issues associated with certain industrial operations, the AQAB has established specific modeling approaches to be used for those industries to evaluate facility-wide pollutant impacts.   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.

1.2.1 Concrete Batch Plants

The AQAB has developed a database for two types of concrete facilities: 1) truck-mix concrete facilities with controls on the truck load-out operation and 2) 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 be used to exempt these concrete facilities from modeling and to establish, as needed, a maximum annual concrete production rate limit to assure compliance. The latest production rates and property line distances are available at: https://ncdenr.s3.amazonaws.com/s3fs-public/Air Quality/permits/files/genrl/Concrete_Production_Modeling_Rates.pdf. 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.

1.2.2 Landfills

Because 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.

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 detailed 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 02Q .0711. Use NC Form 2 (Appendix A.4) or an equivalent form;

e) A detailed discussion of modeling scenario assumptions that form the basis for modeled sources, operating levels (e.g., engine load, operating times, etc.), and associated emission rates and release parameters. Include additional discussion of representativeness and/or conservatism of scenarios as they apply to pollutant annual, daily, and hourly modeled averaging periods.

f) A list or table of stack parameters for all existing and proposed sources. NC Form 3, 3A, and 3V, (Appendix A.5, A.6, A.7) or an equivalent form may be used to list the stack parameters. 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;

g) 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 (where L is equal to the lesser of building height or horizontal projected width). 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);

h) All emission calculations used to derive initial area and initial volume source parameters (e.g., σ_{y0} and σ_{z0} calculations);

i) If using AERMET dataset processed by AQAB, provide a short discussion of the proposed meteorological data (e.g. stations and years selected); **if using on-site or other alternative AERMET dataset**, provide detailed discussion of raw data selection and processing options under Stages 1-3 of the AERMET and AERMINUTE processing, AERSURFACE inputs and precipitation analysis, and any data substitution methods;

j) 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;

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

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 that compares 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 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   General Modeling Information

This section discusses dispersion modeling assumptions, guidelines, and details as applied to modeled source types, good engineering practice stack height, merged point sources, receptors, land use classifications, recommended models, and modeling reporting requirements.

In general, several assumptions and limitations apply to approaches and methodologies presented here in the context of dispersion modeling demonstrations for toxic air pollutants. All toxic air pollutants are assumed to be inert and non-reactive given the relatively short transport distances modeled. This assumption is largely based on the short distances between sources and maximum off-property impacts typically modeled for most facilities. As such, toxic air pollutant releases over these distances are assumed to not have enough reaction time or reagent availability to significantly affect downwind modeled concentrations. Another key assumption for modeling toxic air pollutants involves the relative density of the emissions, or plume, to ambient air. Most dispersion modeling topics covered here imply or assume that the density of the plume carrying the toxic air pollutant is the same as the density of the ambient air. This assumption is based on

the relatively small or dilute concentrations of the toxic air pollutants released in the plume. This assumption is typically valid for combustion emissions. However, plume density assumptions should be reviewed with an NCDAQ air quality engineer in cases such as process emissions where the concentration and/or combination of plume gas constituents may indicate a dense gas release. Lastly, much of the topics covered in this section and throughout the guidance rely on the assumption of steady-state emission and dispersion of pollutants. Source emission rates are typically modeled assuming no non-steady chemical or physical perturbations or fluctuations as observed, for example, during source testing, start-up and shutdown operations, or batch production operations. As such, worst-case emission rates and stack parameters for each pollutant, averaging period, and operating scenario are typically modeled unchanged for the duration of the modeling analysis period. Questions or comments regarding worst-case emission rates, stack parameters, and operating scenarios modeled should be directed to a NCDAQ air quality engineer.

3.1 Source Types

Industrial pollutant emissions can generally be characterized in four different ways:

Point or Flare sources: examples include stacks, chimneys, exhaust fans, vents, or flares. These sources can be modeled with most dispersion models including AERSCREEN and AERMOD, which can evaluate building downwash, and obstructed and/or non-vertical releases.

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_{y0} and σ_{z0}) of the influencing structure, where:

σ_{y0} = length of side / 4.3

σ_{z0} = vertical dimension of source / 2.15 (for surface-based source)

σ_{z0} = building height / 2.15 (for elevated source on or adjacent to a building)

σ_{z0} = vertical dimension of source / 4.3 (for elevated source not on or adjacent to a building)

To determine the lateral side for σ_{y0} 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 to reach agreement on volume source parameters.

The volume release height is typically assumed to be equal to 50% of the source height, but may vary depending upon the specific characteristics of the source under consideration.

<u>Line sources:</u> examples include roadways and streets (mobile fugitive and combustion sources) or lines of roof vents or stacks. AERMOD can simulate line source emissions as multiple volume sources or area line sources. AERMOD can also simulate buoyant line and point sources using algorithms adapted from the Buoyant Line and Point dispersion model (BLP). Contact the AQAB before choosing any line source type for toxics modeling.

3.2   Good Engineering Practice (GEP) Calculations

The atmospheric flow and turbulence around buildings and other obstacles strongly influences 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 because of atmospheric downwash, eddies, or wakes, which may be created by the source itself, nearby structures, or nearby terrain obstacles.

Using the <u>Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations)</u>[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 its 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 the emissions from the sources involved can be 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.

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

d = stack exit diameter (m);

Ts = 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 AERSCREEN, 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.

Generally, receptors are placed along the property boundary and extend outward. In certain situations, receptors may be required to be placed at nearby locations of interest such as schools or hospitals.

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 dispersion modeling assumptions applied under convective and stable atmospheric conditions for different diurnal heat-flux profiles observed in urban and rural environments.   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.), most of North Carolina should be considered rural for modeling purposes. 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, Appendix A to Appendix W of 40 CFR part 51, dated January 2017. Although there are 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 required (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 Support Center for Regulatory Atmospheric Modeling (SCRAM) web site. Web addresses for EPA and SCRAM, as well as other useful sites are listed below:

- US EPA – https://www.epa.gov/

- EPA Support Center for Regulatory Air Models (SCRAM) - https://www.epa.gov/scram

- EPA Region 4 (Atlanta) – https://www.epa.gov/aboutepa/about-epa-region-4-southeast

- NCDAQ/Permits Section – http://deq.nc.gov/about/divisions/air-quality/air-quality-permitting

- NCDAQ AQAB - http://deq.nc.gov/about/divisions/air-quality/air-quality-permits/modeling-meteorology

3.7   Modeling Reporting Requirements

The modeling reports submitted to the AQAB should be thorough 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 discussion of the facility and source operating scenarios represented in the modeling demonstration. The discussion should include sufficient detail to show facility and source operations are conservatively depicted in the modeling such that facility impacts are below the AAL for the entire meteorological data period. For example, modeling for a 24-hour pollutant should include a discussion of source and facility daily operating hours, batch processing times, and/or engine loads represented in the modeling.

e) 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 02Q .0711. Use NC Form 2 (A.4) or an equivalent form;

f) 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 of why these sources are represented as area or volume sources. All fugitive emissions should be identified and quantified;

g) 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.

h) All emission calculations used to derive source parameters (e.g. σ_{y0} and σ_{z0} calculations);

o) If using an AERMET dataset processed by AQAB, provide a short discussion of the proposed meteorological data (e.g. stations and years selected); **if using on-site or other alternative AERMET dataset**, provide detailed discussion of raw data selection and processing options under Stages 1-3 of the AERMINUTE processing, AERSURFACE inputs and precipitation analysis, and any data substitution methods);

p) **Electronic files** submitted with the report to include:
   a. If applicant processes own meteorological data:
      i. For on-site meteorological data: All applicable calibration and data validation records, and quality assurance plan documents

      ii. All land use raw data, AERSURFACE input control files, and spreadsheets for precipitation analysis

      iii. All raw 1-minute and/or 1-hour meteorological surface and upper air data files, input control files (e.g., AERMET stages 1-3 files, AERMINUTE inputs), and spreadsheets used for any data-substitutions

      iv. All building downwash input and output files

      v. All terrain raw data files and pre-processor input control files (e.g., AERMAP), and receptor output files

      vi. All model control input and output files, and any include files (e.g., hourly emissions files, background ozone data files, etc.)

    b. If applicant uses AQAB-processed meteorological data:

      i. All building downwash input and output files

      ii. All terrain raw data files and pre-processor input control files (e.g., AERMAP), and receptor output files

      iii. All model control input and output files, and any include files (e.g., hourly emissions files, background ozone data files, etc.)

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 urban/rural considerations;

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

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

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, that are not exempt under 15A NCAC 02Q .0702, 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.

4.1   AERSCREEN

AERSCREEN is a screening-level model based on AERMOD. AERSCREEN includes state-of-the-art dispersion science and enhanced terrain capabilities. 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 here.

The data required to perform simple point source screening modeling are: stack height, exit velocity, stack diameter, exit temperature, individual pollutant emission rates for a single stack, distances from stacks to the property/fence line, and detailed information about any structure within 5L of the stack.   Facilities with multiple stacks may merge emissions from all stacks into one representative stack, as appropriate, to determine facility-wide impacts, or sum impacts from separate screening modeling runs for each individual stack. Please see the AERSCREEN User's Guide for further details on inputs for area and volume sources. 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 screening model options for a single point source:

a) Stack exit velocity: For stacks with raincaps use the POINTCAP source type, and for stacks with horizontal discharge use the POINTHOR source type. POINTCAP or POINTHOR source types require knowledge of stack actual flow rate, exit temperature, and stack diameter. If stack actual flow rate, exit temperature, or stack diameter are uncertain or unknown, use an exit velocity of 0.01 m/s.

b) Stack exit temperature: use actual stack exit temperature associated with modeled actual flow rate and based on reliable engineering data.

c) 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).

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

e) Building downwash: For building downwash effects, the user can 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 BPIP input file is not used, the buildings should be evaluated through a GEP analysis to determine the controlling structure to be used for screening model input.
f) Terrain heights should generally be included for all sources and terrain configurations.
g) Discrete or flagpole receptors may be entered for any areas of interest in the analysis.
h) The source location can be entered in either Lat/Lon or UTM coordinates.
i) When using NED elevation data files (1-arc-second resolution recommended), select the NAD 1983 dataset option. Note: Geotiff file format required for input to AERMAP.
j) Automated receptor array: Recommended and must begin at the nearest location of contiguous property line from the source. It should extend far enough to ensure that the maximum concentration is calculated. 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.
k) AERSCREEN determines meteorological conditions by utilizing the MAKEMET preprocessor. MAKEMET inputs are:
   a. minimum and maximum ambient air temperatures (Fahrenheit or Kelvin)
   b. Minimum wind speed (m/s)
   c. Anemometer height (m)
   d. Surface characteristics type

4.2   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 02D .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.

5.0   Refined Modeling

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 introduce refined modeling techniques. The user may wish to expand on this introduction by reviewing the material provided in the individual refined model user's guides and the EPA Guideline on Air Quality Models - Appendix W to 40 CFR part 51.

Use of CALPUFF or other alternate models for refined modeling is allowed only for special cases and on a very limited basis. Please contact the AQAB if you wish to use those models.

5.1   AERMOD

AERMOD is a refined model designed to estimate 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 preferred by the AQAB.

AERMOD can evaluate 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, AERMOD 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 AERMOD:

a) The model should be executed with all regulatory default options unless otherwise approved by the AQAB.
b) Stack exit velocity: For stacks with raincaps use the POINTCAP source type, and for stacks with horizontal discharge use the POINTHOR source type. POINTCAP or POINTHOR source types require knowledge of stack actual flow rate, exit temperature, and stack diameter. If stack actual flow rate, exit temperature, and stack diameter are uncertain or unknown, use an exit velocity of 0.01 m/s.
c) Stack exit temperature: use actual stack exit temperature associated with modeled actual flow rate and based on reliable engineering data.
d) Specify 0.0 degrees Kelvin for discharges at ambient temperature. AERMOD makes the appropriate ambient temperature substitution based on actual hourly temperature obtained from the meteorological surface data file.
e) All facility buildings, including separate tiers, should be modeled in the analysis.
f) Always use the highest impact concentration for comparison to the AAL. Any other arrangement must be approved by the AQAB.

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

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

5.2   Receptor Grids

AERMOD uses a combination of coarse and refined receptor grids, and property-line receptors 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.

5.2.1 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. A resolution of 100 meters is recommended for receptors placed along the property boundary. 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.

5.2.2 Refined Receptor 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 a 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.

5.3   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 set is improved, better maintained, and more frequently updated. The 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 site 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 and it is important that an accurate assessment of the actual elevations be made before the information is input to the model.

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.

5.4   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 provides five-year meteorological surface and upper-air profile 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 as designated for each 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. If solar radiation data and delta-T data are collected on-site, the bulk Richardson method (i.e., 'BLKRN') should be specified in AERMET stage 3 processing. The BLKRN method uses solar radiation and delta-T measurements to calculate daytime and nighttime meteorological parameters, respectively. 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.

The latest version of AERMET provides added capabilities and options for refining meteorological parameters derived under low-wind, stable conditions. The option for refining horizontal friction velocity under low-wind, stable conditions, or "ADJ_U*", has recently been recommended by EPA as a regulatory option for modeling applications. As such, AQAB has processed AERMET data sets using the ADJ_U* option for all NWS stations in the state, and will share these data sets with applicants upon request. Note: use of these alternative, ADJ_U* data sets for toxics modeling will require justification. Justifications should demonstrate that model design concentrations are dominated and controlled by stable, low-wind conditions such that application of the ADJ_U* option is valid. Contact the AQAB for more information if you wish to utilize the ADJ_U* option.

Under certain circumstances (i.e. complex terrain, land-sea breezes) applicants may choose to use MM5/WRF gridded meteorological data to be representative of a site. Using a gridded meteorological dataset will require running the Mesoscale Model Interface Program (MMIF) to generate input files for processing by AERMET. Subsequent outputs from AERMET would then provide meteorological inputs to AERMOD. For more guidance on processing MM5/WRF gridded meteorological data with MMIF, please refer to the EPA guidance page linked here. Applications of AERMOD using meteorological datasets processed with MMIF should follow recommendations from separate EPA guidance linked here. Please contact the AQAB before using this method to determine representativeness and validity of gridded meteorological data.

5.5   Complex / Mountainous Terrain

The AERMOD and CALPUFF models can be used to perform refined modeling in complex terrain such as that found in the mountainous regions of N.C. However, use of the CALPUFF model requires extensive data setup requirements and specialized expertise to execute properly and guidance on its use is beyond the scope of this document. Please consult with the AQAB before modeling in mountainous complex terrain.

5.6   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 airport 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 airport meteorological data must be used. In the case of on-site meteorological data, only one year of data is required to demonstrate impacts are less than 100% of the applicable AAL. 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, as amended.

2. U.S. Environmental Protection Agency, Guidelines on Air Quality Models – Appendix W to 40 CFR part 51, U.S. EPA, Research Triangle Park, NC, January 17, 2017.

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, AERSCREEN Model User's Guide, EPA 454/B-9516-004, U.S. EPA, Research Triangle Park, NC, December 2016.

5. U.S. Environmental Protection Agency, User's Guide for the AMS/EPA Regulatory Model – AERMOD EPA 454/B-16-011, U.S. EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, December 2016.

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 (and Addendum, March 2011).

7. U.S. Environmental Protection Agency, User's Guide for the AERMOD Meteorological Preprocessor (AERMET) EPA 454/B-16-010, U.S. EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, December 2016.

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)

Appendix B

NWS Data Sets for Use with AERMOD

([Click here to open document](#))

https://ncdenr.s3.amazonaws.com/s3fs-public/Air%20Quality/permits/mets/met_stations_by_county.pdf

Appendix C
Definitions and Terms

DEFINITIONS AND TERMS

AAL: Acceptable Ambient Level

AQAB: Air Quality Analysis Branch

Area source: Source represented by horizontal area and initial vertical 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](#))