Chapter 4
Air Dispersion Modeling

What's Covered in Chapter 4:

- Air Modeling Approach
- Assessment Area Specific Inputs
- ISCST3 Input Files
- ISCST3 Model Output

The air modeling component of the RAIMI Pilot Study calculates quantitative ambient contaminant air concentrations and deposition rates as air parameters for input to the risk modeling component (see Chapter 5). This information is necessary to support evaluation of potential human health exposure associated with the release of contaminants to the air pathway.

The general approach to air modeling for the RAIMI Pilot Study scenario of multiple facilities, sources, contaminants, and neighborhood receptors–presents unique implementation challenges. Specifically, a primary challenge is the calculation of air impacts from literally hundreds of sources located throughout the assessment area in a fashion that ensures adequate data are available to support the risk modeling component, but does not result in the generation of significant amounts of unnecessary data that competes for data management resources or result in the need to repeat air modeling to accommodate the flexibility in site specific risk evaluation. Air dispersion modeling for the RAIMI Pilot Study is conducted using EPA's ISCST3 model, following guidance in the HHRAP, which implements the guidance in *Guideline on Air Quality Models* (GAQM), with specific model inputs as recommended in the *User's Guide For The Industrial Source Complex Dispersion Models* and *PCRAMMET User's Guide* (U.S. EPA 1995a; 1998b; 1999b; 1999c; 1999d; 2000d). For certain aspects of air modeling grouped sources (i.e., establishing number and location of grouped source locations within a census tract), the RAIMI Pilot Study adapts additional guidance from the source definition methods of the *Modeling Cumulative Outdoor Concentrations of Hazardous Air Pollutants* (CEP) (U.S. EPA 1999a).

This chapter describes the air dispersion modeling component of the RAIMI Pilot Study. The overall approach to air dispersion modeling, including model selection, approach to modeling individual and grouped emission sources, modeling with a unitized emission rate, and accounting for emission-phase partitioning, is described in Section 4.1. Section 4.2 describes assessment area specific inputs to the implementation of the ISCST3 air dispersion model, including terrain, land-use, facility characteristics, and meteorology. Section 4.3 describes development of ISCST3 input files and grid node array over the assessment area; while ISCST3 model execution and output is presented in Section 4.4.

4.1 AIR MODELING APPROACH

The RAIMI Pilot Study design goals, presented in Section 1.2, identify several broad objectives that require consideration with regard to the planning and strategic implementation of the air modeling component. Specific to air modeling is the need to (1) support a standardized and consistent means for the assessment and evaluation of risk and hazard from multiple emissions sources of multiple contaminants from multiple facilities, (2) provide the necessary levels of detail for risk-based source-specific decision making, (3) support the calculation and tracking of concentrations, and consequent estimated exposures and risks from hundreds of sources, and (4) be able to implement these goals through a flexible and dynamic project platform. From an implementation perspective, achieving these goals requires calculating air impacts from literally hundreds of sources located throughout the assessment area in a manner that:

- Ensures adequate data are available to support the risk modeling component;
- Minimizes the production of unnecessary data so that data management resources are not strained; and
- Accommodates the flexible design of site-specific risk evaluation and management without the need for repetitive air modeling events.

Considering the objectives noted above, the air dispersion modeling component of the RAIMI Pilot Study can best be described as a “single-pass” air modeling approach. The focus of single-pass air modeling is the up-front production of all necessary air modeling data to support current and anticipated future risk modeling needs. One important element of this approach is to use unit emission rates (see Section 4.1.4) to model each specific emission source. The benefit of utilizing unit emission rates in the single-pass air modeling is that the same modeling for a source can be used to evaluate that source’s potential resulting risks for any combination of emissions scenarios (e.g., reported actual emissions, permitted allowable emissions, revised quantities of emissions due to operational changes, or inclusion of new contaminants in the emissions profile) specific to current or anticipated future emissions. Most importantly, these risk evaluations can be conducted without requiring additional runs of the air dispersion model. In addition to using unit emission rates, other key elements of the single-pass air modeling approach include phase-specific modeling runs to account for emissions partitioning (see Section 4.1.5), and comprehensive design and placement of the receptor grid node array (see Section 4.3).

It is important to note, that while the RAIMI Pilot Study approach readily supports evaluation of risk from various emission scenarios, only reported actual emissions were used to test the approach and to obtain the results presented in Chapter 6 (see Chapters 3 and 6). Also, while use of the single-pass air modeling approach in the RAIMI Pilot Study supports wide-scale completion of air dispersion and risk modeling to generate results that meet design objectives, the potential need for refining the evaluation always exists and may require that additional air dispersion modeling runs be conducted. Examples of further refinement that may require additional air modeling to address, but not conducted as part of the RAIMI Pilot Study, include building downwash analysis (see Section 4.2.3), and chemical specific transformations such as degradation of highly reactive contaminants (see Section 4.1.6) and secondary formation of contaminants (see Section 6.2). Since refinements may be important based on preliminary risk results or risk management considerations, design of the RAIMI Pilot Study allows for additional air modeling runs to be conducted on a case-by-case basis, but with resource expenditures correlated to required refinement of results. The focused integration of refinement during the air modeling, or any other component of the RAIMI Pilot Study, is intended as an approach for balancing objectives with resource expenditures.

Another important aspect of the air dispersion modeling approach implemented for the RAIMI Pilot Study is the careful selection of an appropriate air model for evaluating both individual and grouped emission sources. Discussion of the reasons for using the ISCST3 model in the RAIMI Pilot Study are described in the next section.

4.1.1 Model Selection

The selection of the most appropriate air dispersion model for application of the methods in the RAIMI Pilot Study focuses on the following selection criteria regarding capabilities and features:

- Has broad regulatory acceptance and experience in evaluating the impacts of air contaminants emitted from various industrial sources (e.g., short and tall stack heights, fugitive emissions from process and storage areas, and surface-based impoundments);

- Can evaluate impacts attributable to a single source, with capability for evaluating multiple sources;
- Can evaluate pollutants emitted as vapor or particulate phase with consideration of deposition and removal processes based on the physical characteristics of the contaminant;
- Accepts placement of grid nodes at any location within the applicable range of the air model;
- Can conduct stepwise evaluation of hourly meteorological conditions for multiple years of data producing short-term (acute) and long-term (chronic) averages as outputs;
- Can evaluate building downwash effects; and
- Can evaluate chemical transformation for assessing the degradation of primary contaminants and the formation of secondary contaminants.

Four air models in current regulatory use, or proposed by the U.S. EPA Office of Air Quality Planning and Standards (OAQPS), satisfy most of these criteria - ISCST3, AERMOD, CALPUFF and ISC-PRIME - and were considered for the RAIMI Pilot Study. However, the EPA Industrial Source Complex-Short Term, Version 3 (ISCST3), version 99155, was selected based on its status as the:

- Current OAQPS recommended refined air model for regulatory decisions on source-specific impacts from various industrial sources;
- Model most used by regional, state and local agencies; and
- Model satisfying the most selection criteria.

ISCST3 calculates quantitative ambient air concentrations and deposition rates as air parameters for input to the risk modeling following current EPA guidance (U.S. EPA 1995a; 1998b; 1999b; 1999c; 1999d; 2000d). As previously discussed, the air modeling approach has been designed to provide efficient modeling of emissions sources to meet the needs and objectives of the RAIMI Pilot Study.

The other three air models are proposed by OAQPS as refined regulatory air models in the revisions to the Guideline on Air Quality Models (U.S. EPA 1999d). Of particular interest is the American Meteorological Society/EPA regulatory model (AERMOD) that is proposed to replace ISCST3 as the recommended air quality model for most regulatory applications (Federal Register 2000). AERMOD has been evaluated extensively by the air modeling community for improvements over the ISCST3 algorithms for vertical contaminant distribution from sources with tall stacks, terrain effects in areas with terrain elevations above the top of emission source stacks, and enhanced nighttime dispersion in urban areas. For assessment areas in Jefferson County evaluated in the RAIMI Pilot Study (i.e., Port Neches Assessment Area), this improvement would not be realized since there are no terrain elevations above emission sources stacks. The other two features would be advantageous for the urban conditions of the Port Neches Assessment Area and the nighttime dispersion from emission sources with tall stacks. However, AERMOD was not selected because it is currently a proposed model with minimal regulatory experience. Also, it does not have the capability to assess deposition and removal processes, which would require the use of an additional model to support future analysis of indirect exposure pathways. AERMOD would be an important consideration for applying the methods of the RAIMI Pilot Study if adopted by OAQPS and gains broad regulatory acceptance, if the assessment area contains significant terrain features (i.e., terrain elevations above emission source stacks), and if the quantitative effects of deposition and removal are not required to support exposure pathway analysis.

The California Puff Model (CALPUFF) model is proposed in the OAQPS revisions to the GAQM (Federal Register 2000) for long-range transport (greater than 50 kilometers), and for the special conditions of very light or calm winds (less than 1 meter per second) on a case-by-case basis. CALPUFF may be an important consideration to applying RAIMI Pilot Study methods in cases for evaluating chemical transformation of highly reactive contaminants based on long residence times during extended periods of light winds or calm conditions, transport over long distances, recirculation of contaminants due to local wind effects, or in hilly terrain and river valleys.

The proposed OAQPS revisions to the GAQM also recommends that the version of ISCST with the new downwash algorithm, ISC-PRIME, be used for applications where aerodynamic building downwash is important (Federal Register 2000). The required information and inputs to evaluate the effects of building downwash (see Section 4.2.3), however, are not available in the digital emissions inventory databases evaluated (see Chapter 3) in the RAIMI Pilot Study. Therefore, improvements to the building downwash calculation would only be realized on a case-by-base basis.

Although air dispersion modeling in the RAIMI Pilot Study for the Port Neches Assessment Area utilizes ISCST3, design of the RAIMI Pilot Study approach allows for use of other air models. Evaluation of other models should consider the OAQPS proposed ISC-PRIME, AERMOD, or CALPUFF, should these models be adopted in the revised GAQM; and if they more substantially meet the selection criteria established as appropriate based on the study objectives and assessment area characteristics.

Specific to its ability to meet air modeling requirements of the RAIMI Pilot Study, the ISCST3 model is technically capable of providing evaluation of:

- Gaussian dispersion rates in vertical and horizontal plume cross-section;
- Urban and rural dispersion coefficients;
- Terrain effects;
- Source characterization as a discrete point, two-dimensional area, or three-dimensional volume;
- Short-term and long-term averages (1-hour and annual);
- Surface meteorology data includes hourly observations of wind speed (nearest 1/10th mile per second), wind direction (nearest degree), stability class (6 categories), and temperature (nearest degree);
- Mixing height data interpolated from twice daily upper air soundings corresponding to each hour of surface data;
- Deposition processes for conservation of mass with particle wet and dry deposition and removal, and vapor wet deposition and removal (vapor dry deposition is implemented external to air modeling by applying a single deposition velocity; see Section 4.3.1);
- Hourly precipitation amount and type act on wet deposition and removal; and
- Single first order exponential decay rate.

Emissions sources can be defined in ISCST3 with either stack dimensions at a discrete point, as a two-dimensional area source, or in three dimensions as a volume source. Therefore, ISCST3 offers the flexibility to model sources based on source type (i.e., stack, fugitive, and mobile), as well as, accommodate the organization of emissions inventory data as individual or grouped emission sources (see Chapter 3). The following sections describe the air dispersion modeling approach for individual and grouped emission sources.

4.1.2 Individual Emission Source Modeling

Individual sources–as discussed in Chapter 3–are those emission sources for which the available emissions inventories (i.e., NTI or PSDB) provide complete data sets specific to each source so as to enable source-specific air dispersion and risk modeling. Individual sources are typically stack or fugitive source types for which air dispersion modeling can readily be conducted as prescribed by guidance presented in the HHRAP, and utilizing inputs further defined in the following sections of this chapter. The general approach to air modeling individual sources for the RAIMI Pilot Study is summarized in the following steps:

1. Identify individual sources for air modeling as described in Section 3.3.1;
2. Obtain physical characteristics from the PSDB emissions inventory that are reported for the prioritized source;
3. Review reported physical characteristics for completeness, and verify accuracy of values to the extent possible;
4. Determine site-specific ISCST3 inputs (see Section 4.2);
5. Utilize reported physical characteristics to define required source-specific inputs to ISCST3 (see Section 4.3); and
6. Model each source using unit emission rates (see Section 4.1.4), and conduct multiple modeling runs as necessary to address emissions partitioning (see Section 4.1.5).

Source-specific inputs to ISCST3 are defined using the physical characteristics for each source as reported in the available emissions inventories or ancillary data sets (e.g., trial burn reports, permit applications and permits). With the exception of particle density and size distribution (see Section 4.1.5), surrogate values were not assigned for sources with missing physical characteristics data. As a result, individual sources not adequately characterized in the emissions inventories are not modeled. Another important note specific to individual sources is that a facility may define a fugitive source either with stack parameters or as an area source (previously discussed in Chapter 3). In such cases, the physical characteristics for the source as reported in the emissions inventory are utilized in the air modeling, and are not re-defined. This approach was favored because it promotes a standardized and objective air dispersion modeling evaluation by relying on physical source characterization data provided by the cited emissions inventories, and eliminates the need for the air modeler to make data substitutions with regards to incomplete source characterization. It should be noted that in some cases this approach can limit inclusion of specific emission sources in the analysis, and therefore, effect the representativeness of the results specific to these sources and receptor locations that they may impact.

4.1.3 Grouped Emission Source Modeling

Grouped emission sources–as discussed in Section 3.2.3–are those sources for which emission characterization data are not readily available on an individual basis (e.g., dry cleaners, gas stations, lawn mowers, etc.). Therefore, these sources, as reported in emissions database inventories (i.e., NTI), are single sources combined within a particular area (typically a county that can be allocated to a census tract level; see Section 3.2.3), with both the emission rate and occurrence for each individual source summed into a group emission rate based on a surrogate (e.g., population density, land use area, etc.). As a result, air modeling for grouped emission sources is approached in a different manner than as described in Section 4.1.2 for individual emission sources.

Since the location of each single source combined into the grouping is not provided in the NTI database inventories, hypothetical source locations have to be defined so that air modeling of the grouped emission sources within a particular area (census tracts for the Pilot Study), and subsequently impacts, can be conducted. For the RAIMI Pilot Study, hypothetical locations to represent the grouped emission sources are defined consistently across each census tract within the Port Neches Assessment Area, and the grouped emission sources are modeled at these hypothetical locations as pseudo-stacks. This approach to air modeling grouped sources, as further detailed below, is selected because it utilizes the available emissions and source data to provide representative results across a census tract with sufficient accuracy to support risk-based prioritization of emissions from each grouped source. It is also consistent with methods implemented in a national scale study (U.S. EPA 1999a) for modeling area and mobile source categories.

Pseudo-source locations for grouped source modeling are shown on Figure 4-1. The general approach to air modeling grouped sources for the RAIMI Pilot Study is summarized in the following steps:

1. Identify prioritized grouped emission sources for air modeling as described in Section 3.3.2;
2. For each census tract located within the assessment area and containing at least one prioritized grouped emission source; define a circle, centered on the centroid of each census tract, such that the area of the circle is equal to the area of the census tract;
3. Position five pseudo-stack source locations within each census tract, using GIS, as follows:
    - One pseudo-stack source at the center of the circle (i.e., centroid of the census tract); and
    - One pseudo-stack source in each direction of North, East, South and West from the center of the circle at a distance of one-half of the radius of the circle.

4. For each pseudo-stack source, set ISCST3 source-specific inputs to represent no plume rise occurs, as follows:

    - Set the pseudo-stack source release temperature to 0 degrees Kelvin (ISCST3 will automatically read the ambient temperature from the meteorological data file and set it equal to the source temperature, resulting in no temperature differential between the source and the ambient air, thus no thermal plume rise);

    - Set the pseudo-stack source release velocity to 0.001 meters per second (a negligible real value, but a required input by ISCST3 to avoid an input error), resulting in no momentum plume rise;

    - Set the pseudo-stack source release diameter to 0.001 meters (a negligible real value, but a required input by ISCST3 to avoid an input error), resulting in no momentum plume rise;

    - Set the pseudo-stack source release height to an assumed 5 meters to represent the average release height of grouped emission sources; and

    - Set the pseudo-stack source base elevation equal to the terrain elevation extracted at the pseudo-stack source location from the USGS digital elevation data.

5. Execute each ISCST3 run to include all five pseudo-stack sources within the census tract using an unit emission rate (1.0 gram per second [g/s]) allocated in proportion to each pseudo-point source, consistent with the CEP methodology, and as follows:

    - Assign to the center pseudo-stack source one-ninth of the unit emissions (0.112 g/s);

    - Assign to each of the four surrounding pseudo-stack sources two-ninths of the unit emissions (0.222 g/s).

6. For each census tract, specify the center pseudo-stack source location coordinates first in sequence so that they will be defined by the risk modeling software (i.e., IRAP-h View) to represent in its plotting function the locations of the grouped sources modeled.

As discussed in Section 3.3.2, the emissions from each prioritized group source are allocated to the census tracts by dividing the emissions among the five pseudo-stack sources. Representing the grouped sources as pseudo-stack sources is merely a tool for allocating the emissions across the census tract, with the emissions being characterized as being emitted from five stacks.

Specific to modeling grouped emission sources (see Step 4 above), ISCST3 source-specific inputs for each pseudo-stack source are set to represent that no plume rise occurs (i.e., emissions are at ambient temperature, and therefore do not have significant plume rise due to temperatures not being elevated above ambient, or forced up through a stack). This approach is utilized since the majority of emission sources included within the grouped source categories are not expected to experience plume rise. Therefore, air modeling without plume rise is assumed to provide the most representative characterization of emissions behavior for the grouped source as a whole.

A limitation to air modeling of grouped emission sources using data from national inventories (e.g., NTI) is the lack of resolution specific to required modeling inputs (i.e., source specific emission rates and locations). This potentially allows for hot spots to be missed when emissions from point sources are artificially weighted or diluted over an area. Additionally, this may also result in an overestimation of localized impacts in the immediate vicinity of a pseudo-stack due to assigning a specific location of release in the air model to emissions that are actually distributed over larger areas.

Completion of the air modeling as outlined above generates useful results specific to focusing resources on grouped emission source subcategories and contaminants potentially posing the greatest risk. As discussed at the end of Section 3.3.2, however, further refinement may be required to support risk management decisions on a case-by-case basis. This refinement involves more accurately allocating emissions and modeling grouped sources specific to their actual geographic locations instead of assuming the weighted distribution across the census tract (see Sections 3.2.3). For example, modeling results may indicate that significant impacts may be attributable to a specific grouped source subcategory, but these impacts would be highly dependent on the actual locations of the single sources that had been combined in the emissions database inventory through the use of a surrogate. Therefore, local research identifies the locations of the single sources within the census tract, and these sources are modeled at their true locations consistent with the methods discussed for modeling individual emission sources (see Section 4.1.2). This air modeling refinement can be conducted within the RAIMI framework and is dependent on refinement of emissions allocation as described in Step 3 of Section 3.3.2.

4.1.4 Modeling Using an Unit Emission Rate

A unit emission rate of 1.0 g/s is used in each ISCST3 model run for each source to eliminate the extensive effort that would be required to model each contaminant separately, and to provide the flexibility of being able to conduct future risk modeling using any combination of new or revised emissions scenarios without having to conduct additional air modeling of the source. As previously noted, this approach is a key element in the single-pass air modeling strategy. As discussed in Section 4.4, output from the ISCST3 air modeling (i.e., air parameters) based on unit emission rates are adjusted to contaminant-specific values during the risk component to calculate media-specific concentrations using source-specific, contaminant-specific emission rates.

4.1.5 Accounting for Emissions Partitioning

To account for the partitioning of emitted contaminants in the ambient air after release, it is important to consider the need to conduct separate air modeling runs to represent partitioning to the vapor phase, particle phase, and particle-bound phase. Partitioning of emitted contaminants are of most concern regarding affect on results when a contaminant is released as a particle, or has a portion of its mass adhered to particles. The redistribution of mass away from the source is very sensitive to the deposition and removal processes of particles. For very small particles (diameter less than 1 micron) and vapor contaminants, the mass distribution is dominated by the dispersive characteristics of the air flow. For larger particles, the added effects of deposition closer to the source, and subsequent removal of the deposited mass at the surface nearer the source, lowers concentrations in the air and subsequent downwind deposition rates for all locations.

The tendency of a contaminant to be present in a particular phase–as a vapor molecule, as a solid particle, or adhered as a coating on the outside of existing particles– is expressed as the fraction of the contaminant air concentration in the vapor phase, F_v, as follows:

- Vapor Phase $F_v = 1.0$
- Particle-bound Phase $0 < F_v < 1.0$
- Particle Phase $F_v = 0$

The vapor phase is modeled to evaluate volatile organic contaminants that are assumed to occur in the vapor phase as molecules of the contaminants (i.e., contaminants with $F_v = 1.0$). ISCST3 outputs for the vapor phase are air concentrations and wet vapor deposition. Particle-size distribution is not needed for vapor-phase modeling.

The particle-bound phase is modeled to evaluate the fraction of organic contaminants that upon release to the atmosphere have condensed onto the surface of associated particulates (i.e., contaminants with F_v between 0 and 1.0). ISCST3 outputs for the particle-bound phase are air concentrations, dry deposition, wet deposition, and combined deposition. The portion of contaminants in the particle-bound phase is dependent on the particulate surface area available for chemical adsorption. Therefore, a surface area weighted particle-size distribution is a required input for the particle-bound phase modeling run.

The particle phase is modeled to evaluate most metals and organic contaminants with low volatility that are assumed to occur in the particle phase (i.e., contaminants with $F_v = 0$). ISCST3 outputs for the particle phase runs are air concentrations, dry deposition, wet deposition, and combined deposition. Particle size is the main determinant of the dispersion and deposition of particles in the emission, whether wet or dry. For the particle-phase modeling run, deposition is calculated from the particle size and density, and modeled on a mass-weighted basis.

Specific to review and consideration of available information on sources within the assessment area for the RAIMI Pilot Study, the following approach was incorporated to account for the effects of emissions partitioning. For sources that are clearly identified as elevated stacks or vents, it is assumed that the potential for particulate to be emitted is high and separate air modeling runs are conducted to represent both particle and particle-bound phases. For emission sources that are otherwise described as fugitive sources and there is no indication of fugitive dust or particulate, it is assumed that there is very low potential for particulate to be emitted and only a vapor phase run is made to account for the volatile fugitive emissions. For fugitive sources that do have unknown particulate emissions and are modeled only with a vapor phase run, modeling results may not be fully representative of actual impacts (bias is expected to be source, contaminant, and receptor location specific). The air modeling of fugitive sources with particulate emissions as vapors will tend to under predict the air concentration and deposition near the sources, and over predict the impacts away from the sources. However, specific to sources evaluated in the RAIMI Pilot Study for the Port Neches Assessment Area, the effect on results due to potentially air modeling fugitive sources with particulate emissions as vapor is expected to be nominal as only two of the over sixty sources reporting particulate emissions of at least 1 ton per year are fugitive sources. These two sources are cooling towers with particulate emissions (likely to be small condensate) reported as less than 10 microns in diameter.

With the exception of RCRA combustion units which are required to report particle data along with trial burn data, emission inventories (see Chapter 3) typically do not provide source-specific particle size distributions or particle density data. Therefore, if measured or reported particle data are not available, particle and particle-bound phase air modeling runs are conducted assuming that 100 percent of the particulate mass released is 1 micron in diameter. The basis of this assumption is that a particle 1 micron in diameter has nominal terminal velocity, remaining suspended in the air with dispersion behavior similar to vapor phase contaminants, but allowing ISCST3 to apply phase allocation of mass, and particle deposition and removal. If actual plume particles are larger than the assumed 1 micron average modeled for a given source, the anticipated effect on results would be higher deposition rates near the source [than predicted] due to the increased terminal velocities, with corresponding lower concentrations and deposition rates [than predicted] occurring at distance from the source. However, since most combustion sources in the RAIMI Pilot Study assessment area report natural gas as the predominant fuel, and many sources report air pollution control devices, the 1 micron diameter is likely to be a more representative assumption than a larger particle size typical of uncontrolled emissions resulting from other fossil fuels. In lieu of reported data, a default particle density of 1 gram per cubic centimeter (g/cm^3) is used, as recommended in the HHRAP (U.S. EPA 1998b). A sensitivity study conducted by U.S. EPA Region 6 (see Appendix SEN) identified that the air modeling is not sensitive to this assumption unless the actual particle density is 2 or 3 g/m^3. As these higher particle densities are typically found only in the processing of minerals or aggregates in the stone or cement industries, and these source types are not identified to be located in the Port Neches Assessment Area, the assumption of 1 g/cm^3 is considered representative of the sources in the area.. If available, measured or facility reported particle data are utilized over defaults.

Note that since the particle size distribution has a single category of particle size (1 micron), the particle-bound phase ISCST3 results will be identical to the particle phase ISCST3 results. Therefore, an efficiency is gained in that only the particle phase is required to be modeled with the results applicable to both particle and particle-bound emissions.

4.1.6 Accounting for Degradation of Reactive Contaminants

The numerical influence of degradation on modeled risk results is specific to the reactivity of each individual contaminant and the distance (function of time and wind speed) it must travel before reaching a potential receptor. For example, highly reactive contaminants, such as 1,3-butadiene will degrade with a half-life from 4 to 8 hours, while less reactive contaminants have half-life values as slow as 24 to 48 hours. Considering a very light wind speed (scenario for which maximum degradation would be expected to occur) of 1 meter per second, the ISCST3 air model will transport a highly reactive pollutant 13 to 26 kilometers from the source before achieving a 50 percent degradation. Even for the most highly reactive contaminants, a degradation of less than 20 percent within 3 to 5 kilometers would be computed by the air model using a minimal wind speed. For more typical or average wind speeds (5 meters per second), degradation effects of less than a few percent would result within 3 to 5 kilometers from the emission source.

Considering the limited potential numerical influence on risk results and the objectives of the RAIMI Pilot Study, the extensive effort required to explicitly model each of reactivity categories of the various contaminants is not supported. Instead, air modeling for the RAIMI Pilot Study is conducted on the simplifying assumption that computed air concentrations, without accounting for chemical degradation, are representative of long term average exposure. However, design of the RAIMI Pilot Study allows for additional air modeling runs to be conducted on a case-by-case basis, but with resource expenditures correlated to required refinement of results. For example, the transport of highly reactive contaminants beyond the study area to other locations of interest, or the potential secondary formation of contaminants such as formaldehyde transported into the study area from distant sources (see Section 6.2.5). The focused integration of refinement during the air modeling is intended as an approach for balancing objectives with resource expenditures.

4.2 ASSESSMENT AREA SPECIFIC INPUTS

ISCST3 air dispersion modeling requires certain input parameters that are defined by the physical characteristics of the assessment area, including (1) terrain elevation data, (2) land uses in the assessment area, (3) characteristics of buildings located close to sources, and (4) meteorological data. These characteristics of the assessment area, and the corresponding ISCST3 inputs they define, are described in the following sections specific to their use as inputs to the air modeling component of the RAIMI Pilot Study.

4.2.1 Surrounding Terrain Information

Terrain data for the assessment area are obtained using 90-meter-spaced, USGS digital elevation data. Terrain data are important to air modeling because air concentrations and deposition rates are greatly influenced by the height of the plume above local ground level. Considering the importance of terrain with regards to potential effect on results, all receptor grid nodes and emission sources within the assessment area are evaluated in the RAIMI Pilot Study utilizing actual terrain elevations. The incorporation of terrain data into the ISCST3 modeling occurs during generation of the receptor grid node arrays (see Section 4.3.3).

4.2.2 Surrounding Land-Use Information

Land use within the assessment area is analyzed for the purpose of identifying land-use categories, dispersion coefficients, and surface roughness height parameters. For the RAIMI Pilot Study, surrounding land use information is characterized using land use land cover (LULC) maps, topographic maps, facility maps, and field reconnaissance. For processing of meteorological data and selecting appropriate air dispersion parameters inputs to ISCST3 (see Section 4.2.4), urban or rural factors are used based on the correlating land use defined within the assessment area.

4.2.3 Building Characteristics

Building wake effects, which are also referred to as "building downwash", are ambient air flow lines that can cause a plume from a stack source located within about five times the height of a nearby building to be forced down to the ground much sooner than it would if a building were not present. The effect can multiply the short-term (24 hour average or less) concentration and deposition rates by up to six times that of an unaffected plume, increasing values near the source and reducing values away from the source due to the removal processes in the air model (Gratt et al. 1995). However, for long-term average impacts, another study found that including building wake effects only increased impacts by up to 20 percent (U.S. EPA 1999a).

Another important consideration of building wake effects is that they are only associated with stack sources, and not fugitive emissions. Therefore, only stacks with nearby buildings (within 25 to 50 meters for one and two story buildings) may be affected. Also, only plumes from stacks less than about 2.5 times the height of the nearby building will be affected. As most buildings, observed during a field survey of the Port Neches Assessment Area to be in the general vicinity of stack emission sources, have an approximate height of one or two stories (about 5 to 10 meters high), any stack emission source taller than about 25 meters would not be expected to be affected by building downwash. For emission sources with stacks that are located near buildings that may be affected by building downwash, air concentrations and deposition rates may be underestimated by a factor of two to five within a distance of about 500 to 1,000 meters from the emission source.

Since building wake effects are identifiable and can be represented in the air model, they should be considered whenever data inputs are available to permit inclusion. Unfortunately, the required building data are not available in the NTI or other emission databases evaluated; which prevents the wide-scale inclusion of building downwash analysis for every stack source evaluated in the RAIMI Pilot Study. The RAIMI Pilot Study approach is to conduct source-specific building downwash analysis when the data may be requested from the facility, or estimated by indirect methods (field survey photographs compared to known heights), on a case-by-case basis. For these stacks, analysis of building downwash could be conducted with consideration for the resources to obtain the required source-specific building dimension data, potential effect on modeled results without building downwash, and proximity to receptors of concern to the area of impact subject to potential building wake effects.

4.2.4 Meteorological Data

Meteorological data should be selected to adequately represent the meteorological conditions in the study area that effect contaminant transport. Factors that influence spatial representativeness of the selected data include wind flow patterns, land use variations, localized channeling or directional changes of flow (e.g., river valleys, hilly terrain, water bodies), and distance from the study area to the meteorological data measurement station. Temporal representativeness must ensure that worst-case meteorological conditions effecting contaminant transport are adequately represented while selecting a period of sufficient length to achieve stability in the frequency distribution of the key meteorological variables. One study considered the effects of varying the period of record included in an air modeling analysis (Burton et al. 1983). The study compared various periods from a 17-year data set to determine the minimum number of years of data needed to approximate the concentrations modeled with the complete 17-year data set. Results indicated that the variability of model estimates due to the meteorological data input was adequately reduced if a 5-year period of record was used. Therefore, the U.S. EPA Guideline on Air Quality Models (U.S. EPA 1999d) recommends using five years of data for temporal representativeness, with preference for the most recent five consecutive years that are readily available.

For the RAIMI Pilot Study, meteorological data collected for five years from a representative National Weather Service (NWS) station near the facility are required as input to ISCST3 to account for year-to-year variations in the meteorological data (U. S. EPA. 1999d). The meteorological measurement station location spatially representative of the surface weather patterns in the Port Neches Assessment Area is the Jefferson County Airport (also known as, Port Arthur, Texas [BPT]) station as recommended by TNRCC (www.tnrcc.state.tx.us/air/nsr_permits/admt/metbpt.htm). The station representative of the upper air weather patterns in the RAIMI Pilot Study assessment area is the Lake Charles station also identified on the TNRCC Internet site. Several potential sources for the surface data are available, including the OAQPS Internet site (www.epa.gov/ttn/scram/), National Climate Data Center (NCDC) solar and meteorological solar observation network (SAMSON) compact disk, NCDC 144 data, and NCDC Hourly United States Weather Observations (HUSWO) data. As recommended in the HHRAP (U.S. EPA 1998b), the surface data for this study is obtained from the NCDC SAMSON CD ROM which includes data from 1961 through 1990. The SAMSON data are selected based on the availability of all required parameters, including precipitation amount and type (liquid or frozen) for air modeling of wet deposition, from a single source which has undergone quality assurance. More recently available data, such as the supplemental SAMSON data through 1995 and the NCDC HUSWO data sets, are not used since these data sets do not have the required meteorological variables to address the effects of wet and dry deposition in the air model.

The surface data selected for the Port Neches Assessment Area include the five years 1984, 1985, 1988, 1989, and 1990 from the Jefferson County Airport, 7.5 miles northwest of Port Arthur, Texas, NWS station (Weather Bureau Army Navy [WBAN] 12917). These surface data are found on the NCDC SAMSON CD Rom. These years are selected as the most recent available data on the NCDC CD Rom without significant missing data, and with available corresponding mixing height data from the EPA Internet site (U.S. EPA 1999e). However, these five years should be representative of any five-year period selected as indicated in a comparison of a summary of these five years with the 42 years of station records. The 42-year station record annual average wind speed is 4.34 meters per second compared to 4.46 meters per second for these five years. Similar comparisons of wind direction statistics using plots of wind roses (frequency of wind direction and speed) and precipitation data indicate that these years are typical of the area while representing the variations in the weather conditions within the period. The upper air data corresponding to these same five years are from the Lake Charles, Louisiana, NWS station (WBAN 03937). All five years of mixing height data used in the air modeling for the RAIMI Pilot Study can be downloaded from the previously referenced EPA Internet site. The ISCST3 air modeling runs are made with the anemometer height reported for the Jefferson County Airport of 10.0 meters for all five years.

The best available meteorology data based on representativeness, completeness, and measured parameters required for risk assessment air modeling are obtained for 1984, 1985, 1988, 1989, and 1990. Although the emissions data from the Texas PSDB represent 1997 data (see Section 3.2), meteorological data for these years are not used for air modeling in the RAIMI Pilot Study due to the change in data collection methods by the NWS to automated stations beginning in 1993. However, the five years of meteorological data used (1984, 1985, 1988, 1989, and 1990) are representative of weather conditions at the study area for any 5-year period, including 1997.

4.2.4.1 Meteorological Pre-processors and Interface Programs

Five years of meteorological data are required as input to ISCST3 (U.S. EPA 1998b). From the selected meteorological data, these required input files are created using EPA's personal computer version of the regulatory air model meterological preprocessor (PCRAMMET) software, as prescribed in EPA guidance (U.S. EPA 1998b; 1999c). The meteorological input files are prepared for wet deposition using measurement and application site parameters and the precipitation data included in the SAMSON surface data files (NCDC 1993).

The measurement site, Jefferson County Airport, is defined as rural land use. This rural land use definition is supported by NWS and Federal Aviation Administration siting criteria which require meteorological sensors for airport stations to be in open, unobstructed wind flow and grass covered areas. All site parameters input into the PCRAMMET pre-processor represent the measurement site with the exception of application site surface roughness length. For consistency in performing multiple ISCST3 analyses over the entire Jefferson County, the application site surface roughness is selected as urban for all ISCST3 runs, in lieu of computing a new site-specific surface roughness for the various application sites which would require reprocessing a new meteorological data file for each ISCST3 run. This assumption of a single representative application site surface roughness value is expected to have nominal effect on modeled results based on the continuity of urban land use surrounding the facilities with sources included in the assessment. The site parameters, representative of the rural land use conditions at the measurement site and urban land use for the application sites, are summarized in the following key input parameters specified for the PCRAMMET process:

- Minimum Monin-Obukhov length: 2.0 meters (U.S. EPA 1998b, rural area)
- Surface roughness length (measurement site): 0.10 meters (U.S. EPA 1998b; grassland and summer)
- Surface roughness length (application site): 1.0 meters (Urban, see discussion below)
- Noontime albedo: 0.18 (U.S. EPA 1998b; rural and grassland)
- Bowen ratio: 0.70 (U.S. EPA 1998b; rural and grassland)
- Anthropogenic heat flux: 0.0 (U.S. EPA 1998b; southern United States)
- Fraction net radiation absorbed at ground: 0.15 (U.S. EPA 1998b; rural and grassland)

The urban land use for the assessment area is defined in available aerial photographs, land use maps, and topographic maps. Current mapping indicates that dense single/multi-family residential areas constitute approximately 50 percent of the area, including residential structures, driveways, sidewalks and streets (non-vegetative areas). Also, dense industrial clusters represent additional cover across the assessment area. These features are associated with a surface roughness length of 1.0, corresponding to urban land use. Residential vegetative areas include lawns, with a surface roughness length of 0.1, and landscaped deciduous/coniferous trees with a surface roughness length of 1.3 for summer. In consideration of all these factors, a surface roughness length of 1.0 is used for the assessment area. This urban surface roughness height accounts for both the mechanical turbulence of urban structures and the thermal turbulence of industrial and urban activities.

4.3 ISCST3 INPUT FILES

The ISCST3 model is prepared for execution by creating an input file. The required input file is structured in the following six sections, or pathways, designated by two-letter abbreviations:

- Control (CO) pathway
- Source (SO) pathway
- Receptor (RE) pathway
- Meteorological (ME) pathway
- Terrain grid (TG) pathway
- Output (OU) pathway

The following subsections discuss the specific parameter values input to each pathway for execution of the ISCST3 modeling runs for the RAIMI Pilot Study. Table 4-1 lists the air modeling input parameter values used in the RAIMI Pilot Study. The actual input files specific to each emission source are also included as Appendix ISC to this report.

4.3.1 Control Pathway

The CO pathway directs ISCST3 to perform specific types of computations. CO pathway specifications include the EPA required default parameters; concentration, dry deposition, wet deposition, and total deposition for the particle phase and particle-bound phase runs; concentration and wet deposition for vapor phase runs; annual and 1-hour averaging times; and designation to use actual terrain elevations for receptor grid nodes (U.S. EPA 1998b). Some key inputs for all years of evaluation are as follows:

- Model options: Regulatory default options, concentrations, depositions, removal processes, and urban land use
- Averaging times: 1 hour and annual
- Terrain heights: Elevated

An additional ISCST3 option within the CO pathway, the dry vapor deposition algorithm, allows for direct input of a single value of dry vapor deposition, or alternately the model can be assigned to calculate a time variant dry vapor deposition velocity that varies based on diurnal changes in vegetative respiration (requires extensive data inputs to execute). Consistent with the method provided in the HHRAP (U.S. EPA 1998b), calculation of dry vapor deposition was not implemented within the air model in the RAIMI Pilot Study, but instead calculated external to the air model by multiplying the

TABLE 4-1

AIR MODELING INPUT PARAMETER VALUES

Parameter Description	Units	Value
Met preprocessor: Surface station	--	Jefferson County Airport, TX (WBAN 12917)
Met preprocessor: Upper air station	--	Lake Charles, LA (WBAN 03937)
Met preprocessor: Years selected	yr	1984, 1985, 1988, 1989, 1990
Met preprocessor: Minimum M-O Length	m	2.0
Met preprocessor: Surface roughness length (measurement site)	m	0.10
Met preprocessor: Surface roughness length (application site)	m	1.0
Met preprocessor: Noontime albedo	--	0.18
Met preprocessor: Bowen ratio	--	0.70
Met preprocessor: Anthropogenic heat flux	--	0.0
Met preprocessor: Fraction of net radiation absorbed at ground	--	0.15
ISC COntrol: Model options	--	DFAULT CONC DEPOS DDEP WDEP DRYDPLT WETDPLT URBAN
ISC COontrol: Averaging times	--	1 ANNUAL
ISC COntrol: Terrain heights	m	ELEV
ISC SOurce: Location	m	UTM coordinates (NAD-83)
ISC SOurce: Base elevation	m	(Above mean sea level)
ISC SOurce: Emission rate	g/s	1.0
ISC SOurce: Particle diameter	µm	1.0 (or use stack test data)
ISC SOurce: Mass fraction	--	1.0 (or use stack test data)
ISC SOurce: Particle density	µg/m3	1.0 (or use stack test data)
ISC SOurce: Scavenging coefficients	1/(s-mm/hr)	Liquid: 0.45E-04; Ice: 0.15E-04
ISC SOurce: Source groups	--	ALL
ISC TG: Terrain grid	--	Special terrain grid array not used (terrain elevation at each grid location entered in REceptor pathway)

TABLE 4-1

AIR MODELING INPUT PARAMETER VALUES

Notes:

--	Unitless
g/s	Grams/second
m	Meter
1/(s-mm/hr)	Inverse of (seconds-millimeters/hour)
µg/m3	Microgram per cubic meter
µm	Micrometer
yr	Year

concentration in air of the contaminant by a single value of dry vapor deposition velocity (3.0 centimeters per second).

A limitation to this method is that calculation of dry vapor deposition external to the air model does not remove the mass that is computed to be deposited as a dry vapor as the plume travels downwind from the emission source. As a result, selection of this model option to directly input a single representative value of vapor deposition velocity to address the conservation of mass by the removal of deposited vapors within the model would be an improvement to the applied method. However, direct input of a single value of dry vapor deposition would be preferred over the alternate model option to calculate a time variant dry vapor deposition velocity that varies based on diurnal changes in vegetative respiration. This is primarily because the refinement in results does not justify the extensive expenditure of resources required to obtain and specify required inputs of hourly values for solar insulation and leaf area index to execute this algorithm.

Additionally, use of single dry vapor deposition value to represent multiple contaminants may overestimate dry vapor deposition rates for some contaminants. However, conducting air modeling to consider contaminant specific rates of dry vapor deposition would require an extensive expenditure of resources (i.e., contaminant specific air modeling runs) that also could not be justified based on the resulting minimum refinement to results.

4.3.2 Source Pathway

The SO pathway in the ISCST3 input file contains information on the source type, emission gases, and particulate emissions. In addition to source type-specific parameters for stack, fugitive, and mobile sources, some key inputs in this pathway are as follows:

- Location: UTM coordinates (meters)
- Base Elevation: Plant grade above mean sea level
- Emission rate: Unit (1.0 g/s)
- Particle diameters: Assumed 1 micron (unless provided from stack test data)
- Mass fraction: Assumed 1.0 (unless provided from stack test data)

- Particle density: Default of 1.0 microgram per cubic meter as stated in the HHRAP (U.S. EPA 1998b) (unless provided from stack test data)

- Scavenging coefficients: Obtained from ISC3 User's Guide as recommended in the HHRAP (U.S. EPA 1995a; 1998b)

- Source group: One stack only (use "ALL"; only one emission source is included in each ISCST3 run represented in a single source group)

Specific to emission source locations, verification of source location is a very important step since it can severely skew the location of where the predicted zone of impact will occur, and errors in reported source locations are commonly observed to occur. Failure to accurately identify and verify actual source locations can result in significant error to air modeling, and subsequently risk modeling, results. In addition, although simplifying assumptions and the assigning of hypothetical source locations at facility centroids (e.g., as with modeling using TRI data and assuming facility emissions originate from a hypothetical stack located at the center of the facility) could be made to reduce effort required to verify source locations and to conduct air modeling, these simplifications can produce results that are orders of magnitude in error and typically biased low. For example, representing the emissions of all sources at one location on the facility will not accurately represent, and may totally miss, the impacts immediately surrounding the facility for actual sources located near the facility boundary. As contaminants dilute exponentially with increasing distance from the release location, reductions of estimated impacts from the air model are commonly an order of magnitude within the first hundred meters, and several orders of magnitude within a few kilometers from the source. Typical of many potential study areas, large facilities in the Port Neches Assessment Area do not have a single facility location that appropriately represents the actual source locations. Source separation on these facilities are up to several hundred meters which would effect the air modeling results by orders of magnitude if modeling hypothetical or inaccurate source locations versus actual.

Therefore, specific to the RAIMI Pilot Study approach, prior to input into ISCST3 all emission source locations are verified on a GIS platform using aerial photographs, topographic maps, facility maps and other reported source specific data such as, field surveys (as available). Verification of source location is a very important step since it can severely skew the location of where the predicted zone of impact will occur, and errors in reported source locations are commonly observed to occur when facility coordinates are converted to UTM coordinates from the facility plant coordinates or latitude/longitude. Another important note specific to source locations, is that a facility may only report a single set of coordinates to define the location of a fugitive source, even though the fugitive source actually consists of multiple individual sources in relatively close proximity (previously discussed in Chapter 3). In such cases, the physical characteristics for the source, including the source location, as reported in the emissions inventory are utilized in the air modeling, and are not re-defined.

To ensure consistency among source locations and the digital data products used for area characterization (e.g., land use, terrain elevations, roadways, waterways, railways), all emission source locations in the RAIMI Study are input into ISCST3 in the North American Datum 1983 (NAD-83) UTM coordinate system. Extra caution must be exercised in using source locations reported by facilities or extracted from digital source inventories. Experience indicates that facilities typically use plant coordinates and latitude-longitude survey points for plant siting and operations. The requirement to report UTM coordinates to air regulatory agencies in inventories is not often a familiar practice to those responsible for extracting and providing these data. Reviews of reported UTM coordinate locations with facility plot plans and digital data products frequently identify discrepancies. In addition to possible errors in conversion between plant and UTM coordinate systems, another potential source of error is that USGS 7.5 minute topographic maps are plotted in the NAD-27 coordinate system, and the difference in locations between the two systems is approximately 200 meters in the north-south direction. As with location, the base elevations for all emission sources evaluated in the RAIMI Pilot Study are verified or extracted using a USGS digital terrain database. Since elevation data correlates directly to a given location, the verification of emission source base elevation is done only after verification of the source location.

As previously discussed in Section 3.3, reported contaminant specific emission rates are used in the prioritization of emission sources steps to be evaluated in the RAIMI Pilot Study and are also used in the risk modeling component for calculating media specific exposure concentrations (see Section 4.1.4). Emission sources prioritized for evaluation in the RAIMI Pilot Study are air modeled using an unit emission rate in the ISCST3 model runs. This approach is further discussed in Section 4.1.4.

As previously discussed in the section regarding accounting for emissions partitioning in the air modeling (see Section 4.1.5), limited source-specific particle data are available for use in the RAIMI Pilot Study. Therefore, for stack emission sources that do not have available measured or facility reported particle data, particle and particle-bound phase air modeling runs are conducted assuming that 100 percent of the particulate mass released is 1 micron in diameter. This assumption is expected to be representative of the emission sources being evaluated, while also accounting for the appropriate allocation of contaminant mass to the particle-bound and particle phases (see Section 4.1.5). A default particle density of 1 g/cm^3 is also used as recommended in the HHRAP (U.S. EPA 1998b). If available, measured or facility reported particle data are utilized over defaults.

Scavenging coefficients for particle and particle-bound phase are entered based on the assumed particle diameter and Figure 1-11 in the ISC3 User's Guide as recommended in the HHRAP (U.S. EPA 1995a; 1998b). When modeling vapor phase, gas scavenging coefficients of 1.7E-04 for liquid and 0.6E-04 for ice are used, consistent with recommended values provided in the HHRAP (U.S. EPA 1998b).

4.3.3 Receptor Pathway

The RE pathway in the ISCST3 input file identifies the receptor grid nodes by UTM coordinates and elevation above mean sea level. These data are used by ISCST3 as the locations to compute estimates of air concentrations and dry and wet deposition rates. The assessment area evaluated in the RAIMI Pilot Study has a specific receptor grid node array. This receptor grid node array was developed to provide complete coverage so that representative air parameter values can be extracted from the air modeling results for any desired location within the assessment area to support subsequent analysis in the risk modeling component.

For example, a receptor input pathway identified in Zone 15 of the UTM coordinate system (North American datum 83) for the Cartesian receptor grid node array is established across the Port Neches assessment area based on the spacing and dimensions provided in Table 4-2. The naming of the grid areas are based on the respective UTM coordinate of the southwest corner. Grid nodes spaced 500 meters apart cover the entire Port Neches assessment area. Additionally, a denser array of grid nodes is placed every 100 meters apart in five areas of high industrial activity with numerous emission sources and nearby residential areas. The grid spacing is consistent with recommendations provided in the HHRAP (U.S. EPA 1998b), but applicable to multiple emission sources and a larger study area. As noted in Section 4.2.1, terrain elevations based on 90-meter-spaced USGS digital elevation data points are specified for all receptor grid nodes within the defined array. The Port Neches Assessment Area receptor grid node array is shown on Figure 4-2.

TABLE 4-2

GRID NODE ARRAY AREAS
PORT NECHES ASSESSMENT AREA

Grid Name	Spacing	Minimum UTM X (m)	Maximum UTM X (m)	Minimum UTM Y (m)	Maximum UTM Y (m)	Dimensions (km)
395-3311	500-meter	395,000	418,000	3,311,000	3,323,000	23 x 12
397-3319	100-meter	397,000	402,000	3,319,000	3,322,000	5 x 3
403-3318	100-meter	403,000	408,000	3,318,000	3,321,000	5 x 3
408-3314	100-meter	408,000	411,000	3,314,000	3,319,000	3 x 5
412-3313	100-meter	412,000	415,000	3,313,000	3,316,000	3 x 3
396-3315	100-meter	396,000	399,000	3,315,000	3,319,000	3 x 4

4.3.4 Meteorological Pathway

The ME pathway in the ISCST3 input file contains the meteorological data. As discussed in Section 4.2.4, the meteorological input files are prepared from data collected over a five years from a representative NWS surface and upper air station located near the facility.

4.3.5 Terrain Grid Pathway

The terrain in the assessment area is coastal and mostly less than 10 meters above sea level. Therefore, the TG pathway is not specified due to the numerically negligible affect on air modeling expected due to relatively consistent variations in the elevation over the area. The TG pathway input relates to the variation in elevation between the emission source base and receptor grid node locations. It should not be confused with the terrain elevations based on 90-meter-spaced USGS digital elevation data, which is specified for all receptor grid nodes evaluated in the RAIMI Pilot Study and incorporated into the ISCST3 modeling during generation of the receptor grid node arrays (see Sections 4.2.1 and 4.3.3).

4.3.6 Output Pathway

The OU pathway in the ISCST3 input file directs ISCST3 to generate outputs for reviewing, summarizing, and plotting the air modeling results. Plot files are produced for the annual averaging periods for all applicable air parameters to post-process the modeled ISCST3 results into the risk modeling component.

4.4 ISCST3 MODEL OUTPUT

Output from the execution of ISCST3 provides unitized average annual air concentration and deposition rates, or air parameters, for each phase (i.e., vapor, particle, and particle-bound), for each emission source modeled, and each receptor grid node in the defined array. These unitized annual average air parameter values are stored in the ISCST3 annual average plot files and used as inputs in the risk modeling component to estimate media-specific contaminant concentrations.

ISCST3 vapor phase outputs are the unitized air concentration and wet vapor deposition air parameters for vapor emissions from each emission source. ISCST3 particle phase outputs for the particle phase runs are the unitized air concentration, dry deposition rate, wet deposition rate, and total deposition rate air parameters. ISCST3 outputs for the particle-bound phase runs are unitized air concentration, dry deposition rate, wet deposition rate, and total deposition rate air parameters.