# AMP (Air Model Preprocessor) Version 1.0 Validation Report

## Executive Summary

This validation report details the efforts U.S. Environmental Protection Agency (U.S. EPA) Region 6 made to ensure AMP (Air Model Preprocessor) Version 1.0 operates according to its design. U.S. EPA developed AMP under the Regional Air Impact Modeling Initiative (RAIMI) to meet the functional need of preparing data and input files for use in the air dispersion model, ISCST3. Other related RAIMI Tools allow for completion of the air modeling:

- ISCBatch executes multiple ISCST3 air modeling runs in a single batch run.
- AIR2GIS consolidates the large plot files generated by each
- ISCST3 run into a single file for each source to input into the Risk-MAP Node Array Index Table.

This validation effort tested the core capabilities of AMP. These core capabilities perform three key functions for air modeling within the RAIMI environment:

- Implement site parameter quantification (surface roughness, urban/rural land use) for each emission source in accordance with RAIMI methods.
- Prepare source-specific meteorological files using U.S. EPA Meteorological Processor for Regulatory Models (MPRM).
- Auto-generate air model input files for multiple sources for all four potential contaminant phases to include source-centered universal grid node array with extracted terrain elevations.

These core capabilities constitute the required functionality to meet project objectives. Validation did not test the entire AMP feature set, nor did it include regression testing or error handling verification. Testing validated the output AMP generated.

## Functional Capabilities

The three core capabilities of AMP provide the air modeler with a tool to prepare source-specific meteorological and ISCST3 air model input files to allow for completing the air modeling on numerous sources (greater than 100) within a regional or county-wide study area.

As each source has unique surrounding land use, available land use data analyzed using geographic information system (GIS) tools provides for accurate, repeatable determination of appropriate site parameters that influence the air dispersion and subsequent disposition of emitted contaminants downwind from a release source. These parameters may then be integrated with AMP into the MPRM input files for execution of source-specific meteorological data for a five-year period to satisfy RAIMI requirements.

Finally, the location of each source is combined with surrounding terrain data from U.S. Geological Survey (USGS) digital elevation model (DEM) digital files to build a universal grid node array aligned with the USGS longitude/latitude specifications for DEM files to complete the creation of the required ISCST3 air model input files for volatile vapor, particle, particle-

bound and mercury vapor phase air modeling.

### Implement Site Parameter Quantification

The U.S. EPA has identified a refined methodology for determining site-specific surface roughness and urban/rural classification for use in completing the meteorological data processing. The recommended RAIMI method uses the U.S. EPA MPRM, which allows for directional (12, 30-degree sectors) and seasonal variations in land use. The result is the input of 48 surface roughness values into MPRM instead of the previous single value. This method is implemented in the refined air models by U.S. EPA (ISCST3, AERMOD, CALPUFF). The air model also requires source-specific specification of the surrounding land use as urban or rural for model selection of corresponding air dispersion coefficients. The AMP must be able to generate these values to allow for timely practical implementation of the revised RAIMI methods using the latest U.S. EPA meteorological pre-processor and air modeling methods.

### Prepare Source-Specific Meteorological Data Files

The five years of meteorological data required for air modeling to support RAIMI applications are pre-processed applying the 48 surface roughness values determined for each source. MPRM Stage 1 to quality assure and replace missing data for the surface and upper meteorological data are executed stand-alone by the air modeler prior to using AMP. AMP completes MPRM Stage 3 applying the source-specific site parameters.

### Auto-Generate ISCST3 Air Model Input Files

The processing of large numbers of sources (more than 100) in a RAIMI study area is impractical using manual methods, including spreadsheet manipulations, due to the processing time and potential for human errors. Two examples are the preparation of the receptor grid pathway (referred to as 'grid node array' in RAIMI) in the ISCST3 input file, and the creation of source-specific ISCST3 input files for each of the four potential contaminant phases - volatile vapor, particle, particle-bound, and mercury vapor. AMP prepares the ISCST3 air model input files for multiple sources affecting a study area.

## Validation Criteria

AMP validation tested the site parameter determination, meteorological data file generation and ISCST3 air model input file generation capabilities.

### Validation Approach

The validation approach consisted of the following steps for each of AMP's core capabilities:

1. Manually generate the values.
2. Use AMP to generate the same information.
3. Compare the manually generated values to the AMP values through visual inspection.

The AMP validation would be considered successful if there were no discrepancies during the comparison.

## Execution

The following sections describe the specific steps performed during the AMP validation.

***Implement Site Parameter Quantification***

- Use the Land Use Land Cover (LULC) for Jefferson County (shapefile '12LULC83.shp') printed to hardcopy map in NAD-83 universal transverse mercator (UTMs) to apply the RAIMI method for a hand-calculation of source-specific (application site) urban/rural and surface roughness for four test locations (see Table 1).
- Use AMP to determine the same application site parameters using the same LULC in electronic format ('12LULC83.shp').
- Compare the results for the urban/rural determination and the 48 directional/seasonal surface roughness values from AMP to the hand-calculated values.

Table 1: Test Locations (NAD-83)

| Company | EPN | UTM-E (m) | UTM-N (m) |
|---|---|---|---|
| Ameripol Synpol (Am) | S-Drier-M | 408,920.0 | 3,317,852.0 |
| Huntsman Corp (H1) | C4 Boiler | 408,426.7 | 3,316,901.8 |
| DuPont (Du) | ACR_FLR57 | 400,742.0 | 3,320,875.0 |
| BASF (B1) | EK-541 | 397,885.0 | 3,315,774.0 |

***Generate Meteorological Data Files***

- Run AMP to execute MPRM on the MPRM Stage 2 merged file created manually to create five years of MPRM Stage 3 output for each source.
- Manually prepare five years of surface meteorological data from Beaumont Port Arthur National Weather Service Station and upper air data from Lake Charles National Weather Service using the MPRM program through Stages 1 and 2 (quality checking and collation).
- Confirm that the five years of meteorological files for each source are created successfully by visual inspection and performing test runs using the ISCST3 air model.

***Auto-Generate ISCST3 Air Model Input Files***

AMP automatically generates two air model input files: RAIMI Grid Node Array and ISCST3 input files. The following sections describe the steps to generate each.

*RAIMI Grid Node Array*

- Confirm generation from the nearest universal grid node to the center of each source using a universal grid system (USGS DEM 3 arc-second grid node designation in geographic Latitude/Longitude).
- Verify by inspection and comparison the grid node selection, special coverage and elevations for each source-specific, source-centered grid node array on the four test sources.

*ISCST3 Input Files*

- Verify generation of the ISCST3 input files for the four separate runs to address the potential phases of the emitted constituents, including volatile vapor, particle, particle-bound and mercury vapor phases.

- Using pre-defined naming convention, verify AMP implements the auto-generation of the ISCST3 input files for all four runs for each source by inspection of input files and test runs in ISCST3 for the four test sources.

| Validation Criteria Table | | | |
|---|---|---|---|
| **Core Capability to be Tested** | **Test Description and Method of Comparison** | **Files** | **Comments** |
| Site Parameter Determination | Test the determination of site-specific surface roughness for each of the 12 sectors for the four seasons.<br><br>Test the determination of the urban/rural classification. | - Test data set (AMP)<br>- Control data set (MS Excel)<br>- Comparison table | This test used AMP to determine the site-specific parameters for each of the four test sources. Each of the 48 values (12 30-degree sectors and four seasons) for each source were compared to manually determined values using hard-copy LULC map and spatial overlay. Used Excel tables to compare manually-determined values to AMP-determined values. |
| Meteorological Data File Generation | Test the capability of AMP to generate the five years of meteorological data for each of the four test sources. Visual inspection of generated files compared to manually prepared control files.<br><br>Test runs on ISCST3 to compare for same results. | - Test data set (AMP)<br>- Control data set (MPRM)<br>- Visual comparison | This test used AMP to generate the five MPRM met files for input to ISCST3 using the site parameter for application site surface roughness determined by AMP. Visual inspection of the MPRM Stage 3 input files generated by AMP, and the generated five years of meteorological files required for ISCST3, confirmed AMP's capability to perform this function. |
| ISCST3 Air Model Input File Generation | Test the capability of AMP to auto-generate the universal grid node array with required spacing and coverage.<br><br>Test capability to prepare the four ISCST3 input files for each source. | - Test data set (AMP)<br>- Control data set (ISCST3)<br>- Visual comparison<br>- ISCST3 test runs | This test used AMP to generate the ISCST3 input files, including the universal grid array. ISCST3 test runs and plotting of ISCST3 output grid node arrays demonstrated correct spacing and coverage of array to satisfy RAIMI requirements. |

## Conclusions and Considerations

**Core Capability 1 - Site Parameter Determination.** The validation effort compared the AMP-generated values for surface roughness calculated using the digitized land use maps to hand-calculated values extracted and summarized from hard-copy land use maps by sector and season for each of the four test locations. Validation also compared the overall urban/rural determination using AMP to hand-calculated values. The comparisons matched with negligible differences between the two data sets. Noted differences are explained by human judgement in estimating areal percentages of land use type within a sector. This core capability is successfully implemented in AMP Version 1.0 for use to determine the required site parameter values for both application site surface roughness and urban/rural land use. AMP may use these parameters to generate the site-specific meteorological data file and the ISCST3 input file required in RAIMI applications.

**Core Capability 2 - Meteorological Data File Generation.** AMP demonstrated the capability to integrate the application site-surface roughness parameters computed as source-specific site parameters into input files for Stage 3 execution of the U. S. EPA MPRM. AMP successfully generated the five input files for each of the five years of required meteorological data for RAIMI applications as demonstrated by visual review of the input files for correct content and structure. Then the validation effort manually executed the MPRM to prepare the raw meteorological data for use by AMP to create the Stage 3 files. AMP successfully created each of the five years of Stage 3 data before concatenating them within AMP into a single site-specific five-year data file. The validation effort visually inspected this five-year file for correct content and format. The file was used to execute a test ISCST3 run with results compared to an ISCST3 run using a manually prepared five-year file. The results were identical. This core capability is successfully implemented in AMP Version 1.0 to prepare the site-specific five-year meteorological data file for each source to be air modeled using ISCST3.

**Core Capability 3 - ISCST3 Air Model Input File Generation.** AMP demonstrated the capability to auto-generate the required grid node array out to 10 kilometers from the source location. Grid nodes were generated on the universal grid applying the latitude/longitude coordinates used by USGS in the digital elevation mapping (DEM) terrain files. Plots of the AMP-generated grid node array and the DEM data demonstrated co-location of grid nodes in both files. Also, AMP demonstrated the capability to auto-generate the ISCST3 air model input files for the four potential phases of contaminant release. The generated files compared identically to files that were manually generated for this test. The two required functions for this core capability are successfully implemented in AMP Version 1.0 to auto-generate the universal grid node array and the four phases of ISCST3 input files for each source. AMP was tested on 20 sources for this validation. However, in RAIMI applications, AMP has successfully prepared the required ISCST3 input files for over 1,000 sources in a single execution.

AMP Version 1.0 satisfies all design elements and correctly implements the three core capabilities to prepare the input files for air modeling using ISCST3 for RAIMI applications.