ADDENDUM

METEOROLOGICAL PROCESSOR FOR REGULATORY MODELS (MPRM)

USER'S GUIDE

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PREFACE

This Addendum to the MPRM User's Guide provides data input requirements of the gas dry deposition algorithm in the form of page inserts to the MPRM User's Guide.

The capability for estimating dry deposition from gaseous pollutants is needed to meet emerging needs for assessing impacts of toxic air pollutants. The gas dry deposition algorithm selected has undergone limited review and evaluation (Moore, at al. 1995), represents the state-of-science approach (EPA, 1995), and has a long history of use (Pleim, 1984). For operational purposes, this algorithm has been incorporated in Industrial Source Complex (ISC3) Model.

Parm1 is the sector number; parm2 is the beginning azimuth (included in the sector), and parm3 is the ending azimuth (excluded from the sector). The azimuth is defined in a clockwise sense; a sector definition may pass through north (360°) without having to terminate at north. The number of 'OS SFC SECTORS' images must correspond to the number of sectors.

The syntax of the **OS SFC VALUES** image is:

OS SFC VALUES parm1 parm2 parm3 ... parm10

The **VALUES** character string indicates that information on surface characteristics follows. Parm1 is the frequency index (1 for annual, 1-4 for season, or 1-12 for monthly) and parm2 is the sector index. Seasons are defined in MPRM as follows: Winter = December, January and February (parm1 = 1); Spring = March, April, and May (parm1 = 2); Summer = June, July, and August (parm1 = 3); Fall = September, October, and November (parm1 = 4). The order and defaults for the surface characteristics (parm3 ... parm10) are:

Albedo	0.25
Bowen Ratio	0.70
Roughness Length (measurement site)	0.15 m
Roughness Length (application site)	0.15 m
Minimum Monin-Obukhov Length	2.00 m
Surface Heat Flux (fraction of net)	0.15
Anthropogenic Heat Flux	0.00 Wm^{-2}
Leaf Area Index	3.00

Guidance for specifying surface characteristics is provided in Section 3.3.

3.1.2 MP Pathway Input

The **MP MET** image identifies the merge data file to be processed (MERGE.223) and provides the number of integer hours to be subtracted from the Greenwich Mean Time (GMT) to convert to local standard time (LST). For a west coast location, the conversion is 8 hours.

The **MP MMP** image defines the name for the processed meteorological data file (TEST324.OUT) and selects a dispersion model (ISCSTWET). The default, if no model is specified, is the ISCST3 model; the output in this case is an ASCII file formatted for use in ISCST3. Detailed information on file formats for the dispersion models supported by MPRM is provided in Appendix F.

The syntax for the **MMP** keyword is:

MP MMP DISK filename model

and the zone of flow affected by an obstacle, they suggest the following minimum values for several urban land use classifications:

agriculture (open)	2 m
residential	25 m
compact residential/industrial	50 m
commercial (19-40 story buildings)	100 m
(> 40 story buildings)	150 m

Surface Heat Flux - The flux of heat into the ground during the daytime is parameterized as a fraction of the net radiation. Values suggested by Oke (1982) are:

rural	0.15
suburban	0.22
urban	0.27

Anthropogenic Heat Flux - The anthropogenic heat flux can usually be neglected (set equal to zero) in areas outside highly urbanized locations. However, in areas with high population densities or high energy use, this flux may not always be negligible. Oke (1978) presents estimates of population density and per capita energy use for 10 cities and obtains a heat flux for each. Summertime values are typically 50% of the mean, while wintertime values are about 150% of the mean in the colder climates. Table 3-7 provides guidance for several urban areas.

Leaf Area Index - The leaf area index (LAI) is the ratio of the leaf surface area to the ground surface area, and is needed to compute dry deposition for gases in the ISCST model. Typical values of LAI are as follows: about 4 for pine and 7 for spruce or fir forests; a maximum of about 5 for deciduous forests; about 3 to 4 for fully cultivated crops; about 2.5 for tall grassland; about 2.0 for grass or pasture land; about 1.5 for range; 0.2 for scrub; and 0.001 for bare ground. A value of 0.0 for LAI is interpreted by the ISCST model as a water surface, and should therefore not be used for bare ground. The value of LAI will vary seasonally for cultivated areas and for areas with deciduous forests. If the option for user-specified deposition velocity in ISCST is being used (CO GASDEPVD), then the value of LAI present in the meteorological input file will be ignored. However, a value must still be included with the surface characteristics.

The surface characteristics used in the example test case are based on an assumed modeling scenario involving a source located on the boundary separating an urban area from a deciduous forest. The two land use types are assumed to occupy contiguous 180 degree sectors. Table 3-8 provides a summary the surface characteristics by season for these two land use types.

3.4 Stage 3 General Report File

The Stage 3 general report is structured somewhat differently than that generated during Stages 1 and 2. If the **LST** keyword has been activated, then the first page of the general report will echo the header information that was written to the output file (i.e., the file defined following the MMP keyword). This would be followed by the listing of the generated meteorological data. The listing would continue for as many pages as necessary. The rest of the Stage 3 general report is standard; an example is shown in Figure 3-1. The general report documents Stage 3 processing under 11 headings as follows:

1. Filenames as determined in setup
2. Dispersion model defined in setup
3. Processing options selected
4. Stability methods used

Table 3-2

Dispersion Models Supported by MPRM

MMP Model Option	Dispersion Model Name	Description
ISCST	ISCST	The ISCST model option results in an ASCII file for use in ISCST; this is the default. The default output consists of ten fields ending with the mixing heights (see Appendix F).
ISCSTDRY	ISCST	ISCSTDRY produces an ASCII file for use in modeling dry deposition with ISCST. Each record includes three additional fields following the mixing height: surface friction velocity, Monin-Obukhov length and surface roughness length at the application site.
ISCSTWET	ISCST	ISCSTWET produces an ASCII file for use in wet deposition modeling with ISCST. Each record includes five additional fields following the mixing height: surface friction velocity, Monin-Obukhov length, surface roughness length at the application site, precipitation type and precipitation amount.
ISCGASD	ISCST	ISCGASD produces an ASCII file for use in modeling dry deposition for gases with ISCST. Each record includes two additional fields relative to ISCSTDRY: incoming short-wave radiation (from Eq. 4.5) and leaf area index. May also be used for particle dry deposition applications.
ISCGASW	ISCST	ISCGASW produces an ASCII file for use in modeling dry and wet deposition for gases with ISCST. Each record includes two additional fields relative to ISCSTWET: incoming short-wave radiation (from Eq. 4.5) and leaf area index.
BLP COMPLEX1 RAM	BLP COMPLEX1 RAM	Selection of these models results in a RAMMET binary output file with 24 hours of data per record. The same file also supports the unformatted (binary) option of ISCST.
CALINE-3	CALINE-3	This selection results in an ASCII file for use in CALINE-3. This format has 1 hour of data in each record.
RTDM	RTDM	This selection results in an ASCII file for use in RTDM. This format has 1 hour of data in each record.
VALLEY ISCLT CDM16*	VALLEY ISCLT CDM 2.0*	This selection results in an ASCII file containing data describing the joint frequency distribution of wind direction and wind speed by stability class. Sixteen wind direction sectors are used in developing the frequency distribution, with the first 22.5° sector centered on winds from the North.
CDM36*	CDM 2.0*	This selection results in an ASCII file containing data describing the joint frequency distribution of wind direction and wind speed by stability class. Thirty-six wind direction sectors are used in developing the frequency distribution, with the first 10° sector centered on winds from the North.

* The CDM 2.0 dispersion model can process meteorological frequency function data (often referred to as STability ARray data, STAR), constructed using either 16 or 36 wind direction sectors. To provide this flexibility, we have used CDM16 and CDM36 to identify whether 16 or 36 wind direction sectors are desired in constructing the STAR data. STAR output for CDM use the six stability categories A, B, C, D-day, D-night, E-F. STAR output for the ISCLT and VALLEY models use the six stability categories: A, B, C, D, E, F.

4.2.4 Mixing Height

The default method for processing mixing height is to use the interpolation scheme employed in the RAMMET meteorological processor, which uses the twice-daily mixing heights from the nearest NWS upper air observation site, coupled with the stability category determined for the hour. This method is described in more detail in the RAM model user's guide (Catalano et al., 1987). The user may also designate the on-site mixing height to be employed. In this case MPRM will use the value for the hour given in the on-site observation.

4.2.5 Surface Characteristics

MPRM provides the means to specify direction-dependent surface characteristics for use in estimating boundary layer parameters (see Section 4.3). The surface characteristics are: albedo, Bowen ratio, surface roughness length (at the measurement site and at the application site), minimum Monin-Obukhov length for stable conditions, fraction of the net radiation absorbed at the ground, anthropogenic heat flux, and leaf area index. Guidance for specifying these surface characteristics is provided in Section 3.3. The following defaults apply if values are not specified:

Albedo	0.25
Bowen Ratio	0.70
Roughness (measurement site)	0.15 m
Roughness (application site)	0.15 m
Minimum M-O Length	2.00 m
Surface Heat Flux (fraction of net)	0.15
Anthropogenic Heat Flux	0.00 Wm^2
Leaf Area Index	3.00

The default values are typical for cultivated land with average moisture and will not apply to all modeling situations.

The roughness length is used in Stage 3 processing to adjust the σ_E and σ_A stability category boundaries, in accordance with guideline recommendations (Appendix W to 40 CFR Part 51; U.S. EPA, 1987). When an attempt is made to determine the stability category for a given hour using one of these on-site methodologies, the wind direction at the lowest level (above 2 m) on the tower is used to define the wind direction sector from which the wind is blowing. The roughness length is then determined given the wind direction sector and the month of the year. See U.S. EPA (1987) for recommendations on estimating site-specific roughness lengths.

4.3 Boundary Layer Parameters

Estimates of the surface friction velocity and Monin-Obukhov length are required for dry and wet deposition and depletion in the ISCST3 dispersion model. The surface friction

Keyword:	**SFC VALUES** on Pathway OS
Purpose:	Specify values for surface characteristic

Syntax:	**OS SFC VALUES** Parm1 Parm2 ... Parm10
Parm1:	Parm1 is the frequecy index (1 for annual, 1-4 for season, or 1-12 for monthly). Seasons are defined in MPRM as follows: Winter = December, January and February (parm1 = 1); Spring = March, April, and May (parm1 = 2); Summer = June, July, and August (parm1 = 3); Fall = September, October, and November (parm1 = 4).
Parm2:	Parm2 is the sector index (maximum value 12)
Parm3:	Parm3 is Noon-time albedo (default = .25)
Parm4:	Parm4 is Bowen ratio (default = 0.70)
Parm5:	Parm5 is surface roughness length (meters) at the site where meteorological data are collected (default = 0.15 m)
Parm6:	Parm6 is surface roughness length (meters) at the site where the output from Stage 3 are to be applied (default = 0.15 m)
Parm7:	Parm7 is minimum Monin-Obukhov length (meters) for stable conditions (default = 2.0 m)
Parm8	Parm8 is fraction of net radiation absorbed by the ground (default = 0.15)
Parm9	Parm9 is anthropogenic heat flux (default = 0.0 Wm^{-2})
Parm10	Parm 10 is the leaf area index (default = 3.0)
Example:	OS **SFC VALUES** 1 1 0.25 0.70 0.15 0.15 2.00 0.15 0.00 3.00

Keyword:	**STA** used on Pathways JB, MP, UA, SF, OS AND MR
Purpose:	Signals beginning of input run stream data for pathway

Syntax:	Pathway **STA**
Parm1:	This keyword has no parameters
Example:	JB **STA**

Model Output Files

ISCST

The meteorological input required to run ISCST depends on the application and options employed. Basically, there are five options which determine the meteorological variables needed to run the model. The modeling options available with ISCST include concentration (with and without plume depletion), dry deposition for particles and gases, and wet deposition for particles and gases. Minimum requirements, common to all options, are wind direction, wind speed, temperature, stability class, and mixing height. The minimum requirements apply when one is modeling concentration without deposition or plume depletion; the MPRM output format for this option is described in Table F-17. Additional variables are needed if one is modeling dry deposition and/or dry depletion for particles; the MPRM output for particle dry deposition/depletion estimates is described in Table F-18. Precipitation data are needed if one is modeling wet deposition and/or depletion; the MPRM output for wet deposition/depletion for particles is described in Table F-19. Additional variables are needed if one is modeling dry deposition and/or dry depletion for gases; the MPRM output for gas dry deposition/depletion estimates for gases is described in Table F-19a. Precipitation data are also needed if one is modeling both wet and deposition and/or depletion for gases; the MPRM output for wet and dry deposition/depletion for gases is described in Table F-19b. The data records for all five options are preceded by an identical header record described in Table F-16.

Table F-19a

Output File Format for ISCGASD

Field	Description	Format	Columns
01	Year (2 digits)	I2	01-02
02	Month	I2	03-04
03	Day	I2	05-06
04	Hour	I2	07-08
05	Randomized flow vector	F9.4	09-17
06	Wind speed (m/s)	F9.4	18-26
07	Ambient temperature (kelvin)	F6.1	27-32
08	Stability category	I2	33-34
09	Rural mixing height (m)	F7.1	35-41
10	Urban mixing height (m)	F7.1	42-48
11	Surface friction velocity, application site (m/s)	F9.4	49-57
12	Monin-Obukhov length, application site (m)	F10.1	58-67
13	Surface roughness length, application site (m)	F8.4	68-75
14	Incoming Short-wave Radiation (W/m^2)	F8.1	76-83
15	Leaf Area Index	F8.3	84-91

Table F-19b

Output File Format for ISCGASW

Field	Description	Format	Columns
01	Year (2 digits)	I2	01-02
02	Month	I2	03-04
03	Day	I2	05-06
04	Hour	I2	07-08
05	Randomized flow vector	F9.4	09-17
06	Wind speed (m/s)	F9.4	18-26
07	Ambient temperature (kelvin)	F6.1	27-32
08	Stability category	I2	33-34
09	Rural mixing height (m)	F7.1	35-41
10	Urban mixing height (m)	F7.1	42-48
11	Surface friction velocity, application site (m/s)	F9.4	49-57
12	Monin-Obukhov length, application site (m)	F10.1	58-67
13	Surface roughness length, application site (m)	F8.4	68-75
14	Incoming Short-wave Radiation (W/m^2)	F8.1	76-83
15	Leaf Area Index	F8.3	84-91
16	Precipitation code (0 for none, 1-18 for liquid, 19 and above for frozen)	I4	92-95
17	Precipitation amount (mm)	F7.2	96-102