Emissions Data, Receptor Grids and Other CALPUFF Inputs

If the Federal Land Manager (FLM) indicates that a Class I area evaluation is necessary prior to permit issuance, and the facility is located greater than 50-kilometers from a Class I area, a refined air quality impact analysis using the CALPUFF modeling system will be required. Refined air quality analyses utilize real-world meteorological data inputs, comprehensive receptor grids and site-specific source characterizations.

The most recent version of the CALPUFF air quality model should be used unless prior approval for the use of an alternate version or alternate model has been obtained from the FLM. The Environmental Protection Agency maintains a website, the Support Center for Regulatory Atmospheric Modeling (SCRAM) Dispersion Modeling | TTN - Support Center for Regulatory Atmospheric Modeling | US EPA, that provides links to the preferred/recommended models that are currently in use.

The following sections briefly describe each data element that is required in order to complete a refined air quality impact analysis following by a CALPUFF checklist.

Modeled Emission Rates

The construction permit engineer is responsible for the approval of all emission estimates that are used in ambient air quality impact analyses within the State of Missouri. All emission estimates should be based upon the use of maximum, ***hourly*** emissions or federally enforceable limits (for existing sources) contained within construction permits, operating permits or other enforceable mechanisms such as consent decrees, state requirements, or federal requirements. In the absence of limits, potential to emit calculations should be used to determine compliance with each applicable air quality standard.

When determining hourly emission estimates, it is important to understand the processes that are occurring and what operating scenarios result in the worst case ambient impact. For example, the emission estimates for a boiler that primarily combusts natural gas with a fuel oil backup, must consider which fuel results in the worst case, hourly emission estimates. Depending on the pollutant being considered, the primary fuel may not result in the maximum, hourly emission rate.

In addition, combustion sources may be required to consider reduced operating loads. Again, the operating load that produces the worst case ambient impact must be used to establish compliance with the air quality standards.

Lastly, any emission limits applied to the new source or modification must be clearly described and must include a detailed account of all assumptions used in the calculation of the emission estimates. ***Any limits that are noted will become a special condition within the construction permit.***

Source Characterizations

The construction permit applicant is required to provide the methodology that will be used to characterize emission releases within the ambient air quality impact analysis. AERMOD, the preferred air quality model for refined dispersion analyses, allows the user to input three differing release types: point, volume and area sources.

The point source algorithm should be used to characterize emissions from stacks, exhaust fans, cooling towers and non-passive, isolated vents. Any restriction to vertical flow due to the presence of rain caps or horizontal stacks should be accounted for by reducing the exit velocity to 0.001 meters per second in the model input file. In some instances, the presence of buildings can impact the dispersion of pollutants within the atmosphere, a phenomenon known as building downwash. If building downwash is potentially an issue, site specific information on the location and height of each building must be obtained and incorporated into the air quality analysis.

The volume source algorithm should be used to model fugitive emission releases, with the exception of haul roads and storage piles, which are not vented through a stack such as conveyor drop points, truck receiving pits, crushers, sawing, etc. Additionally, any emission release vented inside an enclosed structure, without a stack, should be characterized as a volume source with release parameters equivalent to the size of the openings that allow for the escape of fugitive emissions.

Lastly, area source emission releases result from haul road traffic and outdoor storage piles. All haul road releases should be modeled according to the recommended area source configuration procedures outlined in the March 2, 2012 Environmental Protection Agency report entitled "Haul Road Workgroup Final Report Submission to EPA-OAQPS."

Detailed information on the assignment of release parameters can be found on the Source Characterizations website. Permit applicants are encouraged to review the procedures outlined in the Point Source, Volume Source, and Area Source documents because they contain preferred characterization methodologies that can directly impact the results obtained from the ambient air quality impact analysis.

Receptor Grid and Terrain Elevations

When conducting an ambient air quality impact analysis, the applicant is required to determine the impact that each emission source will have within the boundary of the Class I area under consideration. The Air Resources Division within the National Park Service developed a database that contains uniform receptor grids for each Class I area within the United States. The receptor grids are available from the National Park Service website at the following location: Class I Receptors.

Meteorological Data

The CALPUFF modeling system accepts mesoscale meteorological outputs from the CALMET meteorological model. The FLMs recommend that three to five years of gridded data be processed for use in the air quality analysis, refer to the following document for recommendations and default modeling options: Meteorological Data & CALMET.

Interactive Source Inventories for Cumulative Impact Assessments

Background concentrations are an integral part of the overall air quality within a region and should be included in the air quality review if the impact from the new source or modification exceeds the deposition or visibility screening thresholds. The Construction Permit Modeling Unit will provide a model ready interactive (existing background sources) source input file to the applicant for those sources that are located within the State of Missouri. The applicant will be required to obtain out state source inputs from the appropriate state agency. All interactive source inputs should be explicitly modeled.

Increment Consumption

In addition to determining compliance with the deposition and visibility thresholds, applicants are required to determine compliance with the Prevention of Significant Deterioration (PSD) increment standards. The PSD increment standards are the maximum ambient concentration increase that can occur above a baseline. When the amount of "new" pollution exceeds the increment standards, significant deterioration has occurred. In order to determine the amount of increment consumed, the applicant must consider the emissions increase due to the new source or modification in addition to off-site emissions increases since the baseline date.

The amount of increment consumed should be determined through the inclusion of existing sources within the region that could have a significant impact within the radius of influence from the proposed source or modification. The Construction Permit Modeling Unit will provide a model ready interactive (increment consumers) source input file to the applicant. All interactive source inputs should be explicitly modeled.

Building Downwash

The presence of buildings can affect plume rise and the initial dispersion of pollutants within the atmosphere. Turbulent wake zones can be created around buildings that force pollutants to the ground instead of allowing them to freely rise within the atmosphere. Building downwash can be defined as the effect on pollution from nearby stacks that occurs when wind flows over and around buildings.

In order to account for building downwash parameters within the refined dispersion model, the Environmental Protection Agency developed a preprocessor, BPIP PRIME, in order to calculate enhanced plume dispersion coefficients due to turbulent wakes and to calculate reduced plume rise caused by the combination of the descent of streamlines on the leeward side of buildings and the increased entrainment within the wake. Additionally, PRIME addresses both the near and far field wake zones produced downwind of a building or group of structures.

The information needed to execute BPIP PRIME are the heights and locations of structures, which may contribute to building downwash, and the stack locations in relation to these structures. Based upon the facility configuration, the BPIP program will determine if a stack is being subjected to wake effects from a surrounding structure or structures. If structure wake effects are evident, flags are set to indicate which stacks are affected by building wake zones. Once it is determined that a stack is influenced by a structure, BPIP will calculate the building heights and widths to be included in the dispersion model so that building downwash effects can be considered.

Good Engineering Practice Stack Height

The Clean Air Act states that a stack should be high enough to ensure that its emissions do not result in excessive ground level pollutant concentrations in the area surrounding the stack due to downwash effects caused by the source itself, nearby structures, or complex terrain. It also states that the stack shall not exceed two and one-half times the height of the obstructing source unless a demonstration can be made that this is necessary. According to 40 CFR 51,l(ii), good engineering practice (GEP) stack height is the greater of 65 meters (measured from base of the stack) or the height of the nearby structure (measured from base of stack) plus 1.5 times the lesser dimension of the nearby structure. Any stack built prior to December 30, 1970 is grandfathered and is exempt from the GEP stack height requirements.

If a proposed, or existing stack, exceeds the criteria noted above, the GEP stack height should be used to determine compliance with the air quality standards, not the actual stack height.

CALPUFF Keyword Reference

Table 1 contains a listing of all required CALPUFF inputs for far field Class I area impact assessments. The keyword reference provides guidance on those items that are default values and those that are user defined values. If a CALPUFF keyword is not present in Table 1, it is likely that the keyword is not required or is not acceptable for use in a Class I analysis. For example, the FLMs require applicants to input three to five years of mesoscale meteorological data into the CALPUFF system. Because other meteorological inputs are not suggested for use, they are not contained within Table 1, i.e. ISCDAT, PLMDAT, PRFDAT, and SFCDAT.

Table 1
CALPUFF Keyword Reference & Default Input Values

Keyword	Description	Default Value	Required?
METDAT	CALMET Input File Name	User Defined	Yes, 3-5 Years
PUFLST	CALPUFF List File, Ouput	Filename.LST	Yes, CALUPFF List File
CONDAT	Output Concentration File	Filename.DAT	Yes, Increment & Visibility
DFDAT	Output Dry Flux File	Filename.DAT	Yes, N & S Deposition
WFDAT	Output Wet Flux File	Filename.DAT	Yes, N & S Deposition
VISDAT	Output Relative Humilities	Filename.DAT	No, Dependent Upon Visibility Method Used
OZDAT	Hourly Ozone File	User Defined	No, Dependent Upon Visibility Method Used

LCFILES	Filename Conversion to Upper or Lower Case	T = Lower Case, F = Upper Case	Yes
NMETDAT	Number of CALMET Files Used in the Analysis	User Defined	Yes
METDAT	CALMET File Name	User Defined	Yes, Repeat for Each File Input
METRUN	0 = Run User Defined Data Periods, 1 = Run All	0	Yes
Keyword	**Description**	**Default Value**	**Required?**
IBYR	Start Year	User Defined	Yes
IBMO	Start Month	User Defined	Yes
IBDY	Start Day	User Defined	Yes
IBHR	Start Hour	User Defined	Yes
XBTZ	Time Zone	6	Time Zone = 6
IRLG	Run Length in Hours	User Defined	Yes
NSPEC	Number of Chemical Species	5	Yes
NSE	Number of Chemical Species Emitted	3	Yes
MRESTART	Restart Option if Model Run is Broken into Multiple Time Periods	User Defined	No
METFM	Meteorological Data Format	1, CALMET	Yes
AVET	Averaging Time	60	Yes, Minutes
PGTIME	PG Averaging Time	60	Yes, Minutes
MGAUSS	Near Field Vertical Distribution	1 = Gaussian	Yes
MCTADJ	Terrain Adjustment Method	3 = Partial Plume Path Adjustment	Yes
MCTSG	Sub grid Hills Modeled?	0 = No	Yes
MSLUG	Near-Field Puff, Elongated Slugs?	0 = No	Yes
MTRANS	Transitional Plume Rise	1 = Yes	Yes
MTIP	Stack Tip Downwash	1 = Yes	Yes
MBDW	Building Downwash Method	2 = PRIME Method	Yes
MSHEAR	Vertical Wind Shear Modeled Above Stack Top?	0 = No	Yes
MSPLIT	Puff Splitting?	0 = No	Yes
MCHEM	Chemical Mechanism Flag	1 = MESOPUFF II Chemistry	Yes
MAQCHEM	Aqueous Phase Transformation Flag	0 = Aqueous Phase Transformation Not Modeled	Yes
MWET	Wet Deposition?	1= Yes	Yes
MDRY	Dry Deposition?	1 = Yes	Yes
MTILT	Gravitational Settling?	0 = no	Yes
MDISP	Dispersion Co-efficient Computation Method	3 = PG Dispersion Co-efficient for Rural and MP for Urban	Yes
MTURBVW	Sigma-v/Sigma Theta, Sigma-w Measurements?	3 = Use Both to Calculate Sigma-y and Sigma-z	Yes

MDSIP2	Back-up Dispersion Method for Missing Turbulence Data	3 = PG Dispersion Co-efficient for Rural and MP for Urban	Yes
MTAULY	Lagrangian Timescale for Sigma-y	0 = Draxler Default, 617.284 Seconds	Yes
Keyword	**Description**	**Default Value**	**Required?**
MTAUADV	Advective Decay Timescale for Turbulence	0 = No Turbulence Advection	Yes
MCTURB	Computation Turbulence Method Using Micro-Met Variables	1 = Standard CALPUFF Routines	Yes
MROUGH	PG Sigma-y, z Adjusted for Roughness?	0 = No	Yes
MPARTL	Partial Plume Penetration of Elevated Inversion?	1 = Yes	Yes
MTINV	Temperature Inversion Strength Provided in PROFILE.Dat Extended Records?	0 = No	Yes
MPDF	PDF Used for Dispersion Under Convective Conditions?	0 = No	Yes
MSGTIBL	Sub-Grid TIBL Module Used for Shore Line?	0 = No	Yes
MBCON	Boundary Conditions Modeled?	0 = No	Yes
MSOURCE	Individual Source Contributions Saved?	0 = No	Yes
MFOG	Configure for FOG Model Output?	0 = No	Yes
MREG	Test Options to See if Regulatory?	1 = Yes	Yes
CSPEC	Modeled Species, Repeat Line for Each Species Modeled	SO2, SO4, NOx, HNO3, NO3, PM10 &Others As Requested by FLM	Yes
Species Modeled	Specify if Modeled, Emitted, Dry Deposited or Grouped	User Defined	Yes
PMAP	Map Projection	UTM	Yes
FEAST	False Easting for Map Projection Origin	0.00	Yes
FNORTH	False Northing for Map Projection Origin	0.00	Yes
IUTMZN	UTM Zone	15	Yes
UTMHEM	Hemisphere for UTM Projection	N = Northern	Yes
RLAT0	Latitude for Projection Origin	35.367N	Yes
RLON0	Longitude for Projection Origin	94.01W	Yes
XLAT1	Matching Parallels of Latitude	36N	Yes
XLAT2	Matching Parallels of Latitude	40N	Yes
DATUM	Datum	WGS-84	Yes
NX	Number of Grid Cells in X-Direction	User Defined	Yes
NY	Number of Grid Cells in Y-Direction	User Defined	Yes
NZ	Number of Vertical Layers	10	Yes
DGRIDKM	Grid Spacing	User Defined	Yes
ZFACE	Cell Face Heights	0, 20, 40, 80, 160,	Yes

		320, 640, 1200, 2000, 3000	
XORIGKM	Reference Coordinate of SW Corner	User Defined	Yes
YORIGKM	Reference Coordinate of SW Corner	User Defined	Yes
IBCOMP	X Index of Lower Left Corner	User Defined	Yes
Keyword	**Description**	**Default Value**	**Required?**
JBCOMP	Y Index of Lower Left Corner	User Defined	Yes
IECOMP	X Index of Upper Right Corner	User Defined	Yes
JECOMP	Y Index of Upper Right Corner	User Defined	Yes
LSAMP	Gridded Receptors?	F = No	Yes
IBSAMP	X Index of Lower Left Corner	User Defined	Yes
JBSAMP	Y Index of Lower Left Corner	User Defined	Yes
IESAMP	X Index of Upper Right Corner	User Defined	Yes
JESAMP	Y Index of Upper Right Corner	User Defined	Yes
MESHDN	Nesting Factor for Sampling Grid	1	Yes
ICON	Concentrations	1	Yes
IDRY	Dry Flux	1	Yes
IWET	Wet Flux	1	Yes
IT2D	2D Temperatures	0	Yes
IRHO	2D Density	0	Yes
IVIS	Relative Humidity	1	Yes
LCOMPRS	Data Compression of Outputs?	T	Yes
IQAPLOT	Standard Output Plots?	0 = No	Yes
IMFLX	Mass Flux Across Specified Boundaries?	0 = No	Yes
IMBAL	Mass Balance for Each Species?	0 = No	Yes
ICPRT	Print Concentrations?	0 = No	Yes
IDPRT	Print Dry Flux?	0 = No	Yes
IWPRT	Print Wet Flux?	0 = No	Yes
ICFRQ	Concentration Print Interval	1 = Hour	Yes
IDFRQ	Dry Flux Print Interval	1 = Hour	Yes
IWFRQ	Wet Flux Print Interval	1 = Hour	Yes
IPRTU	Line Printer Output Units	3 = $\mu g/m^3$	Yes
IMESG	Screen Tracking of Messages During Run?	2 = Date, # Old Puffs, # Puffs Emitted	Yes
Output Species	Species List Output Options	User Defined	Yes
LDEBUG	Logical for Debug Option	F	Yes
IPFDEB	First Puff to Track	1	Yes
NPFDEB	Number of Puffs to Track	1	Yes
NN1	Met Period to Start Output	1	Yes
NN2	Met Period to End Output	10	Yes
NHILL	Number of Terrain Features	0	Yes
NCTREC	Number of Special Complex Terrain Receptors	0	Yes
MHILL	Terrain and CTSG Receptor Data	2 = Hill Data Created	Yes

		by OPTHILL	
XHILL2M	Factor to Convert Horizontal Dimensions	1	Yes
ZHILL2M	Factor to Convert Vertical Dimensions	1	Yes
XCTDMKM	X-Origin of CTDM System	0	Yes
YCTDMKM	Y-Origin of CTDM System	0	Yes
Keyword	**Description**	**Default Value**	**Required?**
Dry Gas Deposition	Chemical Parameters for Dry Deposition of Gases	User Defined	Yes
Size Parameters	Size Parameters for Dry Deposition of Particles	User Defined	Yes
RCUTR	Reference Cuticle Resistance	30	Yes
RGR	Reference Ground Resistance	10	Yes
REACTR	Reference Pollutant Reactivity	8	Yes
NINT	Number of Particle-Size Intervals to Evaluate Effective Deposition Velocity	9	Yes
IVEG	Vegetation State in Unirrigated Areas	1	Yes
Wet Deposition	Wet Deposition Parameters	User Defined	Yes
MOZ	Ozone Input Option	1 = Hourly Ozone Data Input	Yes
BCKO3	Monthly Ozone Concentrations	80	Yes
BCKNH3	Monthly Ammonia Concentrations	10	Yes
RNITE1	Nighttime SO2 Loss Rate	0.2	Yes
RNITE2	Nighttime NOx Loss Rate	2	Yes
RNITE3	Nighttime HNO3 Formation Rate	2	Yes
MH2O2	H2O2 Data Input Option	0 = Use Monthly Values	Yes
BCKH2O2	Monthly H2O2 Concentrations	12*1	Yes
BCKPMF	Fine Particulate Concentration		Yes
OFRAC	Organic Fraction of Fine Particulate		Yes
VCNX	VOC/NOx Ratio After Reaction	Clean Continental	Yes
SYTDEP	Horizontal Puff Size to Switch to Time Dependence	5.5E+02	Yes
MHFTSZ	Heffter for Vertical Dispersion	0	Yes
JSUP	PG Stability Class Above Mixed Layer	5	Yes
CONK1	Vertical Dispersion Constant for Stable Conditions	0.01	Yes
CONK2	Vertical Dispersion Constant for Neutral Conditions	0.1	Yes
TBD	Transition for Downwash	0.5	Yes
IURB1	Land Use Categories for Urban Land Use	10	Yes
IURB2	Land Use Categories for Urban Land Use	19	Yes
ILANDUIN	Land Use Category for Modeling Domain	20	Yes
ZOIN	Roughness Length for Modeling Domain	0.25	Yes

XLAIIN	Leaf Area Index for Modeling Domain	3.0	Yes
ELEVIN	Elevation Above Sea Level	0	Yes
XLATIN	Latitude for Met Location	User Defined	Yes
XLONIN	Longitude for Met Location	User Defined	Yes
ANEMHT	Anemometer Height	10.0	Yes
Keyword	**Description**	**Default Value**	**Required?**
ISIGMAV	Form of Lateral Turbulence Profile	1 = Read Sigma-v	Yes
IMIXCTDM	Choice of Mixing Heights	0 = Read Predicted	Yes
XMXLEN	Maximum Length of Slug	1.0	Yes
XSAMLEN	Maximum Travel Distance of a Puff/Slug in Sampling Step	1.0	Yes
MXNEW	Maximum Number of Slugs/Puffs Released from One Source During One Time Step	99	Yes
MXSAM	Maximum Number of Sampling Steps for One Puff/Slug During One Time Step	99	Yes
NCOUNT	Number of Iterations in Computation of Transport Wind for a Sampling Step	2	Yes
SYMIN	Minimum Sigma-y for a New Puff/Slug	1.0	Yes
SZMIN	Minimum Sigma-z for a New Puff/Slug	1.0	Yes
SVMIN	Default Minimum Turbulence Velocity Sigma-v	0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.37, 0.37, 0.37, 0.37, 0.37, 0.37	Yes
SWMIN	Default Minimum Turbulence Velocity Sigma-w	0.2, 0.12, 0.08, 0.06, 0.03, 0.016, 0.2, 0.12, 0.08, 0.06, 0.03, 0.016	Yes
CDIV	Divergence Criteria	0.1, 0.1	Yes
WSCALM	Minimum Wind Speed for Non-calm Conditions	0.5	Yes
XMAXZI	Maximum Mixing Height	3000	Yes
XMINZI	Minimum Mixing height	50	Yes
WSCAT	Default Wind Speed Classes	1.54, 3.09, 5.14, 8.23, 10.8	Yes
PLX0	Default Wind Speed Profile Power Law Exponents for Classes 1-6	0.7, 0.7, 0.10, 0.15, 0.35, 0.55	Yes
PTGO	Default Potential Temperature Gradient for Stability Classes E and F	0.02, 0.035	Yes
PPC	Default Plume Path Co-efficient for Each Stability Class	0.5, 0.5, 0.5, 0.5, 0.35, 0.35	Yes
SL2PF	Slug-to-Puff Transition Criterion Factor	10	Yes
NSPLIT	Number of Puffs That Result Every Time a Puff is Split	3	Yes
IRESPLIT	Time of Day When Split Puffs Can Split Again	Hour 17 = 1	Yes
ZISPLIT	Split is Allowed Only If Last Hour's Mixing Height > Minimum Value	100.0	Yes

ROLDMAX	Split is Allowed Only if Ratio of the Last Hour's Mixing Height to Max Mixing Height is Less than a Max Value	0.25	Yes
NSPLITH	Number of Puffs Every Time a Puff Splits	3	Yes
SYSPLITH	Minimum Sigma-y of Puff Before it May be Split	1	Yes
Keyword	**Description**	**Default Value**	**Required?**
SHSPLITH	Minimum Puff Elongation Rate Due to Wind Shear	2	Yes
CNSPLITH	Minimum Conc of Each Species in Puff Before it Splits	1.0E-07	Yes
EPSSLUG	Fractional Convergence Criteria for Numerical SLUG Sampling Integration	1.0E-04	Yes
EPSAREA	Fractional Convergence Criteria for Numerical AREA Source Integration	1.0E-06	Yes
DSRISE	Trajectory Step-Length for Numerical Rise Integration	1	Yes
HTMINBC	Minimum Height to Which BC Puffs Are Mixed as Emitted	500	Yes
RSAMPBC	Search Radius Around a Receptor for Sampling Nearest BC Puff.	10	Yes
MDEPBC	Near-Surface Depletion Adjustment to Concentration Profile	1 = Adjust Concentration for Depletion	Yes
Point Sources	Point Source Inputs	User Defined	Yes
Area Sources	Area Source Inputs	User Defined	Yes
Line Sources	Line Source Inputs	User Defined	Yes
Volume Sources	Volume Source Inputs	User Defined	Yes
NREC	Number of Receptors	Provided by FLM	Yes
Receptor Data	Location and Elevation of Receptors	Provided by FLM	Yes

Again, this document merely provides a summary of the data elements that are required to be incorporated into a refined air quality impact analysis. Detailed information on specific modeling procedures should be reviewed and approved by the FLM.