

## GULF OF MEXICO AIR EMISSIONS CALCULATIONS INSTRUCTIONS

### **General**

This updated document and workbook (DOCD\_AQ.XLS) were prepared by the Bureau of Ocean Energy Management (BOEM), formerly Minerals Management Service (MMS). This document and the companion workbook have been revised extensively with updated emission factors and emission estimation methods, and additional pollutants and equipment types. Note that the units associated with the data you are required to enter may be different than in the previous version of the workbook. This document is intended to standardize the way we estimate our potential air emissions for Development Operations Coordination Documents (DOCD)<sup>1</sup> approved by BOEM. It is intended to be thorough but flexible to meet the needs of different operators. To facilitate spreadsheet review by BOEM, any changes you make to emission factors or cell formulas will automatically be highlighted. This instructions document gives the basis for the emission factors used in the EMISSIONS spreadsheets as well as general instructions for using the spreadsheets.

The following sections describe the spreadsheets in the DOCD\_AQ.XLS workbook.

### **TITLE**

The TITLE sheet requires input of your company's name, area, block, OCS-G number, platform and/or well(s), drilling rig name and type, contact information, distance to shore, and start year in the corresponding lines. These data will automatically be transferred to the EMISSIONS and SUMMARY sheets.

### **STATIONARY FACTORS**

The emission factors were compiled from the latest U.S. Environmental Protection Agency (USEPA) AP-42 references (USEPA 2014a) or from industry studies or the latest available Gulfwide emission inventory emission averages if no USEPA AP-42 reference was available. Factors may be revised as more data becomes available. A change to the STATIONARY FACTORS sheet will be automatically changed in the EMISSIONS sheets. A Sulfur Content table was added in 1996 and revised in 2015. A change in this table will automatically revise SO<sub>2</sub> emission factors and the corresponding emission estimates. If your sulfur content is different than the default values in the table, you should change the values in the table to match your actual fuel sulfur content. Tables for Fugitive THC Emission Factors, Default Sales Gas Composition, Mud Degassing THC Emission Factors, THC Emission Speciation for Mud Degassing, and fuel conversion factors were added in 2015. Changes to these tables will automatically be reflected in the associated emission factors and emission estimates.

#### *Turbines, Engines, Heaters/Boilers/Burners, and Liquid Flaring*

1. Particulate matter (PM) emission factors for natural gas combustion are for filterable PM only.
2. It is assumed that PM = PM<sub>10</sub> = PM<sub>2.5</sub> unless individual species are provided in AP-42.
3. If an emission factor for VOC is not provided in AP-42, it is assumed that TOC or nonmethane TOC = VOC.
4. The EMISSIONS sheets allow you to enter either the Heat Input Capacity (MMBtu/hr) **or** the horsepower rating (HP) for turbines and natural gas-fired engines. You should only enter activity data for one of the units specified per piece of equipment. If you enter activity data for MMBtu/hr and HP for a single piece of equipment, the total emissions for the platform will be overestimated.
5. Fuel Usage Conversion Factors are provided on the STATIONARY FACTORS sheet for natural gas and diesel-fired turbines and engines. If your fuel usage conversion factors are different than

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<sup>1</sup> Referred to as Development and Production Plans (DPP) in the Alaska OCS Region.

the default values in the table, you should change the values in the table to match your actual fuel usage conversion factors.

### *Natural Gas Flares*

The emission factors are from AP-42, Chapter 13.5. The emission factors are in units of lbs/MMBtu. These factors are multiplied by the heat value of natural gas (MMBtu/MMscf) in order to convert units to lbs/MMscf. The spreadsheet is set up to use a natural gas heat value of 1050 MMBtu/MMscf. If your natural gas heat value is different than 1050, revise the heat value shown in the spreadsheet. The VOC factor is based on the hydrocarbon emission factor in table 13.5-1 and the average non-methane components in table 13.5-2. The SO<sub>2</sub> emission factor is based on an assumed gas density of 0.0947 lbs H<sub>2</sub>S/ft<sup>3</sup> H<sub>2</sub>S, the atomic weights of SO<sub>2</sub> and H<sub>2</sub>S, and the sulfur content of the flared gas. If the sulfur content of the flared gas is not 3.38 ppmv, then the corresponding value in the sulfur content table should be revised.

### *Storage Tanks, Amine Gas Sweetening Units, Glycol Dehydrators, Gas Venting, and Loading Operations*

Average emission values were estimated from the BOEM 2005 or 2011 Gulfwide Emission Inventory Studies as indicated in the Ref. column. Total emissions from each equipment type are estimated according to the counts provided on the EMISSIONS sheets.

If you plan to install a flare or sulfur recovery unit for an amine gas sweetening unit, provide an estimate for SO<sub>2</sub> directly.

### *Fugitives*

The worst-case THC emission factor is selected from the Fugitive THC Emission Factors table according to the stream type. VOC emissions are estimated from the THC emissions based on the fractions in the table: Default Speciation Weight Fractions for Fugitive THC Emissions by Stream Type. If component counts are not known, you may enter the **total** API 1993 surrogate count shown in Table 1.

Table1. Surrogate Fugitive Component Counts

Component	Surrogate Count
Connectors	9,194
Valves	1,713
Open-Ends	285
Others	228
<b>TOTAL</b>	<b>11,420</b>

### *Mud Degassing*

Hydrocarbon emissions from mud degassing occur when gas that has seeped into the well bore is separated from the mud. VOC emission factors for mud degassing are derived from the Mud Degassing THC Emission Factors table and the THC Emission Speciation for Mud Degassing table. Methane and ethane are not considered to be VOCs.

### *Pneumatic Pumps and Pressure Level Controllers*

VOC emissions are estimated based on the throughput reported on the EMISSIONS sheets and the Default Sales Gas Composition table. The VOC component of the sales gas includes C<sub>3</sub> through C<sub>8+</sub>.

## **VESSEL FACTORS**

The VESSEL FACTORS sheet was added in 2015 to accommodate revised emission factors for vessels and drilling rigs. Emissions from support helicopters need not be quantified. The emission factors are provided by engine category. The emission factors were obtained from the following sources: e-mail communications with the USEPA regarding data from USEPA's regulatory program; NEI 2011 documentation (USEPA 2014b); and USEPA's Federal Marine Compression-Ignition (CI) Engines -- Exhaust Emission Standards (USEPA 2012).

The emission factors are presented relative to USEPA marine compression engine categories which are presented in Table 2. The categories are defined relative to displacement volume (in liters) of a single cylinder.

Table 2. USEPA Categories for Compression Ignition Marine Engines

USEPA Category	Propulsion Engine Displacement per Cylinder (liters)
C1	Less than 5
C2	Equal to 5, less than 20
C3	Equal to or greater than 20

It is appreciated that detailed information about the fleet of vessels that will be needed for the construction project may not be available at the time that the construction permit is being submitted; the emission factors presented here may be an overestimation of vessel characteristics and emissions providing a worst case estimate. This overestimation of emissions ensures that once construction is implemented activities will not be limited due to assumptions about vessel characteristics and emissions made in the construction application.

For use in the Alaska OCS, separate emission factors are provided for on-ice equipment based on the onroad diesel fuel emissions factors. These emissions are calculated in a separate section in the EMISSIONS sheets.

The VESSEL FACTORS sheet also includes a lookup table for the adjustment factors for operating loads less than 20%. Formulas in the EMISSIONS sheet reference these tables automatically if the engine load is indicated to be less than 21%. Any changes to the adjustment factors in this tab will affect all vessel calculations.

One additional piece of information necessary to calculate the SO<sub>2</sub> emission factors for vessels is the sulfur content in the fuel. The fuel sulfur content needs to be entered in a separate table in the VESSEL FACTORS sheet. The recommended default for vessel fuel sulfur content for projects implemented 2012, the default is 15 ppm.

## **VESSEL KW RATINGS**

The VESSEL KW RATINGS sheet was added in 2015 to provide a lookup of the default kW ratings of vessels for emission calculations. The default kW ratings are based off vessel type and were compiled from the IHS Marine Vessel Dataset (IHS 2014) and emission estimates compiled for the BOEM (ERG 2012). However, the EMISSIONS sheets have the capability to accept a custom kilowatt rating, if the vessel kilowatt is known. Please see the instructions on the EMISSIONS sheets from more details.

## **METHODOLOGY**

The METHODOLOGY sheet was added in 2015 to show the formulas used to estimate emissions on the EMISSIONS sheets.

## **EMISSIONS**

The emissions from an operation should be presented for a calendar year (2015, 2016, etc.). The operation may include production only or production in conjunction with other activities such as drilling or construction operations. For additional years, the EMISSIONS sheets are renamed EMISSIONS\_2, EMISSIONS\_3, etc. The sheets are designed to auto-populate all the equipment entered in the previous year. The different operating parameters for each year should be entered to calculate revised emissions for that year. The emissions will be calculated as shown on the METHODOLOGY sheet for each equipment type.

There are drop-down lists in the columns labeled Equipment/Vessel Type, Engine Type, Category, and Units to describe each specific vessel or piece of equipment. To customize the spreadsheet for your application, it is possible to delete lines for non-applicable equipment/activities or copy/insert an entire line if more than one similar type of equipment is present. **If you add or delete rows, you should confirm that the correct cells are being referenced from the STATIONARY FACTORS and VESSEL FACTORS sheets.** If you used alternate emission factors, you should confirm that the calculation methodology is correct for your alternate factors. If you add rows, it is recommended you insert a blank row within the appropriate operation section and copy a row with comparable calculations. This will ensure that the appropriate formulas and emissions factor tables are used, as well as SUMMARY sheet calculations are preserved.

The production equipment can be customized further by adding the use of the equipment behind the equipment type name in the "EQUIPMENT Category" field in column C. For example, "TURBINE" could be changed to "TURBINE – Gas Compressor;" or "HEATER/BOILER/BURNER" could be changed to "HEATER/BOILER/BURNER - Line Heater."

For 2015, the ability to enter a vessel's engine load factor has been incorporated into the spreadsheet. If no engine load factor is entered for a vessel, the calculation assumes 100% load for Auxiliary engines and 82% load for Main engines based on values entered for Engine Type (column E). The formulas also allow for either default power rating for vessels or custom values in the activity column. The default values for the various vessels types are provided in the VESSEL kW RATINGS sheet. If the Engine Type column (E) indicates a custom kilowatt rating, and none is supplied in the ACTIVITY column (H) the emissions calculations will produce an error message of "Enter Activity".

The Estimated Duration fields, Start Date and End Date, should be populated for each row. These fields are used to estimate maximum rolling monthly total emissions. The dates are limited to the calendar year associated with the EMISSIONS year, which is indicated just above the estimated duration column. Failing to enter a start year on the title page will result in an error message when entering dates. If the End Date is prior to the Start Date, the End Date cell will turn red to indicate the error.

Simple error checking has been added to the sheet to ensure all necessary values are included for the calculations. Please review the columns for MAXIMUM POUNDS PER HOUR and ESTIMATED TONS PER YEAR to ensure there are no error messages for active rows.

## **SUMMARY**

The SUMMARY sheet is designed to show a proposed estimate of emissions from an activity over a ten year period. The first line (Row 7) of the summary sheet is linked to the yearly totals in the EMISSIONS\_1 sheet; the second line (Row 8) is linked to the EMISSIONS\_2 sheet, etc. If additional years of calculations

are necessary to reach a constant, then a spreadsheet can be copied and linked to the SUMMARY sheet for future years. Once emissions are constant, the values are carried to the end of the ten year period.

In 2015, additional summary tables were added to the SUMMARY sheet to show maximum monthly emissions, maximum hourly emissions, maximum 3-hour emissions, maximum 8-hour emissions, and maximum 24-hour emissions. The SUMMARY tab also includes the maximum emissions from any 12-month period.

## **REFERENCES**

Eastern Research Group, Inc. (ERG). 2012. Updated Eastern Planning Area Spreadsheet. U.S. DOI, BOEM, Gulf of Mexico Region.

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