

**MEMORANDUM**

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**SUBJECT**: Summary of Analysis of 2017 GHGRP Subpart W Data for Use in the 2017 NEI Nonpoint Oil and Gas Emission Estimation Tool

The purpose of this memo is to summarize an analysis of 2017 reporting year (2017RY) Greenhouse Gas Reporting Program (GHGRP) Subpart W data that may be used to inform the 2017 NEI Nonpoint Oil and Gas Emissions Estimation Tool (Tool). Data used in this analysis was obtained from EPA’s Envirofacts website (https://www3.epa.gov/enviro/index.html).

**2017RY Subpart W Data**

The 2017RY Subpart W data represents:

* 497 facilities,
* 39 basins,
* 1,466 sub-basins (county + formation type), and
* 489,055 wells.

Under Subpart W, there are 5 sub-basin formation types, so there are potentially 5 sub-basins for any single county. Well counts for 2017 are reported for each county + formation type combination. The sub-basin formation types are:

* Coal seam,
* High permeability gas,
* Oil,
* Shale gas, and
* Other tight reservoir rock.

To complete the data analysis for application in the Tool, facility-level well count data was developed for each well type. To accomplish this, each of the 5 sub-basin formation types was assigned as “oil”, “gas”, or “coalbed methane”. The “Other tight reservoir rock” sub-basin formation type was assigned to either “oil” or “gas” based on the gas-to-oil ratio of the county as found in the 2017 NEI version of the Tool, using a threshold of 100,000 cubic feet of gas per barrel of oil to distinguish between oil and gas. This analysis resulted in 6 sub-basin formation types:

* Coal seam (coalbed methane),
* High permeability gas (gas)
* Oil (oil),
* Other tight reservoir rock – gas (gas),
* Other tight reservoir rock – oil (oil), and
* Shale gas (gas).

Using these designations, facility well counts were summed for oil, gas, and coalbed methane wells based on the well counts reported for each sub-basin (county + formation type) for each facility.

The well assignment methodology has been improved since the 2014 Subpart W analysis was conducted as well counts at the sub-basin level were not available in 2014. For 2014, facility level well counts for each well type were allocated in proportion to the distribution of sub-basin types for that facility. For example, if a facility had 100 wells and two sub-basins, it was assumed that the 100 wells were represented equally between each sub-basin, so, 50 wells were assigned to each sub-basin.

**2017 NEI Tool**

Subpart W data was determined to be useful in application of the Tool for 8 source categories:

* Associated gas venting and flaring,
* Condensate tanks,
* Crude oil tanks,
* Dehydrators,
* Fugitives,
* Heaters,
* Pneumatic devices, and
* Wellhead Compressor Engines

Within these 8 source categories, there are 31 data elements used in the Tool that may be informed using the Subpart W data. These data elements are listed in the table below.

| **Source Category** | **Data Element** |
| --- | --- |
| Associated Gas | ASSOC\_GAS\_FRACTION\_VENTS\_CONT |
| Condensate Tanks | COND\_TANK\_FLARE\_FRACTION |
| Condensate Tanks | COND\_TANK\_VRU\_FRACTION |
| Crude Oil Tanks | OIL\_TANK\_FLARE\_FRACTION |
| Crude Oil Tanks | OIL\_TANK\_VRU\_FRACTION |
| Dehydrators | DEHYD\_NUM\_PER\_WELL |
| Fugitives | FUG\_CONN\_GAS |
| Fugitives | FUG\_CONN\_HO |
| Fugitives | FUG\_CONN\_LO |
| Fugitives | FUG\_FLANGES\_HO |
| Fugitives | FUG\_FLANGES\_LO |
| Fugitives | FUG\_OEL\_GAS |
| Fugitives | FUG\_OEL\_HO |
| Fugitives | FUG\_OEL\_LO |
| Fugitives | FUG\_OTHERS\_HO |
| Fugitives | FUG\_OTHERS\_LO |
| Fugitives | FUG\_PUMP\_SEALS\_LO |
| Fugitives | FUG\_VALVES\_GAS |
| Fugitives | FUG\_VALVES\_HO |
| Fugitives | FUG\_VALVES\_LO |
| Heaters | HEATERS\_NUM\_TYPICAL |
| Pneumatic Devices | PNEUMATIC\_CBM\_WELL\_HIGH\_BLEED\_NUM\_DEV |
| Pneumatic Devices | PNEUMATIC\_CBM\_WELL\_INTERM\_BLEED\_NUM\_DEV |
| Pneumatic Devices | PNEUMATIC\_CBM\_WELL\_LOW\_BLEED\_NUM\_DEV |
| Pneumatic Devices | PNEUMATIC\_GAS\_WELL\_HIGH\_BLEED\_NUM\_DEV |
| Pneumatic Devices | PNEUMATIC\_GAS\_WELL\_INTERM\_BLEED\_NUM\_DEV |
| Pneumatic Devices | PNEUMATIC\_GAS\_WELL\_LOW\_BLEED\_NUM\_DEV |
| Pneumatic Devices | PNEUMATIC\_OIL\_WELL\_HIGH\_BLEED\_NUM\_DEV |
| Pneumatic Devices | PNEUMATIC\_OIL\_WELL\_INTERM\_BLEED\_NUM\_DEV |
| Pneumatic Devices | PNEUMATIC\_OIL\_WELL\_LOW\_BLEED\_NUM\_DEV |
| Wellhead Compressor Engines | WELLHEAD\_FRACTION\_GASWELLS\_NEED\_COMPRESSION |

The analysis conducted for each of these 8 source categories is described below, including key assumptions and findings for each category.

**Associated Gas Venting and Flaring**

Associated gas venting and flaring refers to the practice of venting associated gas from oil wells which may occur when the well is not connected to a gas sales pipeline or when the amount of gas produced by the well is so limited that is not profitable for capture. In some areas of the country, this gas may be flared.

Data for this category was obtained from the “EF\_W\_ASSOCIATED\_NG\_UNITS” Envirofacts table. Under Subpart W, facilities are required to report the number of wells venting directly to the atmosphere as well as the number of wells flaring associated gas. These well counts were used as a surrogate to estimate the percentage of production flared in each basin. As a result of this analysis, it was determined that for companies reporting associated gas venting, approximately 25% of their wells are controlled by flaring, with a range of 0% (multiple basins) to 100% (North Park Basin). These figures compare to a default average of 8.7% used in the 2014 Tool.

Basin average associated gas flaring percentages may be found in Attachment A, including the county level basin assignments and the value used for each county in the 2014 Tool. Details on the analysis for associated gas venting and flaring may be found in Attachment B.

**Condensate and Crude Oil Tanks**

Condensate and crude oil tanks are used at well pads to store condensate and crude oil prior to being trucked off-site for processing.

Data for this category was obtained from the “EF\_W\_ATM\_STG\_TANKS\_CALC1OR2” Envirofacts table. Under Subpart W, facilities are required to report production and tank control data (flaring and vapor recovery) on a sub-basin (county) level for Calculation Methods 1 and 2.

Data reported under Calculation Method 3 (used for wells and separators with oil throughput <10 barrels/day) was not further evaluated in this analysis as it was reported at the basin level and production type (condensate or crude oil) could not easily be determined. Production reported under Method 3 accounts for approximately 25% of total liquids production reported for storage tanks under Subpart W. A cursory evaluation of this data shows an overall liquids control value for flaring similar to that reported under Methods 1 and 2 (~70%), and a slightly lower liquids control value using vapor recovery of ~11%, as compared to ~21% reported under Methods 1 and 2.

For this analysis, liquids produced in “gas” sub-basin formations (determined as described above) was assumed to be condensate, and liquids produced in “oil” sub-basin formations was assumed to be crude oil. This methodology is consistent with how activity data is used in the Tool.

Using production and control characterization data, basin average condensate tank flaring percentages were calculated for 31 basins with a national average of 81% and a range of 0% (multiple basins) to 100% (multiple basins). These figures compare to a default average of 68.8% used in the 2014 Tool. The estimated national average vapor recovery factor for condensate tanks was 4%, with a range of 0% to 53%. Vapor recovery was not considered in the 2014 version of the Tool, so no comparison to previous values are available.

Using production and control characterization data, basin average crude oil tank flaring percentages were calculated for 31 basins with a national average of 70% and a range of 0% (multiple basins) to 100% (multiple basins). These figures compare to a default average of 52.8% used in the 2014 Tool. The estimated national average vapor recovery factor for crude oil tanks was 16%, with a range of 0% to 100%. Vapor recovery was not considered in the 2014 version of the Tool, so no comparison to previous values are available.

Basin average condensate and crude oil tank flaring and vapor recovery percentages may be found in Attachment A, including the county level basin assignments and the flaring control value used for each county in the 2014 Tool. Details on the analysis for condensate and crude oil storage tanks may be found in Attachment C.

**Dehydrators**

Dehydrator units are used to remove excess water from produced natural gas prior to delivery to the pipeline or to a gas processing plant. The prevalence of dehydrators (dehydrators per well) is used in the Tool to estimate emissions from the reboilers, which are used to heat the spent glycol to drive off the water which has been removed from the gas stream. Data for this category was obtained from the “EF\_W\_EQUIP\_LEAKS\_ONSHORE” Envirofacts table. Only data for the “Onshore petroleum and natural gas production” sector has been used in this analysis. Subpart W data for dehydrators was not evaluated for the 2014 Tool.

Under Subpart W, facilities are required to report the number of wells and the number of dehydrators for each facility. Therefore, dehydrator per well counts are available at the facility level, and that data has been aggregated up to the basin level to estimate basin average dehydrator per well counts. As a result of this analysis, it was determined that nationally there is an average of 0.02 dehydrator per well, with a range of 0 (multiple basins) to 0.72 (Central Western Overthrust Basin). These figures compare to a default average of 1 dehydrator per well used in the 2014 Tool.

Basin average dehydrator per well counts may be found in Attachment A, including the county level basin assignments and the value used for each county in the 2014 Tool. Details on the analysis for dehydrators may be found in Attachment D.

**Fugitives**

This source category refers to emissions generated by leaking components such as connectors, flanges, open-ended lines, valves, and compressor wet seals. Data for this category was obtained from the “EF\_W\_EQUIP\_LEAKS\_ONSHORE” Envirofacts table. Only data for the “Onshore petroleum and natural gas production” sector has been used in this analysis. Subpart W data for fugitive components was not evaluated for the 2014 Tool.

Under Subpart W, facilities are required to report the number of wells and the number of components (by component type) for each facility. Using this information, component counts per well are available at the facility level, and that data has been aggregated up to the basin level to estimate basin average components (by component type) per well counts. Using this methodology, data is available for 14 different component types.

Data provided for the “Pressure relief valves - Gas Service” (PRV) component type has been combined with data for the “Valves - Gas Service” component type as the Tool does not currently accommodate the PRV component type. While the Subpart W emission factor for PRV is approximately 50% greater than the emission factor for valves, there are significantly more valves reported than PRVs (~13,000,000 valves and ~600,000 PRVs) so the impact on the emission estimate is not expected to be significant.

There were no data available in Subpart W for “Flanges – Gas Service”. Therefore, existing legacy data in the Tool for this component type has been deleted.

Basin average components per well counts may be found in Attachment A, including the county level basin assignments and the value used for each county in the 2014 Tool. Details on the analysis for fugitives may be found in Attachment E.

**Heaters**

Heaters may be used at well pads to provide heat input to separators (separator heaters or heater treaters), to prevent the formation of hydrates during pressure reductions (line heaters), or to provide heat to tanks (tank heaters).

Data for this category was obtained from the “EF\_W\_COMBUST\_SMALL\_UNITS” Envirofacts table. Under Subpart W, unit counts are reported separately for units under 5 MMBtu/hr and for units over 5 MMBtu/hr. Given the size of the heaters category used in the Tool (national average of 0.64 MMBtu/hr with a maximum of 1.3 MMBtu/hr), the larger units reported under Subpart W were not evaluated further.

Using facility well counts and heater counts, a default value of 0.37 heaters per well was calculated, with a range of 0 (Ouachita Folded Belt) to 1.84 (Central Western Overthrust). These figures compare to a default value of 0.36 heaters per well used in the 2014 Tool.

Basin average heater per well counts may be found in Attachment A, including the county level basin assignments and the value used for each county in the 2011 Tool. Details on the analysis for heaters may be found in Attachment F.

**Pneumatic Devices**

Pneumatic devices use high-pressure produced gas to produce mechanical motion. These devices are typically under operation throughout the year and they may or may not vent the working fluid during operation.

Data for this category was obtained from the “EF\_W\_NGPNEUMATIC\_PMP\_UNITS” Envirofacts table. Under Subpart W, facilities are required to report counts of low-bleed, high-bleed, and intermittent-bleed devices. Well counts by well type (oil, gas, coalbed methane) are available for each facility from the “EF\_W\_FACILITY\_OVERVIEW” table, allowing for an estimate of the average device counts per well for each basin for each well type (oil, gas, and coalbed methane). For example, if a facility had 100 low-bleed devices and 1 oil well and 1 gas well, 50 low-bleed devices were assigned to oil wells, and 50 low-bleed devices were assigned to gas wells.

Using this methodology, it was determined that oil wells have an average of 1.57 pneumatic devices per well (compared to 1.34 devices per well used as a default value in the 2014 Tool), gas wells have an average of 1.77 pneumatic devices per well (compared to 1.78 devices per well used as a default value in the 2014 Tool), and coalbed methane wells have an average of 2.06 pneumatic devices per well (compared to 2.46 devices per well used as a default value in the 2014 Tool).

Basin average pneumatic device counts may be found in Attachment A, including the county level basin assignments and the value used for each county in the 2014 Tool. Details on the analysis for pneumatic devices may be found in Attachment G.

**Wellhead Compressor Engines**

Wellhead compressor engines are generally small natural-gas fired engines located at the well site and used to boost produced gas pressure from downhole pressure to the required pressure for delivery to a transmissions pipeline. The prevalence of these engines (engines per well) is used in the Tool to estimate emissions. Data for this category was obtained from the “EF\_W\_EQUIP\_LEAKS\_ONSHORE” Envirofacts table. Only data for the “Onshore petroleum and natural gas production” sector has been used in this analysis.

Under Subpart W, facilities are required to report the number of wells and the number of compressors for each facility. Therefore, compressors per well counts are available at the facility level, and that data has been aggregated up to the basin level to estimate basin average compressor per well counts. As a result of this analysis, it was determined that nationally there is an average of 0.076 compressors per well, with a range of 0 (multiple basins) to 1.17 (Sedgwick Basin). These figures compare to a default average of 0.078 (compressors/well) used in the 2014 Tool.

Basin average compressor per well counts may be found in Attachment A, including the county level basin assignments and the value used for each county in the 2014 Tool. Details on the analysis for compressors may be found in Attachment H.

**Attachment A – “2017 NEI Oil and Gas Tool Subpart W Analysis - Summary Results.xlsx”**

**Attachment B – “2017 NEI Oil and Gas Tool Subpart W Analysis - Associated Gas Venting and Flaring.xlsx”**

**Attachment C – “2017 NEI Oil and Gas Tool Subpart W Analysis - Storage Tanks.xlsx”**

**Attachment D – “2017 NEI Oil and Gas Tool Subpart W Analysis - Dehydrators.xlsx”**

**Attachment E – “2017 NEI Oil and Gas Tool Subpart W Analysis - Fugitives.xlsx”**

**Attachment F – “2017 NEI Oil and Gas Tool Subpart W Analysis - Heaters.xlsx”**

**Attachment G – “2017 NEI Oil and Gas Tool Subpart W Analysis - Pneumatics.xlsx”**

**Attachment H – “2017 NEI Oil and Gas Tool Subpart W Analysis – Wellhead Compressor Engines.xlsx”**