



2020 National Emissions Inventory Technical Support Document: Oil and Gas Exploration and Production

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2020 National Emissions Inventory Technical Support Document: Oil and Gas Exploration and
Production

U.S. Environmental Protection Agency
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13 Oil and Gas Exploration and Production

13.1 Sector Descriptions and Overview

This sector includes processes associated with the exploration and drilling at oil, gas, and coal bed methane (CBM) wells and the equipment used at the well sites to extract the product from the well and deliver it to a central collection point or processing facility.

Table 13-1 lists the processes below with their corresponding SCCs; the SCCs used by EPA to estimate nonpoint emissions are marked in second column. Note also that the SCCs in this list are only the SCCs that either the EPA used or the submitting State agencies used in this NEI. All of the SCCs that the EPA oil and gas tool uses are nonpoint SCCs. Lastly, Y marked with an asterisk (Y*) denote SCCs that are produced by the tool, but only for the state of Pennsylvania, by special request.

Table 13-1: Point and Nonpoint SCCs used for the Oil and Gas Production Sector

Data Category	EPA uses	SCC	SCC Description (Abbreviated)
Nonpoint	Y	2310000220	All Processes; Drill Rigs
Nonpoint		2310000230	All Processes; Workover Rigs
Nonpoint	Y	2310000551	All Processes; Produced Water from CBM Wells
Nonpoint	Y	2310000552	All Processes; Produced Water from Gas Wells
Nonpoint	Y	2310000553	All Processes; Produced Water from Oil Wells
Nonpoint	Y	2310000660	All Processes; Hydraulic Fracturing Engines
Nonpoint		2310001000	All Processes: On-shore; Total: All Processes
Nonpoint		2310002000	Off-Shore Oil and Gas Production; Total: All Processes
Nonpoint		2310002401	Off-Shore Oil and Gas Production; Pneumatic Pumps: Gas And Oil Wells
Nonpoint		2310002411	Off-Shore Oil and Gas Production; Pressure/Level Controllers
Nonpoint		2310002421	Off-Shore Oil and Gas Production; Cold Vents
Nonpoint	Y	2310010100	Crude Petroleum; Oil Well Heaters
Nonpoint	Y	2310010200	Crude Petroleum; Oil Well Tanks - Flashing & Standing /Working /Breathing
Nonpoint	Y	2310010300	Crude Petroleum; Oil Well Pneumatic Devices
Nonpoint		2310010700	Crude Petroleum; Oil Well Fugitives
Nonpoint	Y	2310011001	On-Shore Oil Production; Associated Gas Venting
Nonpoint		2310011020	On-Shore Oil Production; Storage Tanks: Crude Oil
Nonpoint		2310011100	On-Shore Oil Production; Heater Treater
Nonpoint	Y	2310011201	On-Shore Oil Production; Tank Truck/Railcar Loading: Crude Oil
Nonpoint		2310011450	On-Shore Oil Production; Wellhead
Nonpoint		2310011500	On-Shore Oil Production; Fugitives: All Processes
Nonpoint	Y	2310011501	On-Shore Oil Production; Fugitives: Connectors
Nonpoint	Y	2310011502	On-Shore Oil Production; Fugitives: Flanges

Nonpoint	Y	2310011503	On-Shore Oil Production; Fugitives: Open Ended Lines
Nonpoint		2310011504	On-Shore Oil Production; Fugitives: Pumps
Nonpoint	Y	2310011505	On-Shore Oil Production; Fugitives: Valves
Nonpoint		2310011506	On-Shore Oil Production; Fugitives: Other
Nonpoint	Y	2310011600	On-Shore Oil Production; Artificial Lift Engines
Nonpoint		2310012000	Off-Shore Oil Production; Total: All Processes
Nonpoint		2310012020	Off-Shore Oil Production; Storage Tanks: Crude Oil
Nonpoint		2310012516	Off-Shore Oil Production; Fugitives, Other: Oil
Nonpoint		2310012526	Off-Shore Oil Production; Fugitives, Other: Oil/Water
Nonpoint	Y*	2310020600	Natural Gas; Compressor Engines
Nonpoint	Y	2310021010	On-Shore Gas Production; Storage Tanks: Condensate
Nonpoint		2310021011	On-Shore Gas Production; Condensate Tank Flaring
Nonpoint	Y	2310021030	On-Shore Gas Production; Tank Truck/Railcar Loading: Condensate
Nonpoint	Y	2310021100	On-Shore Gas Production; Gas Well Heaters
Nonpoint		2310021101	On-Shore Gas Production; Natural Gas Fired 2Cycle Lean Burn Compressor Engines < 50 HP
Nonpoint	Y	2310021102	On-Shore Gas Production; Natural Gas Fired 2Cycle Lean Burn Compressor Engines 50 To 499 HP
Nonpoint		2310021103	On-Shore Gas Production; Natural Gas Fired 2Cycle Lean Burn Compressor Engines 500+ HP
Nonpoint		2310021109	On-Shore Gas Production; Total: All Natural Gas Fired 2Cycle Lean Burn Compressor Engines
Nonpoint		2310021201	On-Shore Gas Production; Natural Gas Fired 4Cycle Lean Burn Compressor Engines <50 HP
Nonpoint	Y	2310021202	On-Shore Gas Production; Natural Gas Fired 4Cycle Lean Burn Compressor Engines 50 To 499 HP
Nonpoint		2310021203	On-Shore Gas Production; Natural Gas Fired 4Cycle Lean Burn Compressor Engines 500+ HP
Nonpoint		2310021209	On-Shore Gas Production; Total: All Natural Gas Fired 4Cycle Lean Burn Compressor Engines
Nonpoint	Y	2310021251	On-Shore Gas Production; Lateral Compressors 4 Cycle Lean Burn
Nonpoint	Y	2310021300	On-Shore Gas Production; Gas Well Pneumatic Devices
Nonpoint		2310021301	On-Shore Gas Production; Natural Gas Fired 4Cycle Rich Burn Compressor Engines <50 HP
Nonpoint	Y	2310021302	On-Shore Gas Production; Natural Gas Fired 4Cycle Rich Burn Compressor Engines 50 To 499 HP
Nonpoint		2310021303	On-Shore Gas Production; Natural Gas Fired 4Cycle Rich Burn Compressor Engines 500+ HP
Nonpoint		2310021309	On-Shore Gas Production; Total: All Natural Gas Fired 4Cycle Rich Burn Compressor Engines
Nonpoint	Y	2310021310	On-Shore Gas Production; Gas Well Pneumatic Pumps
Nonpoint	Y	2310021351	On-Shore Gas Production; Lateral Compressors 4 Cycle Rich Burn
Nonpoint	Y	2310021400	On-Shore Gas Production; Gas Well Dehydrators

Nonpoint		2310021401	On-Shore Gas Production; Nat Gas Fired 4Cycle Rich Burn Compressor Engines <50 HP w/NSCR
Nonpoint		2310021402	On-Shore Gas Production; Nat Gas Fired 4Cycle Rich Burn Compressor Engines 50 To 499 HP w/NSCR
Nonpoint		2310021403	On-Shore Gas Production; Nat Gas Fired 4Cycle Rich Burn Compressor Engines 500+ HP w/NSCR
Nonpoint		2310021412	On-Shore Gas Production; Gas Well Dehydrators/Reboiler
Nonpoint		2310021450	On-Shore Gas Production; Wellhead
Nonpoint	Y	2310021500	On-Shore Gas Production; Gas Well Completion - Flaring
Nonpoint	Y	2310021501	On-Shore Gas Production; Fugitives: Connectors
Nonpoint	Y	2310021502	On-Shore Gas Production; Fugitives: Flanges
Nonpoint	Y	2310021503	On-Shore Gas Production; Fugitives: Open Ended Lines
Nonpoint		2310021504	On-Shore Gas Production; Fugitives: Pumps
Nonpoint	Y	2310021505	On-Shore Gas Production; Fugitives: Valves
Nonpoint	Y	2310021506	On-Shore Gas Production; Fugitives: Other
Nonpoint		2310021509	On-Shore Gas Production; Fugitives: All Processes
Nonpoint		2310021600	On-Shore Gas Production; Gas Well Venting
Nonpoint		2310021602	On-Shore Gas Production; Gas Well Venting - Recompletions
Nonpoint	Y	2310021603	On-Shore Gas Production; Gas Well Venting - Blowdowns
Nonpoint		2310021700	On-Shore Gas Production; Miscellaneous Engines
Nonpoint	Y	2310021801	On-Shore Gas Production; Pipeline Blowdowns and Pigging
Nonpoint		2310021802	On-Shore Gas Production; Pipeline Leaks
Nonpoint		2310021803	On-Shore Gas Production; Midstream gas venting for maintenance, startup, shutdown, or malfunction
Nonpoint		2310022000	Off-Shore Gas Production; Total: All Processes
Nonpoint		2310022010	Off-Shore Gas Production; Storage Tanks: Condensate
Nonpoint		2310022051	Off-Shore Gas Production; Turbines: Natural Gas
Nonpoint		2310022090	Off-Shore Gas Production; Boilers/Heaters: Natural Gas
Nonpoint		2310022105	Off-Shore Gas Production; Diesel Engines
Nonpoint		2310022300	Off-Shore Gas Production; Compressor Engines: 4Cycle Rich
Nonpoint		2310022420	Off-Shore Gas Production; Dehydrator
Nonpoint		2310022506	Off-Shore Gas Production; Fugitives, Other: Gas
Nonpoint	Y	2310023000	Coal Bed Methane Natural Gas; Dewatering Pump Engines
Nonpoint	Y	2310023010	Coal Bed Methane Natural Gas; Storage Tanks: Condensate
Nonpoint	Y	2310023030	Coal Bed Methane Natural Gas; Tank Truck/Railcar Loading: Condensate
Nonpoint	Y	2310023100	Coal Bed Methane Natural Gas; CBM Well Heaters
Nonpoint	Y	2310023102	Coal Bed Methane Natural Gas; CBM Fired 2Cycle Lean Burn Compressor Engines 50 To 499 HP
Nonpoint	Y	2310023202	Coal Bed Methane Natural Gas; CBM Fired 4Cycle Lean Burn Compressor Engines 50 To 499 HP
Nonpoint	Y	2310023251	Coal Bed Methane Natural Gas; Lateral Compressors 4 Cycle Lean Burn

Nonpoint	Y	2310023300	Coal Bed Methane Natural Gas; Pneumatic Devices
Nonpoint	Y	2310023302	Coal Bed Methane Natural Gas; CBM Fired 4Cycle Rich Burn Compressor Engines 50 To 499 HP
Nonpoint	Y	2310023310	Coal Bed Methane Natural Gas; Pneumatic Pumps
Nonpoint	Y	2310023351	Coal Bed Methane Natural Gas; Lateral Compressors 4 Cycle Rich Burn
Nonpoint	Y	2310023400	Coal Bed Methane Natural Gas; Dehydrators
Nonpoint		2310023401	Coal Bed Methane Natural Gas; Dehydrators/Reboiler
Nonpoint		2310023509	Coal Bed Methane Natural Gas; Fugitives
Nonpoint	Y	2310023511	Coal Bed Methane Natural Gas; Fugitives: Connectors
Nonpoint	Y	2310023512	Coal Bed Methane Natural Gas; Fugitives: Flanges
Nonpoint	Y	2310023513	Coal Bed Methane Natural Gas; Fugitives: Open Ended Lines
Nonpoint	Y	2310023515	Coal Bed Methane Natural Gas; Fugitives: Valves
Nonpoint	Y	2310023516	Coal Bed Methane Natural Gas; Fugitives: Other
Nonpoint	Y	2310023600	Coal Bed Methane Natural Gas; CBM Well Completion: All Processes
Nonpoint	Y	2310023603	Coal Bed Methane Natural Gas; CBM Well Venting - Blowdowns
Nonpoint	Y	2310023606	Coal Bed Methane Natural Gas; Mud Degassing
Nonpoint		2310030220	Natural Gas Liquids: Gas Well Tanks - Flashing & Standing/Working/Breathing, Controlled
Nonpoint		2310030300	Natural Gas Liquids; Gas Well Water Tank Losses
Nonpoint		2310030400	Natural Gas Liquids; Truck Loading
Nonpoint	Y	2310111100	On-Shore Oil Exploration; Mud Degassing
Nonpoint	Y	2310111401	On-Shore Oil Exploration; Oil Well Pneumatic Pumps
Nonpoint	Y	2310111700	On-Shore Oil Exploration; Oil Well Completion: All Processes
Nonpoint		2310111701	On-Shore Oil Exploration; Oil Well Completion: Flaring
Nonpoint		2310112401	Off-Shore Oil Exploration; Oil Well Pneumatic Pumps
Nonpoint	Y	2310121100	On-Shore Gas Exploration; Mud Degassing
Nonpoint	Y	2310121401	On-Shore Gas Exploration; Gas Well Pneumatic Pumps
Nonpoint	Y	2310121700	On-Shore Gas Exploration; Gas Well Completion: All Processes
Nonpoint		2310122000	Off-Shore Gas Exploration; All Processes
Nonpoint	Y*	2310300220	All Processes - Conventional; Drill Rigs
Nonpoint	Y*	2310321010	On-Shore Gas Production - Conventional; Storage Tanks: Condensate
Nonpoint	Y*	2310321100	On-Shore Gas Production - Conventional; Gas Well Heaters
Nonpoint	Y*	2310321400	On-Shore Gas Production - Conventional; Gas Well Dehydrators
Nonpoint	Y*	2310321603	On-Shore Gas Production - Conventional; Gas Well Venting - Blowdowns
Nonpoint	Y*	2310400220	All Processes - Unconventional; Drill Rigs
Nonpoint	Y*	2310421010	On-Shore Gas Production - Unconventional; Storage Tanks: Condensate
Nonpoint	Y*	2310421100	On-Shore Gas Production - Unconventional; Gas Well Heaters

Table 13-2: Data Source for Oil and Gas Production Data in the 2020 NEI

State	Nonpoint	Point
AL	EPA estimates only	Submitted to Point Inventory
AK	EPA estimates and SLT	Submitted to Point Inventory
Allegheny		Submitted to Point Inventory
AZ	EPA estimates only	Submitted to Point Inventory
AR	EPA estimates only	Submitted to Point Inventory
CA	SLT only	Submitted to Point Inventory
CO	EPA estimates and SLT	Submitted to Point Inventory
CT		Submitted to Point Inventory
DE		Submitted to Point Inventory
FL	EPA estimates only	Submitted to Point Inventory
GA		Submitted to Point Inventory
ID	EPA estimates only	
IL	EPA estimates only	Submitted to Point Inventory
IA		Submitted to Point Inventory
IN	EPA estimates only	Submitted to Point Inventory
Jefferson City		Submitted to Point Inventory
KS	EPA Tool with revised inputs	Submitted to Point Inventory
KY	EPA estimates only	Submitted to Point Inventory
Louisville	EPA estimates only	Submitted to Point Inventory
LA	EPA estimates only	Submitted to Point Inventory
MA		Submitted to Point Inventory
MD	EPA estimates only	Submitted to Point Inventory
ME		Submitted to Point Inventory
Memphis		Submitted to Point Inventory
MI	EPA estimates only	Submitted to Point Inventory
MN		Submitted to Point Inventory
MS	EPA estimates only	Submitted to Point Inventory
MO	EPA estimates only	Submitted to Point Inventory
MT	EPA estimates only	Submitted to Point Inventory
Nashville		Submitted to Point Inventory
NE	EPA estimates only	Submitted to Point Inventory
NJ	SLT only	Submitted to Point Inventory
NV	EPA estimates only	Submitted to Point Inventory
NM	EPA Tool with revised inputs	Submitted to Point Inventory
NY	EPA estimates only	Submitted to Point Inventory
ND	EPA estimates only	Submitted to Point Inventory
OH	EPA estimates and SLT	Submitted to Point Inventory
OK	EPA Tool with revised inputs and SLT	Submitted to Point Inventory
OR	EPA estimates only	Submitted to Point Inventory
Omaha		Submitted to Point Inventory
PA	EPA Tool with revised inputs	Submitted to Point Inventory

Pinal		Submitted to Point Inventory
SC		Submitted to Point Inventory
SD	EPA estimates only	
TN	EPA estimates only	Submitted to Point Inventory
TX	EPA Tool with revised inputs and SLT	Submitted to Point Inventory
UT	EPA Tool and SLT	Submitted to Point Inventory
VA	EPA estimates only	Submitted to Point Inventory
WV	EPA Tool with revised inputs and SLT	Submitted to Point Inventory
WI		Submitted to Point Inventory
WY	SLT only	Submitted to Point Inventory
Shoshone Bannock		Submitted to Point Inventory
Southern Ute	SLT only	Submitted to Point Inventory

13.3 EPA-developed estimates

The EPA furthered the development of the existing oil and gas emissions estimation tool that was originally developed for the 2011 NEI, which is a MS Access database that uses a bottom-up approach to build a national inventory. More information on the tool can be found in the documentation provided by ERG, entitled “2020 Nonpoint Oil and Gas Emission Estimation Tool, version 1.3” in the file [“2020 Oil and Gas Emissions Estimation Tool V1 3.pdf”](#). There are two modules, as was put in place since the 2014 tool: Exploration and Production. Changes that have been incorporated in the 2020 Oil and Gas [Production](#) and [Exploration](#) tools since 2017 are addressed in the documentation above. In addition, a memo outlining the additional data from the GHG Reporting Program (subpart W) is entitled [2020 NEI Oil and Gas Tool Subpart W Analysis](#).

In general, the tool calculates emissions for each piece of equipment on a well pad (like condensate tanks or dehydrators, for example) in a county or basin, based on average equipment counts taken from either surveys, literature searches, or the GHG reporting program, also accounting for control devices and gas composition in each county. County-level details are important, since well pads can vary significantly from region to region, basin to basin, and county to county. A well site in Denver, CO in the Denver-Julesburg Basin might look very different from one in the Marcellus Shale in PA, due to changes in technology over time (when the well was first drilled), geologic formations of the oil and gas reservoirs themselves (which also change over time—the ratio of oil to gas changes as pressure in the reservoir is released), and regulations in place guiding the equipment used on site.

The math used in the oil and gas tool is more complex than most other categories, as it uses equations like the ideal gas law and mass balances, in conjunction with more traditional emission rate equations (activity * EF = emissions); thus, the work is best completed in database format. Overall, there are hundreds of inputs to the oil and gas tool, and these are broken down into three basic categories: activity data, basin factors, and emission factors. These inputs to the tool are filled in by EPA, and published with the tool, along with their references. Region specific inputs are preferable and are used when available. Extrapolated inputs from nearby counties in the same basin are then used to fill in gaps in data. National defaults are filled in where no other data is available, and attempts are made to align inputs as much as possible with the GHG reporting program and emissions inventory.

13.3.1 Activity data

The primary source of activity data for the 2020 Tool is the commercially available database developed by Enverus called HPDI, or also called the DI Desktop database. HPDI supplies activity such as number of wells, oil, gas, condensate, and water production, feet drilled, spud counts, and other data. There are cases where this data is not complete, and in those cases, EPA supplemented with data from RIGDATA, from various state oil and gas commissions, and directly from Tool users. More details on these data can be found in the [aforementioned report](#). The following SLTs provided updated activity inputs for the 2020 Tool:

- Kansas (Production)
- Oklahoma (Production)
- Pennsylvania (Production)
- Texas (Production)
- Illinois (Production)
- West Virginia (Production/Exploration).
-

13.3.2 FIPS changes and Temperature changes

State/County FIPS codes were updated for several counties in Alaska and annual county-level average temperatures for 2020 were updated nationally, using EPA's 2020 Weather Research Factorization (WRF) model data.

13.3.3 Basin factors

Basin factors include factors that are secondary to activity and include assumptions about equipment counts on a per well basis, (e.g., the number of pneumatic controllers per well, or the average HP of an engine at a well site) as well as gas speciation profiles (fraction of benzene, toluene, xylene, or ethylbenzene in natural gas at a particular point in the well pad, e.g., post separator).

For 2020 inputs, GHGRP data gathered under subpart W was analyzed to develop updated basin factors for several source categories including storage tanks, dehydrators, fugitive equipment leaks, heaters, pneumatic devices, and wellhead compressor engines. See "[2020 NEI Tool Subpart W Data Analysis](#)" memo dated December 3, 2021.

Western Regional Air Partnership (WRAP) data was used to develop updated basin factors for several source categories for Montana, New Mexico, North Dakota, and South Dakota. Details of the emissions factor, speciation factor and other changes for some WRAP basins are contained in memos and documents provided here:

https://gaftp.epa.gov/Air/nei/2020/doc/supporting_data/nonpoint/oilgas/WRAP_survey/.

Data provided by the California Air Resources Board (CARB) was used to develop updated basin factors for several source categories for oil-related sources. US Energy Information Administration (EIA) data was used to update the volumes of gas vented/flared in the associated gas venting and flaring category, and this data can be found at the following link:

https://www.eia.gov/dnav/ng/ng_prod_sum_a_EPG0_VGV_mmcf_a.htm).

13.3.4 Emission factors

Emission factors are also a part of the formula for estimating emissions, and in the Oil and Gas tool the nomenclature is set such that we only call the standard national factors, like from AP-42 combustion equations, “emission factors.”

For the 2020 Tool, the following emissions factor updates occurred:

1. Drilling and hydraulic fracturing engine emission factors were updated using the MOVES model for 2020.
2. The flaring CO emission factor was updated based on updates to the AP-42.
3. A SO₂ emission factor from AP-42 was added for heater treaters.

13.3.5 Methodology Updates

The methodology used to estimate VOC emissions from associated gas venting and flaring was revised to include only process-based emissions (accounting for VOC sent to the flare). The tool no longer uses the AP-42 flaring VOC emission factor in the calculation.

13.3.6 Point source subtraction

Some states count upstream oil and gas production processes as point sources, and therefore have a need to subtract these from the nonpoint part of the inventory. The tool allows for point source subtraction on either an activity or emissions basis, and a few states have taken advantage of this feature.

The state of New Mexico added a considerable number of sources to their oil and gas point source inventory in the NEI. New Mexico provided a county-SCC summary of emissions for use in the Tool as part of the point source subtraction functionality. Updated nonpoint emissions were generated for New Mexico after this point source subtraction and were used in the 2020NEI.

13.3.7 Other State-specific correspondence

Oklahoma

The Oklahoma Department of Environmental Quality (OK DEQ) uses a mix of both EPA estimates (for the exploration module) and their own emissions using the oil and gas tool (production module only). OK DEQ allows EPA to do HAP augmentation for the SCCs that they submit. One difference between OK DEQ’s SCC emissions dataset and EPA’s SCCs are that OK DEQ aggregates their equipment-specific fugitive emissions into Fugitive All Process SCCs for oil, gas and CBM wells.

Pennsylvania

The PADEP relies on EPA to run the oil and gas tool but utilizes alternative SCCs for several source categories in order to differentiate their emissions for conventional and unconventional oil and gas operations. PA DEP provides unconventional well API numbers which EPA then subtracts from the tool to determine the conventional portion. The process includes the following steps:

1. Run the tool with basin factors that the Mid-Atlantic Regional Air Management Association (MARAMA) provided for the 2014 NEI oil and gas sector for
 - Artificial lifts

- Associated gas
- Condensate tanks
- Crude tanks
- Dehydrators
- Fugitives
- Gas-actuated pumps (oil and gas wells)
-

For associated gas, condensate tanks, crude oil tanks, and dehydrators, if the Tool sources were the 2020 GHGRP factors recently documented, these were not replaced. EPA also incorporated gas composition profiles provided by the PA DEP.

2. Remove the activity data related to the emissions data provided by PA using API numbers for unconventional wells.
3. Run the tool for adjusted emissions.
4. Use the “conventional only” SCCs to replace the more “general” Tool SCCs for 5 source categories:
 - Drilling
 - Gas Well Condensate Tanks
 - Gas Well Heaters
 - Gas Well Dehydrators
 - Gas Well Liquids Unloading

Details regarding the Pennsylvania emissions can be found here:

https://gaftp.epa.gov/Air/nei/2020/doc/supporting_data/nonpoint/oilgas/OIL_GAS_TOOL_v1.3/PA_2020_EMISSIONS_20220801.xlsx

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