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Comments on "Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012"

Environmental Defense Fund (EDF) appreciates the opportunity to submit technical comments on the draft report *Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2012* (Draft 2014 Inventory). EDF has focused its review and comments on the Natural Gas Systems and Petroleum Systems source categories.

EDF supports the United States Environmental Protection Agency's (EPA) efforts to improve the accuracy and transparency of the methods used to estimate greenhouse gas emissions from Natural Gas Systems and Petroleum Systems. In general, we support the changes introduced in the Draft 2014 Inventory, but we have several suggestions for further enhancement. Finally, we provide suggestions for improvements in methods for estimating emissions from Natural Gas Systems gas well completions and workovers with hydraulic fracturing, Petroleum Systems oil well completions and workovers, Natural Gas Systems pneumatic devices, and Natural Gas Systems production sector equipment leaks.

Natural Gas Systems gas well completions and workovers with hydraulic fracturing

EDF supports EPA's approach for estimating methane emissions from hydraulically fractured gas well completions and workovers using data available through the Greenhouse Gas Reporting Program (GHGRP). Estimating net emissions for four categories of completion/workover events (Hydraulic Fracturing Completions and Workovers that vent, Flared Hydraulic Fracturing Completions and Workovers, Hydraulic Fracturing Completions and Workovers with RECs, Hydraulic Fracturing Completions and Workovers with RECs that flare) will improve the transparency and accuracy of emission estimates compared to the previous method of estimating potential emissions and voluntary and regulatory emission reductions.

The GHGRP Subpart W data format is not ideal for disaggregating natural gas well completions and workovers into the four categories and only allows two-thirds of the reported events to be used to develop emission factors. However, EPA's new approach for developing emission factors is a reasonable method considering the limitations of the data format. EPA should consider revising the GHGRP to increase the utility of the data for the GHG Inventory. Enhanced GHGRP data that would be useful for a more complete analysis include disaggregated totals for the following activities: total number of gas well completions, completions with venting, completions with REC, completions with flaring, and completions with RECs and flaring; total number of workovers, workovers with venting, workovers with RECs, workovers with flaring, and workovers with RECs and flaring; methane emissions from completions with venting,

completions with RECs, completions with flaring, completions with RECs and flaring; and methane emissions from workovers with venting, workovers with RECs, workovers with flaring, and workovers with RECs and flaring. This enhanced data may also provide insights into the performance of the NSPS OOOO requirement for use of RECs as of January 1, 2015.

Completion and workover event counts based on GHGRP data underestimate the total number of national events since events from companies below the GHGRP reporting threshold are excluded. As mentioned in the Planned Improvements section, EPA's previous method of estimating the national event count of completions with hydraulic fracturing based on analysis of DrillingInfo DI Desktop data results in lower event counts than the GHGRP, indicating that the method underestimates the number of completions with hydraulic fracturing. EPA should revise their DI Desktop analysis to more accurately determine the national count of completions with hydraulic fracturing, which then could be used to derive the national event counts by completion category by disaggregating the national total count by completion category proportionally to the fraction of each category in the GHGRP.

Estimating completion and workovers categories for previous years should be based on reasonable assumptions rather than a linear increase in emission controls from 1990 to 2011. As stated in the Planned Improvements section, Natural Gas STAR data and state regulation implementation dates can be used to estimate trends in emission controls prior to 2011; it is unlikely that control practices were employed in significant numbers prior to the reporting of RECs in the early part of the 2000s. Additionally, the total number of completions and workovers with hydraulic fracturing prior to 2011 likely will be underestimated if based on the current analysis of DI Desktop data. As mentioned in the previous paragraph, the DI Desktop analysis should be revised to more accurately identify completions with hydraulic fracturing.

The accuracy of the proposed approach also depends on the accuracy of GHGRP emission estimates. The GHGRP Subpart W equations for estimating completion and workover emissions (Equations W-10a, W-10b, W-11a, W-11b, W-11c, & W-12) should be assessed with empirical data and updated if necessary. Since the calculation methods rely on different equations and number of flow rate measurements, the accuracy of emissions data may depend on calculation method. Comparing emission factors by calculation method may reveal if any methods are biased low or high. One potentially useful data source is Allen, et al. (2013), which includes data in Appendix H comparing measured completion flowback methane emissions to emission estimates based on GHGRP Subpart W Equation W-11B.

<u>Petroleum Systems oil well completions and workovers</u>

EPA should update the Petroleum Systems methods for estimating emissions from completions and workovers to account for oil well completions and workovers with hydraulic fracturing. The Draft 2014 Inventory uses emission factors based on data from conventional oil wells completed without hydraulic fracturing. These emission factors are very low: 733 scf CH_4 /completion (0.014 Mg CH_4 / event) and 96 scf CH_4 / workover (0.002 Mg CH_4 / event). New oil

wells increasingly are being completed with hydraulic fracturing and likely have higher emissions per event than the current emission factors. FracFocus, the national hydraulic fracturing chemical registry managed by the Ground Water Protection Council and Interstate Oil and Gas Compact Commission, includes records from 12,056 oil wells that were hydraulically fractured in 2012. Reporting to FracFocus is voluntary in many states, which implies that at least 75% of the 15,753 oil well completions reported in the Draft 2014 Inventory were hydraulically fractured.

GHGRP Subpart W does not require reporting of oil well completion and workovers emissions, but there are 1,754 gas well completion and workover events reported from oil formation type sub-basins in 2011 and 2012. Using the same approach that EPA used to derive gas well completion and workover emission factors from the GHGRP dataset, EDF has derived emission factors from the subset of 2011 and 2012 GHGRP data from oil formation type sub-basins (Table 1). The average emission factor for all completions and workovers in oil formation type sub-basins is 6.2 Mg CH_4 / event, over 400 times higher than the current oil well completion emission factor. The emission factors for the four categories range from 3.6 Mg CH_4 / event for completions and workovers with RECs to 17.3 Mg CH_4 / event for vented completions and workovers. Applying these emission factors to the 2012 activity data of 15,753 oil well completions results in emission estimates between 57 and 273 Gg CH_4, or 163 Gg CH_4 if the 15,753 oil well completions are disaggregated by completion category proportionally to the fraction of each category in the GHGRP oil formation type data subset. It is unclear if the emissions source Petroleum Systems workovers refers to refractures, but if so, then applying the GHGRP oil formation type emission factors to the 2012 activity data of 40,200 oil well workovers results in emissions between 145 and 696 Gg CH_4. These emission estimates for oil well completions and workovers with hydraulic fracturing are similar in magnitude to the 217 Gg CH_4 from gas well completions and workovers with hydraulic fracturing, which highlights the importance of revising the methods for these emission sources.

Other data sources support increasing the emission factors for oil well completions and workovers by at least two orders of magnitude. Allen, et al. (2013) measured emissions from 27 well completion flowbacks, including 6 wells that co-produced gas and hydrocarbon liquids (Table 2). The completion emissions from these co-producing wells ranged from 1.7 to 5.0 Gg CH_4 / event. All the co-producing wells controlled completion flowback emissions with either flaring or a combination of RECs and flaring. The potential emissions from these wells, which are more indicative of vented completions, ranged from 81.9 to 414.1 Gg CH_4 / event. Additionally, EDF has estimated potential emissions from oil well completions in the Eagle Ford and Wattenberg fields by analyzing DI Desktop production data from over 5,000 oil wells with initial production dates between 2010 and 2012. Assuming uncontrolled completion emissions are equal to 3 days of initial gas production with a methane content of 78.8%, uncontrolled completion emissions are estimated to average 9.7 Mg CH_4 / event in the Wattenberg and 24.7 Mg CH_4 / event in the Eagle Ford.

EDF recommends that EPA revise the Draft 2014 Inventory Petroleum Systems category by replacing the current well completion venting and well workover emission sources with the

following sources: oil well completions with hydraulic fracturing, oil well completions without hydraulic fracturing, oil well workovers with hydraulic fracturing, and oil well workovers without hydraulic fracturing. The emission factors for oil well completions and workovers with hydraulic fracturing should be based on recent data such as the subset of GHGRP data from oil formation type sub-basins, which indicates much higher emissions per event than the current emission factors. The activity data for oil well completions with and without hydraulic fracturing can be estimated from DI Desktop data using a similar analysis as used for gas wells. If EPA is unable to revise the 2014 Inventory in time for publication, then they should commit to including the revisions in the 2015 Inventory.

Table 1. Oil well completion and workover emission factors derived from the subset of 2011 & 2012 GHGRP Subpart W data in oil formation type sub-basins using the same method as EPA for deriving the natural gas well completion and workover emission factors

Category	Completions (# events)	Workovers (# events)	Completions & Workovers (# events)	Completions EF (Mg CH4 / event)	Workovers EF (Mg CH_4 / event)	Completion & Workover EF (Mg CH_4 / event)
Vent	320	147	467	21.8	7.6	17.3
Flare	221	66	287	3.7	2.5	3.4
REC	162	0	186	3.6	N/A	3.6
REC+Flare	17	0	17	11.7	N/A	11.7
Ambiguous	732	89	821	1.1	0.0	1.0
All events	**1,452**	**302**	**1,754**	**6.6**	**4.2**	**6.2**

Table 2. Measured and potential emissions of co-producing wells completions from Allen, et al. (2013)

Completion Event	Emission Controls	Measured Emissions (scf CH_4)	Potential Emissions (scf CH_4)	Measured Emissions (Mg CH_4)	Potential Emissions (Mg CH_4)
GC-1	Flaring	105,000	5,005,000	2.0	96.4
GC-2	Flaring	90,000	4,250,000	1.7	81.9
GC-3	REC & Flaring	260,000	21,500,000	5.0	414.1
GC-4	REC & Flaring	180,000	13,000,000	3.5	250.4
GC-6	Flaring	247,000	12,200,000	4.8	235.0
GC-7	Flaring	90,000	4,320,000	1.7	83.2
Average		**162,000**	**10,030,000**	**3.1**	**193.5**

Natural Gas Systems pneumatic devices

EPA should consider revising its method for estimating emissions from Natural Gas Systems pneumatic devices. The current method estimates potential emissions with pneumatic device emission factors and emission reductions from Natural Gas STAR data on the conversion of high-bleed and intermittent-bleed devices to low-bleed or no-bleed devices. Allen, et al. (2013) suggests that this method may significantly underestimate actual emissions. Pneumatic device emission factors should be updated with empirical data from recent and forthcoming studies, including Allen, et al. (2013), the UT Production Study Phase 2, and the 2013 British Columbia pneumatic device study.

A more accurate and transparent approach would be to estimate net emissions for multiple types of pneumatic devices (e.g., high-bleed, intermittent-bleed, and low-bleed). The GHGRP Subpart W requirement to report the number of devices has been deferred until 2015, but GHGRP will be a future source of activity data on pneumatic devices by type. Prior to the availability of the deferred data, pneumatic device counts by type can be estimated from GHGRP emissions data by assuming default natural gas composition and operating hours and back calculating with Equation W-1. If EPA does use GHGRP data to estimate the national number of pneumatic devices, then they should adjust the value upwards to account for pneumatic devices at facilities operated by non-reporting companies. One possible adjustment method is to use DI Desktop data to estimate the number of wells or production by basin and company, determine the fraction of wells or production in each basin from non-reporting companies, then scale up the GHGRP pneumatic device counts in each basin with the fraction of non-reporting wells or production.

Natural Gas Systems production sector equipment leaks

Allen, et al. (2013) reported that 2011 national equipment leak emissions were 38% to 69% higher than estimated by the 2013 Inventory. Allen, et al. (2013) also reported observed emission factors for equipment leaks that were comparable to EPA's estimate of *potential* emissions for similar equipment types. However, Allen, et al. (2013) was unable to directly compare equipment leak emission estimates with EPA because the Inventory does not report equipment leak net emissions. To estimate EPA equipment leak net emissions, Allen, et al. (2013) aggregated potential emissions from gas wells without HF, gas wells with HF, separators, meters/pipe, heaters, and dehydrators, reduced by the fraction of unallocated production sector voluntary emission reductions proportionally to each source's fraction of potential emissions. EPA can improve the transparency of the Inventory by clearly indicating the quantity of voluntary emission reductions that apply to each emission source. Additionally, EPA should clarify how Natural Gas STAR emission reductions are quantified for equipment leaks. These clarifications will allow a comparison of Inventory emission factors with empirical data from recent studies such as Allen, et al. (2013) and the Fort Worth Study, which may indicate that the current EPA emission factors should be revised.

Thank you for the opportunity to submit technical comments on the Draft 2014 Inventory. Please feel welcome to contact me if you have any questions.

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