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Richard Hyde, Executive Director

November 10, 2017

Samantha Dravis
Senior Counsel/Associate Administrator

Mandy Gunasekara
Senior Policy Advisor
U.S. Environmental Protection Agency
1200 Pennsylvania Ave., NW
Washington, DC 20460

RE: The U.S. Environmental Protection Agency's Natural Gas STAR Methane Challenge Program.

Dear Ms. Dravis and Gunasekara:

On behalf of Our Nation's Energy Future Coalition, Inc. (ONE Future), I appreciate your time and interest in visiting with our representatives on October 19, 2017. As discussed during our meeting, One Future members strongly believe that natural gas will have a foundational role in the US and global economy throughout this century. One Future views the EPA's support for the Methane Challenge program, especially the ONE Future Methane Intensity option as a key component to ensure prudent development of natural gas. One future respectfully requests the EPA's continued support in developing the necessary tools based on sound science to enable ONE Future companies to transparently estimate and report their emission performance.

ONE Future's flexible and performance-based approach to the management of methane emissions begins with the establishment of an ambitious goal: by the year 2025, our member companies aim to achieve an average annual methane emission intensity rate across our collective operations of 1% and if applied across the entire natural gas value chain, this voluntary initiative could result in about 52 million tons of methane reductions (as carbon dioxide equivalents or CO_{2e}). "Emission intensity" refers exclusively to the average methane (CH_4) emission rate over total methane throughput (as reported to the U.S. Energy Information Administration) in a given system.

The goal, grants individual companies the flexibility to choose precisely how they can most cost-effectively and efficiently achieve their goal – whether by deploying an innovative technology, modifying a work practice, or in some cases, replacing a high-emitting asset with a low-emitting asset. ONE Future member companies believe strongly that the flexible, performance-based approach we have proposed will accomplish deeper emission reductions among participants at a lower cost than a one-size-fits-all mandatory program. The essential aspect of our program is that companies transparently demonstrate progress toward their emission intensity goal. To that extent, the EPA finalized the ONE Future Methane

Intensity option in 2016[1] and developed specific technical accounting mechanisms to ensure transparent accounting and reporting of methane emissions[2].

We understand that the EPA is working on developing the necessary methane estimation functionality that will be available in the Methane Challenge Module of e-GGRT. We request that the necessary tool be available for testing at the earliest opportunity. In addition, we request three improvements in the current ONE Future Methane Intensity option under Methane Challenge:

1. We recommend EPA improve the incentives to participate in the program;
2. We urge EPA to focus on the results and refrain from collecting non-pertinent information from ONE Future Methane Challenge partners in an effort to differentiate voluntary actions from other commercial or regulatory actions; and
3. ONE Future encourages EPA to allow the *option to* use direct measurements

Below, for your consideration, are ONE Future's detailed comments and recommendations on these areas. ONE Future believes that this innovative EPA-ONE Future collaboration can serve as a template to address future challenges. We appreciate the agency's efforts and we are grateful for the thoughtful and professional constructive engagement that the EPA staff has displayed throughout our interactions over the past year. Thank you for your consideration.

Sincerely,

Richard Hyde
Executive Director,
ONE Future Coalition

[1] https://www.epa.gov/natural-gas-star-program/methane-challenge-program
[2] https://www.epa.gov/sites/production/files/2016-08/documents/methanechallenge_one_future_supp_tech_info.pdf

TABLE OF CONTENTS

Recommendations for Establishing the Conditions that will Incentivize Early Action to Reduce Methane Emissions

Voluntary programs such as the Methane Challenge have the potential to achieve greater emission reductions at lower cost to both industry and consumers than regulatory actions if the appropriate incentives are in place to encourage robust industry participation. Voluntary programs enable companies to apply innovative technologies without regulatory approvals. The EPA Gas STAR has already demonstrated 1.2 trillion cubic feet of methane reductions and has played a large part in over 16% reduction in methane emissions while gross US production of gas has increased by 35%.

While the EPA plans its actions on existing and future methane regulatory policies, EPA can improve the Methane Challenge program to provide incentives to companies to undertake early action to eliminate emissions could avoid a company's exposure to costly prescriptive regulations in the future, or conversely, whether taking early action might actually disadvantage a company with respect to competitors who deferred action.

Utilizing cooperative interagency structures already in place, such as the Interagency Working Group to Support Safe and Responsible Development of Unconventional Domestic Natural Gas Resources, the Administration should consider linking emission reductions achieved under the Methane Challenge with expedited processing of permits and regulatory actions for related activities on federal lands, and streamlined National Environmental Policy Act reviews. Additionally, we encourage EPA to consider providing expedited review for New Source Review (NSR) permit applications submitted by participants in the Methane Challenge that commit to and demonstrate a level of performance consistent with the ONE Future program's commitments.

For ONE Future Methane Challenge participants, we encourage EPA to consider establishing criteria for the elimination or mitigation of civil penalties that result from minor enforcement actions brought under CAA Section 113(b). EPA has (for different reasons) established such criteria for certain small businesses, but in this case we suggest that a company's commitment to make ambitious voluntary methane reductions should be considered a mitigating factor for minor enforcement actions.

Alternatively, EPA could consider the Methane Challenge program as a Supplemental Environmental Project (SEP) that an unaffiliated settling party could consider in lieu of penalties under an enforcement action. The EPA's SEP Policy is designed to encourage environmental benefits beyond existing regulations, and is consistent with the design of the Methane Challenge program.

We urge the EPA to refrain from collecting information from ONE Future Methane Challenge partners in an effort to differentiate voluntary actions from mandated actions

EPA requires that reporting of voluntary emissions reductions (absolute emissions) and qualitative description of voluntary actions (Figures 1 and 2) from ONE Future partners for all applicable emission sources at their facilities. We believe this requirement is cumbersome, unnecessary and not pertinent to a performance-based design. The ONE Future design requires transparent reporting from all facilities (regardless of the reporting threshold under EPA's Greenhouse Gas Reporting Program (GHGRP)) and has been streamlined with the GHGRP to minimize reporting burdens. Our progress should be measured by the extent to which we achieve our methane leakage goals rather than how many voluntary reductions we achieved in one year.

The ONE Future partners will report both absolute methane emissions and methane intensities of their assets annually. EPA and the public can easily see the year to year changes in emissions profile and compare the results to our goals. While the need to demonstrate the volume of methane reductions from applying a work practice or technology at a portion of their facilities may be important for a technology-based design (like the EPA's Best Management Practice option under the Methane Challenge Program or EPA Gas STAR), it is unwarranted in the ONE Future design.

In addition, recent experiences in the Oil and Gas Methane Partnership (OGMP)[3] highlights the perils of such request. In the first year of reporting (2016), the only U.S. company in the program, Southwestern Energy (also a founding member of ONE Future) reported 98% of the total reductions. Similar 98% reductions were reported by Southwestern Energy in 2017, although there were two additional reporters.

As noted throughout, the ONE Future approach was built around identifying a robust, scientifically-determined performance target that is consistent with optimal performance. Even in the unlikely event that a company was to achieve and sustain such a level of performance exclusively by adhering to State and federal mandates, the outcome -- optimal performance – is what matters.

[3] http://ccacoalition.org/en/content/oil-and-gas-methane-partnership-reporting

ONE Future's one percent goal was adopted before EPA finalized the OOOOa rule and Control Techniques Guidelines guidance. The fact that EPA or a State might subsequently mandate some portion of emission reductions through regulation does not diminish the commitment by ONE Future. Even for companies that commit to ONE Future *after* the promulgation of regulations, it is reasonable for EPA to conclude as a matter of policy that the ONE Future commitment is sufficiently ambitious without requiring further reductions to account for regulatory mandates.

We therefore request the EPA to remove the need to breakdown our emissions report to qualitatively and quantitatively document the voluntary reductions.

We encourage the EPA to allow the option to use direct measurements in our emissions quantification under the ONE Future emissions intensity option

The ONE Future coalition is committed to working with EPA to help improve both the quantity and quality of emissions data. To this end we believe it is imperative that Methane Challenge participants be both permitted and encouraged to utilize updated emission factors that are based on the latest science or on representative surveys that utilize direct measurements. Although it is important that the Methane Challenge program avoid conflicting with, or unnecessarily overlapping the Greenhouse Gas Reporting Program (GHGRP), companies must have the flexibility to develop customized emission factors that are based on direct measurements employing generally acceptable protocols.

ONE Future has always advocated for and been explicit about the need to be transparent about our emission estimation calculations and/or measurement methodologies. We have offered multiple recommendations on outlines of a consistent technical protocol that would govern the direct measurement at a site and incorporation of data into the Methane Challenge reports (See Attachment A). These recommendations were aimed also to address EPA staff concern related to potential conflicts between the data reported under GHGRP using default factors versus direct measurements.

We believe that it is important that EPA incorporate the following principles that allow ONE Future partners the option to employ direct measurements:

1. EPA will support the increased use of rigorously collected measured data to quantify and report methane emissions, if the data are measured, collected and tabulated according to EPA-approved protocols and/or peer-reviewed methodologies employed in studies upon which current EPA emission factors are based.[4]

2. For some sources that do not have measurement protocols in the GHGRP, EPA will consider developing such protocols to enable the use of consistent, comparable measurement methods by Methane Challenge partners. EPA anticipates that such protocols, which would be subject to EPA approval, will be comparable to those employed in a variety of recent peer-reviewed studies and will include processes for expert review and input.

[4] EPA has employed the emission factors generated by the Marchese et al; Subramanian et al., and Zimmerle et al.; Lamb et al. studies in the 2016 Greenhouse Gas Inventory.

ONE Future will commit to working with EPA staff in developing these protocols.

Figure 1: Reporting Requirements for Centrifugal Compressors

Emission Source	Data Elements Collected via Facility-Level Reporting	GHGRP
Centrifugal compressors with wet seal oil degassing vents	Number of centrifugal compressors with wet seal oil degassing vents	X
	Annual CH_4 emissions (mt CH_4)	X
Centrifugal compressors with dry seals	Number of centrifugal compressors with dry seals	
	Annual CH_4 emissions (mt CH_4)	
Voluntary action to reduce methane emissions during the reporting year[40]	Number of compressors routed to vapor recovery units	
	Number of compressors routed to flare	
	Number of compressors where source emissions are captured for fuel use or routed to a thermal oxidizer	
	Number of compressors utilizing other emissions control technique (specify emissions control methodology)	
	Methodology used to quantify reductions	
	Emission reductions from voluntary action (mt CH_4)	

Figure 2: Reporting Requirements for Equipment Leaks

Emission Source	Data Elements Collected via Facility-Level Reporting	GHGRP
Equipment Leaks [production][69]	Count of each emission source type	X
	Count of each major equipment type	X
	Annual CH_4 emissions (mt CH_4)	X
Equipment Leaks [gathering & boosting][70]	Count of each emission source type	X
	Count of each major equipment type	X
	Annual CH_4 emissions (mt CH_4)	X
Equipment Leaks [processing]	Number of each surveyed component type identified as leaking	X
	Annual CH_4 emissions (mt CH_4)	X
Equipment Leaks [transmission compression]	Number of each surveyed component type identified as leaking	X
	Annual CH_4 emissions (mt CH_4)	X
Equipment Leaks [storage]	Number of each surveyed component type identified as leaking (storage station components in gas service)	X
	Count of each emission source type (storage wellhead components in gas service)	X
	Annual CH_4 emissions (mt CH_4)	X
Equipment Leaks [LNG storage]	Number of each surveyed component type identified as leaking (LNG storage components in LNG service)	X
	Count of vapor recovery compressors	X
	Annual CH_4 emissions (mt CH_4)	X
Equipment Leaks [LNG import export]	Number of each surveyed component type identified as leaking (LNG terminals components in LNG service)	X
	Count of vapor recovery compressors	X
	Annual CH_4 emissions (mt CH_4)	X
Voluntary action to reduce methane emissions during the reporting year[71]	Mitigation actions implemented to reduce methane emissions (list)	
	Emission reductions from voluntary action (mt CH_4)	

APPENDIX A – Use of Direct Measurements for Methane Challenge ONE Future Option

1. INTRODUCTION

The purpose of this document is to share with U.S. Environmental Protection Agency (EPA) the expected measurement methodologies that the ONE Future members intend to use for specific emission sources. This document provides the available vetted measurement techniques and applicable measurement protocols that apply to each measurement approach.

While Subpart W methodologies incorporate direct measurements for some emission sources, for many sources default emission factors are employed. Under the ONE Future Methane Intensity Option, companies have the flexibility to utilize company specific emission measurements as detailed in Section 3 below. These may include the following:

1. Use of "actual counts" instead of population counts;

For example, on fugitive components, Subpart W allows actual counts to be used in place of population component counts based on major equipment counts.

2. Use of company-specific "leaker" or company emission measurements for emission sources generated by direct measurements. Companies can use such company- specific leaker factors to achieve the following:
    a. Revise "default" emission factors to company-specific leaker factors. For example, company specific emission factors to replace default Subpart W pneumatic controller emission rates;
    b. Revisions in emission factors based on a specific action by a company (i.e. reduction technology, work practice standard). For example, a company that conducts a corporate-wide Leak Detection and Repair (LDAR) program has the ***option*** to also conduct emissions measurements (e.g. Hi Flow Sampler measurements) as part of their leak detection program and to use these measurements to generate leaker emission factors specific to the company's operations.

2. LIST OF EMISSION SOURCES

Table 1 provides the list of emission sources where direct measurements may be employed to update a company's emission rates, rather than using default emission factors that EPA provides in Subpart W of the GHGRP or EPA's National GHG Inventory (GHGI). Measured differences may be due to the unique characteristics of company equipment, or may be due to a specific work practice or emissions reduction technology. The table includes data that addresses the following elements:

- What: Emission source being addressed by a type of direct measurement
- Where: Industry Segment that includes the corresponding emission source
- Why: A description of and reasons for collecting emission measurement data using the direct measurement type for the respective emission source.
- How: Currently available measurement technique(s) & tool(s) and example(s) of measurement protocol(s) that utilize the measurement technique(s)

Table 1. Direct Measurement Source Categories [1]

Source (What)	Segment (Where)	Emission Measurement Data (Why)	Available Measurement Techniques (How)	MethaneChallengeONEFuture Option MeasurementProtocols (How)
Equipment Leak Fugitives	Production, Gathering &Boosting, Processing, Transmission & Storage, and Distribution	Use of company-specific emission measurements for emission sources generated by direct measurements[2]: -Emissions developed as result of a company specific voluntary measurement, DI&M or LDAR program -Emissions measured where regulations already require LDAR (see NSPS or existing state regulations)	Method 21, [in accordance with 98.234(a)(2)]	Method 21
			OGI with additional quantification OGI examples: • FLIR GF320 camera • OptGAL EyeCgas camera • Heath RMLD • Rebellion Photonic GCI Quantification examples: • Bacharach HiFlow • Providence Photonics Q-OGI tablet • Rebellion Photonic GCI+ post processing quantification	OGI Scan + EPA leaker emission Factors (EF) • (EPA OGI Document, allowed use in NSPS OOOO, and potentially under a future NSPS OOOOa 98.234(a)(1) OGI Scan + Measured emission rates for leakers • Independent National Studies by EDF • HiFlow protocols by manufacturer (and as outlined in EDF/Univ of Texas Phase 1 study) • Gas Cloud Imaging (GCI) operators protocol • Q-OGI protocols by Providence Photonics

[1] Additional sources or new measurement methods may be considered in the future and the Methane Challenge program will have a separate review process prior to use of any such methods or existing methods on other emission sources.

[2] U.S. Environmental Protection Agency's (EPA) proposed Greenhouse Gas Reporting Rule: Leak Detection Methodology Revisions and Confidentiality

Determinations for Petroleum and Natural Gas Systems, 81 Fed. Reg. 4987 (Jan. 29, 2016). ONE Future had submitted comments to the docket (Docket ID No. EPA–HQ–OAR–2015–0764) and urged the EPA to allow companies to employ company-specific measurements to generate emission factors that are more representative for their operations. We expect the EPA will finalize these rules soon and should the rules adopt ONE Future's recommendations, the same could be employed in the Methane Challenge Program.

Source (What)	Segment (Where)	Emission Measurement Data (Why)	Available Measurement Techniques (How)	MethaneChallengeONEFuture Option MeasurementProtocols (How)
			Distribution pipelines - Measurements with HiFlow and spectroscopy technology	GTI Pipeline Leak Studies using flux chambers EDF WSU Studies using flux chambers
			Meters: Measurements with HiFlow and spectroscopy technology	EDF WSU Studies
Compressor Component Fugitives (where directed to a vent pipe)	Production, Gathering & Boosting and select compressor component fugitives in the Processing & Transmission & Storage sectors that are not already required to be measured under the GHGRP.	Same as above	Calibrated Bags	Use the same GHGRP Subpart W methods for other segment measurements (instead of default national EFs from production and boosting) Other examples: University of Texas study for EPA, EDF Studies in T&S
			HiFlow Sampler	
			Inserted anemometer in pipe	
			External stack and meter	
			Acoustic Device	
			Heath RMLD (Infrared laser beam illuminated instrument)	
Pneumatic Control Devices	Production, Gathering &Boosting, Processing, Transmission & Storage, and Distribution	Company specific measurements over default generic national emission factors Company specific program to perform LDAR on controllers	Upstream Supply Gas Flow Measurement	University of Texas and EDF Study, Phase 2
			Ambient Air Emission Measurement (HiFlow)	Prasino Canadian Study, and University of Texas and EDF Study, Phase 2
			Hiflow or Modified HiFlow Measurement	*Ongoing API Measurement Study and new API Pneumatics protocol*

Source (What)	Segment (Where)	Emission Measurement Data (Why)	Available Measurement Techniques (How)	MethaneChallengeONEFuture Option MeasurementProtocols (How)
Production Tanks (Flash gas and other gas released from atmospheric tank vents on uncontrolled tanks)	Production, Gathering & Boosting	Company measured data beyond modelling and permit data used for GHGRP Company specific LDAR program that addresses abnormal emissions from tank vents	External stack and meter	Fort Worth Study UniversityofTexas andEDFPhase2 tanks measurements
			HiFlow (may be combined with OGI for screening)	University of Texas EDF Phase 1
			Downwind Measurements, then calculated to emission rate (Tracer, or OTM-33A)	*DOE RPSEA Study (pending)* OTM-33A

3. PROTOCOLS

A direct measurement initiative will usually be a one-time effort to obtain representative samples adequate to characterize the company system being sampled and therefore suitable to represent the system for future years. However, a company may have a recurring measurement program, and as a result could have many years of data, with potential updates each year. Examples of such recurring measurement programs could be logged event data that allowed engineering estimates of blowdowns each year, or perhaps a program that annually detects and repairs leaks (and possibly quantifies them) through a DI&M or LDAR program. Using consistent protocols across all ONE Future participants allows for transparent tracking of the results and sharing best practices.

3.1 General Principles

The following general scientific principles must be applied to any direct measurement technique:

1. A written sampling plan that includes
   a. Breadth of sampling, selection of measurement sites,
   b. Quality Control, such as specifying selected instruments, calibration frequency for instruments,
   c. Data management, and quality checks and verifications
2. A technical review of results by experts, such as the ONE Future Technical Team (not simply by the collector of the data)
3. Documentation of results and reporting.

The following sections expand upon these three key elements.

3.2 Sampling Plans

Sampling plans are established as both a communication tool for all parties affected by the work, and as a documented basis for the science about to be performed. As a communication tool, it serves to make sure the entire field measurement team is coordinated, as well as the sites participating in the measurements. It also serves as a level of transparency for outside reviewers, allowing them to review the plan. Sampling plans must technically describe the source to be measured, and describe the approach to be used to establish the measurement. This includes the instrumentation to be used, the goals and guidelines for the measurements, and the objectives.

One of the most important steps in preparing a sampling plan is determining the breadth and scope of the sampling. In most cases for a selected target source, a subset sample must be taken, because it is not possible to measure all sources continuously all year. There may be a large population of sources, and continuous measurements on all sources are often prohibitively complex and expensive. Sampling is therefore often performed on a subset of all sources for a limited period of time. The sampling plan must outline how the subset will be selected in order to minimize the potential for bias in source selection. Examples of bias would include sampling only the lowest or highest emitting sources, or sampling a non-representative subset. The plan must describe the total population of sources, and must outline any known or expected differences in certain populations that would affect emissions. Samples must be drawn from each of these important population subsets.

Ideally, the number of measurements in each subset must be large enough to perform elementary statistical analysis. While it is not possible to state herein a minimum number of samples required, certainly multiple samples are required for each population category represented.

Finally, the sampling plan should describe how data will be collected and compiled. Data sheets may even be developed in the sampling plan. The data management portion of the sampling plan should outline the quality cross checks that will be performed, such as ordinary cross checks on calculations performed on the data.

The sampling plan must also include quality control and quality assurance items. Examples are the calibration plans for the specific instruments used. Such plans name frequency and method of calibration. They may also name steps taken if a particular instrument is found to be out-of-specification, such as how data collected with the instrument will be handled.

3.3 Peer Review

Peer review is an essential part of measurement programs that are planned within ONE Future. Similar to data that has been collected and published recently in a variety of programs, peer review serves to provide an assessment of the sampling methodology proposed by any one company prior to its use. The peer review should include review of the sampling plan, as well as the results. This is an internal review within ONE Future, and it is not an independent third party review. While the results are not being published in an independent peer reviewed journal, this simple control step should allow a check of techniques, assurance of transparency, and test of the data by all ONE Future participants.

3.4 Documentation and Reporting

Documentation and reporting are a key part of any results that are intended to be transparent, and of use to entities beyond the party making the measurement. The results should make reference or summarize the sampling plan, document the peer review, and summarize the results in such a way that the emission calculations the company intends to use is stated clearly and can be checked by external reviewers. The results of any direct measurement study shall be placed into a brief report that will be shared with other ONE Future participants. The report must include all measurements taken, statistical analysis of the results including confidence bounds, and should document the calibration and quality control methods used on the measurement effort. The quality control methods must include an independent technical review of the dataset. The report must make a conclusion as to what portion of the system the data represents, and should list any limitations of applying the results.

4. SOURCE SPECIFIC PROTOCOLS

4.1 Equipment Leak Fugitives

Equipment leak fugitive emissions come from components where there are sealed surfaces that are designed, in the ideal world not to leak, but which can leak under certain circumstances.

Sealed surfaces include flanges, screwed connections, compression fittings, stem packing in valves, pump seals, valve seats (through-valve leaks through open ended lines), pressure relief valve seats, hatches, and meters and regulators. Fugitive leaks can also come from buried pipelines.

As was shown in Table 1, EPA Method 21 can be used to measure fugitive emissions, but as that method is costly and time consuming to apply, many upstream and midstream operators will use the OGI+quantification methods. Additionally, as shown in Table 1 downstream LDC operators may apply a variety of technologies such as HiFlow sampler measurements or spectroscopy technology taken on buried pipeline and above ground equipment.

EPA's GHGRP allows OGI to identify leakers, which reporters can then combine with a leaker emission factor. The following are recommended steps to conduct direct measurements of fugitive emissions using OGI+direct measurement of the leakers.

1. Use of OGI: The initial step in the measurements is to scan the site using an optical gas imaging camera to identify potential leak sources. Scanning with an infrared camera is an approved alternative work practice (40CFR60.18) used in identifying leaking equipment. The threshold for detecting a leak is 30 g/hr (0.026 scf/m, or 1.6 scfh). The threshold for detection of a leak with an infrared camera can depend, however, on operator interpretation of visual images and site specific parameters such as the background in the image of the potentially leaking component, and atmospheric conditions.
2. Use of Hi-Flow Sampler: Once the site was scanned with the OGI camera, all identified leaks can be measured with a rate quantification device, such as a Hi-Flow Sampler. The Hi-Flow Sampler is a portable, intrinsically safe, battery-powered instrument designed to determine the rate of gas leakage around various pipe fittings, valve packings, open- ended lines, and compressor seals found in natural gas production, transmission, storage, and processing facilities. A component's leak rate is measured by measuring at theactual flow rate of the leak so as to capture all the gas leaking from the component along with a certain amount of surrounding air. By accurately measuring the flow rate of the sampling stream and the natural gas concentration within that stream, the gas leak rate can be calculated (see Equation below). The instrument automatically compensates for the different specific gravity values of air and natural gas, thus assuring accurate flow rate calculations. Most leaks found can be measured by the Hi-Flow sampler, but other tools may be needed to measure leaks above 10 cfm, which is

the upper range of the Hi-Flow device. There are specific instrument use protocols and workplans published in the protocols mentioned in the last column of Table 1. EPA has published an OGI document. In the University of Texas and EDF Phase 1 Production study, detailed leak calculation approaches were defined. A few excerpts from the UT study are shown here for example:

$$\text{Leak} = \text{Flow} * (\text{Gas sample} - \text{Gas background}) * 10^{-2}$$

Where:

Leak = Rate of gas leakage from source (cfm)
Flow = Sample flow rate (cfm)

Gas sample = Concentration of gas from leak source (volume %) Gas
Background = Background gas concentration (volume %)

The measured flow rate and the measured methane levels (both leak and background levels) are used to calculate the leak rate of the component being tested, with all measured and calculated values being displayed on the handheld control unit.

The instrument must be calibrated using samples consisting of pure methane in ambient air. However, when natural gas emissions are measured, the instrument will encounter additional hydrocarbons (typically ethane, propane, butane and higher alkanes). To account for the effect of these species on the measurements, gas composition data must collected for each natural gas production site that was visited. Based on the gas composition, provided for each site, the percentage of carbon accounted for by methane, in the sample stream, should be determined.

This percentage, multiplied by the total gas flow rate reported by the instrument, is the methane flow.

To calculate methane emission rate based on measurements made by a Hi-Flow instrument calibrated with 100% methane, a gas analysis was required. For example, gas compositions that reported as mol percentages for N_2, O_2, CO_2, H_2S, methane, ethane, propane, butanes (n-butane and isobutane), pentanes (n-pentane, isopentane and neopentane) and hexanes (and larger) alkanes. Typically, O_2 and H_2S were negligible. The goal is to calculate the fraction of the carbon that is accounted for by the methane. This fraction is given by:

Total carbon in gas stream = [CO2] + [methane] + 2*[ethane] + 3*[propane] + 4*[sum of butanes] + 5*[sum of pentanes] + 6*[hexanes]

Fraction methane = [methane]/ [total carbon in gas stream]

For example, for a hypothetical natural gas emission consisting 80% methane (volume), 10% ethane, 5% propane, 3% butane, and 2% pentane, 58% of the carbon is in the form of methane:

$$0.58 = (0.8*1)/(0.8*1+0.1*2+0.05*3+0.03*4+0.02*5)$$

Since the instrument is calibrated based on a flow of pure methane, the instrument will report a “whole gas” volumetric flow assuming that the entire volume is methane. For the natural gas sample above, that “whole gas” volumetric flow would be multiplied by 0.58 to yield the volumetric flow of methane.

The emission rate of methane is the total gas flow (calculated using a Hi-Flow instrument calibrated with using a pure methane source) multiplied by the fraction of carbon accounted for by methane (as calculated above)

To obtain a "whole gas" flow rate, the flow rate of methane (in scf per minute) is divided by the mol percentage of methane in the whole gas analysis.

Measurements taken for downstream buried pipeline or above-ground LDC assets may use the following HiFlow protocol.

1. Pipeline Leaks
   - Location of buried leak finds from LDC company existing surveys is reviewed
   - Subset of unrepaired leaks is sampled using flux chamber with HiFlow
   - Correct for gas composition, if needed
   - New company-specific emission factor for leaks by grade and pipe type are generated
2. Above ground meters, Below ground meters, and M&R stations
   - Screen the equipment with a methane gas detector to identify leaks
   - Either use leaker emission factors from Subpart W Table W-7, or a new measurement for each found leak
     - Use HiFlow to measure leak rate from any leaking components at the subject equipment
     - Correct for gas composition, if needed
   - Generate new company-specific meter or M&R stations

Additional information on the protocol elements is provided in EDF/WSU Paper Supporting Information.

4.2 Compressor Component Fugitives

Compressor fugitives are a subset of total fugitive emissions. Compressors have some unique components that can leak at a higher rate, and also can leak at different rates depending on the mode of compressor operation (operating, idle and pressurized, idle and depressurized).

Examples of unique compressor components are rod packing vents on reciprocating compressors, wet seals on centrifugal compressors, dry seals on centrifugal compressors, OELs on compressors such as the blowdown line OELs, and compressor isolation valves acting as OELs. These sources can sometimes be manifolded into a common vent line that is open to the atmosphere, such as the rod packing vent line or a compressor blowdown vent line.

As was shown in Table 1, possible measurement technologies for flow through and out of a contained vent line include:

- OGI may be used to quickly determine zero-emitters, and confirm emitters (this must be combined with another emission quantification measurements on the “found leakers”);
- Calibrated vent bag at vent tip;
- High volume sampler at vent tip;
- Flow Meters (Anemometers of various types vane, hotwire, etc, or turbine meters, or other appropriate meters) inserted into port in the vent line, or in a temporary stack at vent tip; and
- At closed OEL block valves, for through-valve leakage: Acoustic leak detector and associated correlation equation. Note, this method is specified in the GHGRP primarily intended to be used in situations where measurements with other approved tools cannot be safely or feasibly performed, but it is generally not a recommended tool due to its high level of measurement uncertainty.

The last column in Table 1 references some of the method protocols for these approaches. EPA has allowed use of these methods to measure & report emission rates to the GHGRP for several, but not all, of the compressor component fugitives in the Transmissions, Storage, and Processing sectors, though there is no published detailed EPA method. Some published studies have used these techniques such as the GRI/EPA 1996 Methane Emissions from the Natural Gas Industry, and the more recent 2010 EPA study on Fugitive Emission Measurements on Selected Components at Compressor Stations.

The basic measurement protocol includes the following for one-time measurements at compressor vent lines:

A. Sampling Location Determination:
    - Review compressor installation and determine the physical configuration of the compressor vent line. This includes what it tied into the common vent line, or whether each component vents to the atmosphere individually.
    - Evaluate the possible measurement access to the vent tip, or to a port in the vent line.
B. Method Selection and Planning

If a stack measurement test is done, such as with a meter inserted into a port in the vent line or with a meter and temporary stack at the vent tip, the protocol should consider:

- Proper upstream and downstream equivalent diameters of straight run if available, to ensure that the meter operates in the manufacturer’s desired range
- Corrections for cross-sectional velocity differences and gas composition differences (as shown in The University of Texas Gas Well Unloadings stack measurements, ES&T Supporting Information, S.2 on “Corrections to Instrument Flow Measurements based on Temporary Stack Size and Gas Composition”).

If a HiFlow device is used, special checks and QA/QC procedures for the HiFlow should be in place.

C. Sampling Documentation and Sample Set

- Document the operating condition of the compressor at time of sampling (operating, idle and depressurized, idle and pressurized).
- Sample all of the compressors at any single site visited.
- To cover different operating modes, the Sampling Plan should include either include enough samples so that statistically significant sample sets of the different conditions of a compressor are measured, or should include revisits to the station to catch the measured compressors in different modes (*Note that the GHGRP rule requires the latter over a 3 year period to capture compressors in the idle & depressurized mode*).

4.3 Pneumatic Control Devices

Pneumatic control loops using natural gas as power gas are designed to discharge the power gas to the atmosphere. Depending on the design of the device, these can be continuous emitters, but are also commonly intermittent emitters, that discharge only during one cycle of the control valve. Maintenance condition may also effect the nature of the discharge. The EDF and University of Texas Study on Pneumatics found that defective devices were a lead cause of total emissions from this category.

Emissions from pneumatic controllers can be determined either by measuring the supply of gas entering the controller or by measuring the gas discharged from the controller. Either approach can be effective, and both measurement approaches should lead to equivalent measurements, if there are no leaks in the equipment downstream of the controller, and if all the emitted gas is captured by the post emission measurement device.

As was shown in Table 1, possible measurement technologies for gas discharged from pneumatic devices include:

- Upstream supply-gas meter;
- High volume sampler (modified or as-built);
- Q-OGI

While EPA has no required measurement of pneumatic emissions for the GHGRP, many field measurements have been done using the general scientific techniques listed above, and have been published in top-tier peer-reviewed journals (example: "Methane Emissions from Process Equipment at Natural Gas Production Sites in the United States: Pneumatic Controllers." 2015).

The following are protocol steps to use ambient air (post emission) measurement approach with the HiFlow device (as used by Prasino in their study):

1. Selection of post-emission measurement device.
    a. A calibrated bag can be used if the emission is continuous.

b. A standard HiFlow device can be used. Data logging is manual and must be carefully planned
c. A modified HiFlow with more frequent data output and superior data logging may be selected (as was used in the University of Texas Pneumatics study).

2. Selection of measurement duration per device. For intermittent devices, this is perhaps the most difficult decision, because some sites that have intermittent pneumatics and small liquids production may never have actuations while a measurement team is on-site. This is a selection driven by resource limitations (number of meters available, and number of samples needed). It is a balance between the ultimate time needed to catch multiple actuation per device (which may be multiple days in some cases), and the need to collect multiple samples. The UT study used 15 minutes, and took 300+ samples.
3. Number of devices measured per site. It is suggested that all devices at any visited site be measured if practical.
4. Data documentation: specific type of device, model number, purpose/function, etc. should be recorded.
5. Extrapolation. The protocol should consider that zero actuations during any selected measurement period does not mean the device is a zero annual emitter. This must be considered when performing the extrapolation. A company may elect to categorize the results by device types to match actual field populations or to match the three categories used by EPA in GHGRP reporting.

The following are protocol steps to use the supply gas measurement approach (from the Supporting Information of the University of Texas Study):

1. Selection of a meter and data logger. A meter must have a proper response time to catch the intermittent actuation rate change frequency of the gas supply flow. The UT study used the Fox FT2 wire anemometer, and a 1 Hz data logger.
2. Set site connection plan. Connection of the upstream meter requires a temporary disconnection of the supply gas to the pneumatic device. Usually this installation can be made in 1 minute. Time should be allowed for the device to be repowered and stable before the measurement period begins. *Note: One enhancement to consider for this method in the future (versus the UT Pneumatics study) is to add an OGI scan, both before the connection to ensure that the meter insertion did not change the state of the device, and after connection, to ensure that no other emissions exist other than that from the controller itself. This scan could potentially identify other unique emission causes, such as actuator leaks, or stainless tubing line leaks, as unique contributors that are different that pneumatic controller emissions.*
3. Selection of measurement duration per device. For intermittent devices, this is perhaps the most difficult decision, because some sites that have intermittent pneumatics and small liquids production may never have actuations while a measurement team is on-site. This is a selection driven by resource limitations (number of meters available, and number of samples needed). It is a balance between the ultimate time needed to catch multiple actuation per device (which may be multiple days in some cases), and the need to collect multiple samples. The UT study used 15 minutes, and took 300+ samples.
4. Number of devices measured per site. Number of devices measured per site. It is suggested that all devices at any visited site be measured if practical.

5. Data documentation: specific type of device, model number, purpose/function, etc. should be recorded.

6. Extrapolation. The protocol should consider that zero actuations during any selected measurement period does not mean the device is a zero annual emitter. This must be considered when performing the extrapolation. A company may elect to categorize the results by device types to match actual field populations or to match the three categories used by EPA in GHGRP reporting.
7. Data documentation: specific type of device, model number, purpose/function, etc should be recorded.
8. Extrapolation. Same issues as noted previously.

There may be new measurement techniques offered such as the Providence Photonics Q-OGI, that claim to be able to quantify the emission rate on images seen with a FLIR GF320 camera, within certain operating limits. Q-OGI has a tablet with programming that does image processing, and then produces and emission rate estimate. This is just now moving to the commercial marketing stage. If these were to be used, the ONE Future Team will first want to see field tests that prove the validity of the device for quantifying these types of emissions. Some field studies of this nature are being considered now. If successful, the protocol for this device would then be added to the list of planned techniques for pneumatic device emissions.

4.4 Production Tanks

Production tanks have been shown in some studies to be the largest source of production site emissions. In the recent EDF helicopter survey of 8000 wellsites with a FLIR camera, the study found only 4% of sites (on average) were emitting, but most of those found sources were from tanks. At a well site, liquids from a separator will still flash and produce some methane when it reaches an atmospheric storage tank. While all non-controlled (non-flare controlled, or non VRU controlled) atmospheric production tanks will have some expected and permitted atmospheric flash of HC vapors, there are also some cases where operational defects or upsets allow gas to blow through to the tank from upstream separators. These and certain maintenance events (such as gas well liquids unloadings), may be the primary cause of the majority of tank emissions. Therefore any measurement method needs to seek to identify the frequency where non-normal emissions occur.

As was shown in Table 1, possible measurement technologies for production tank emissions include:

a. External stack and meter
b. HiFlow Device (may be combined with OGI to screen)
c. Downwind Measurements, then calculated to emission rate (Tracer, or OTM-33A)

The following are protocol steps to use the external stack and meter approach (from the Supporting Information of the University of Texas Study on Gas well unloadings, which were also measured form the tops of tank vents):

1. Planning:
    a. Access is a very important issue with tanks. This requires careful planning to allow the team to reach all sources that can emit, or to isolate them and eliminate them. For example, though many tanks have catwalks, even those tanks often have an elevated common vent line with an Enardo valve that is not accessible from the catwalk. This care requires that the common vent line be shut off, or that the site have a manlift ready to measure that potential source also. Some tanks do not have catwalks, and access to top ports requires a manlift or scaffold, or safe ladder.
    b. Select stack size and meter types to allow measurement of expected full scale of emissions.
    c. Select data recorder and power source
    d. Determine duration of measurement
    e. Determine sample size in the Sampling Plan. Note: If only 4% are large emitters, as the recent EDF study suggests, then a sample set of 50 may be needed to find 2 large sources. However, a FLIR scan of a large number of sites could quickly identify whether such large emitters existed.
2. Site Installation:
    a. Examine tank connection and vent line configurations, to determine best measurement point for the temporary stack.
    b. Attach the temporary stack. This may be on a gauge hatch opening, or another opening or screwed fitting on the tank. Secure for safety. Close other exits points temporarily.
    c. Review installation for fit and seal (and also consider an OGI scan to ensure emissions are not leaving in an unexpected location)
3. Data Processing and Extrapolation:
    a. Corrections for cross-sectional velocity differences and gas composition differences (as shown in The University of Texas Gas Well Unloadings stack measurements, ES&T Supporting Information, S.2 on “Corrections to Instrument Flow Measurements based on Temporary Stack Size and Gas Composition”).
    b. Handling of large sources. These may need to be separately extrapolated, or if enough were found, could be included in the average data.

The following are protocol steps to use the HiFlow approach. It should be noted that a HiFlow approach on tank vents has been noted to produce some issues with measurement, as the higher VOC (non-methane) content of tank flashing gas versus normal produced natural gas has been speculated to cause issues with the HiFlow device (Howard, 2015 and citation from EPA ORD). Therefore if this approach is used, additional QA/QC steps may be required. The planned steps are:

1. Planning:
    a. Access (see issues mentioned in previous method).
    b. If screening is used, such as OGI, determine if non-detects will be measured or not by HiFlow. If non detects are not measured, a non-zero value should be used (such as half the minimum OGI detection level). If no screening is used, measure all sources with HiFlow.
    c. Allow for alternate method if HiFlow goes full scale or if emission is above intake capability of HiFlow (about 8 scfm).

f. Select method to record data and power source
g. Determine duration of measurement
h. Determine sample size in the Sampling Plan. Note: If only 4% are large emitters, as the recent EDF study suggests, then a sample set of 50 may be needed to find 2 large sources. However, a FLIR scan of a large number of sites could quickly identify whether such large emitters existed.

4. Site Measurements:
   a. Examine tank connection and vent line configurations, to determine needed measurement points for the HiFlow.
   b. Measure all potential emission points. If only a main point is measured, close other exits points temporarily if possible.
   c. Also consider an OGI scan to ensure emissions are not leaving in an unexpected location, and as a QA/QC validation of HiFlow readings
5. Data Processing and Extrapolation:
   a. Corrections for gas composition.
   b. Handling of large sources. These may need to be separately extrapolated, or if enough were found, could be included in the average data.

The following are protocol steps to use the Downwind Measurements, then calculated to emission rate (Tracer, or OTM-33A). Challenges with these methods are assurance that the source is not confounded with any other site source nor offsite source, since only downwind measurements are made. Tracer techniques may offer the more accurate solution, especially if the tracer release can be exactly co-located with the tank emission point, which allows an easier discrimination of other site sources in the downwind concentration traverses. No atmospheric dispersion modelling is required for the tracer method. A key disadvantage to this method is that the site must have access for the tracer vehicle in the appropriate locations; otherwise a lack of downwind and upwind roads surrounding the site, and the wind direction may preclude emission measurements. An advantage to these methods may be a faster screening for large emission sources. *Note: OTM-33A, even though accepted by EPA, may require further vetting (such as documented accuracy in the DOE RPSEA study in progress).*

Here are the steps for the tracer method:

1. Planning:
   a. Site and road access is an important issue.
   i. Determine sample size in the Sampling Plan. Note: If only 4% are large emitters, as the recent EDF study suggests, then a sample set of 50 may be needed to find 2 large sources. However, a FLIR scan of a large number of sites could quickly identify whether such large emitters existed.

2. Site Measurement:
   a. Measurement of upwind background concentration
   b. Placement of tracer, and start of release.
   c. Downwind traverses and measurements that can uniquely locate the tank emission

peak.

3. Data Processing and Extrapolation:
    a. Many tracer approaches, such as those by Aerodyne, can produce emission rate estimates as the tests progress, with data verified and QA/QC's in days following. Some sites will not produce proper peak trending and must be removed.
    c. Handling of large sources. These may need to be separately extrapolated, or if enough were found, could be included in the average data.