

METHANE MEASUREMENT PLAN

Methane Emissions Reduction Program for Marginal Conventional Wells

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WORK PERFORMED UNDER AGREEMENT

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SUBMITTED BY

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Methane Measurement Plan

The Virginia Department of Energy (Virginia Energy) received funding through the “Methane Emissions and Waste Reduction Incentive Program for Petroleum and Natural Gas Systems”, also referred to as the Methane Emissions Reduction Program (MERP). Specifically, these funds are targeted to incentivize Virginia’s natural gas and oil operators to plug marginal conventional wells (MCWs), thereby eliminating the potential for emissions from these wells.

These activities are expected to result in methane and other greenhouse gas (GHG) emission reductions. To ensure this, Virginia Energy will implement this Methane Measurement Plan to be followed by all operators utilizing grant funds to plug MCWs.

Methane measurement can be divided into two main targets.

- Measure methane emissions to provide a preliminary screening of emissions from MCW sites as a mechanism to inform plugging prioritization
- Measure methane emissions from MCW sites prior to and following the plugging and abandonment to quantify mitigated emissions

For screening purposes, operators are not required to utilize equipment that captures emission rates. Qualitative equipment may be used for this step. Similar qualitative equipment may also be used to record the post plugging readings, with an understanding that quantitative equipment may be required if post-plugging emissions are detected.

The following information outlines specific requirements for measurement, reporting, and data sharing. These guidelines are in accordance with the NETL Methane Measurement Guidelines for Marginal Conventional Wells Version 1.0.

Note: facilities that report to the Greenhouse Gas Reporting Program under Subpart W are required to follow the Subpart W quantification methodology to quantify the methane mitigated from well plugging for the purposes of this program.

Qualification of Measurement Specialist

Methane quantification for pre- and post-plugging must be performed by a qualified measurement specialist. Qualifications include obtaining a minimum of 20 hours of training on the specific measurement equipment and methods the specialist intends to utilize, as outlined in Sections 5.1-5.3 of the DOE MCW Measurement Guidance. Measurement specialists should be familiar with the reference documents provided in these guidelines, particularly those relevant to the specific measurement instrumentation that is being used. The qualified specialist must also complete any required safety training necessary to gain access to the site. The specialist should be able to recognize and mitigate safety hazards related to oil and gas wells, field conditions, and weather variables to maintain personal safety and to evaluate all potential leak, flare, and vent points on any MCW site. The qualified

measurement specialist should be prepared to submit data and results in a format that can be easily incorporated into the relevant agency database to ensure consistent reporting.

Specialists must document readings on Virginia Energy's Methane Measurement Report Form.

Measurement for Preliminary Screening and Post-Plugging

Methane emission measurements for screening purposes may implement qualitative techniques to make initial screening more efficient. Post plugging measurements may also implement these techniques. These techniques include methods that measure methane concentrations (in units such as ppm or percent volume).

Screening techniques shall be performed in accordance with the applicable federal guidelines developed specifically for this MERP pertaining to MCW sites as outlined in the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) document "Methane Measurement Guidelines for Marginal Conventional Wells" Dated April 17, 2024 (DOE MCW Measurement Guidance).

- *Portable instruments for quick measurements of methane presence and/or concentration using US EPA Method 21*
 - LEL monitors
 - Portable flame ionization detectors (FIDs)
 - Infrared controlled interference polarization spectrometers
 - Audio Visual Olfactory (AVO) inspections can be used for pre-plugging screening purposes but are not sufficient for post-plugging verification. AVO inspections are not a robust screening tool to be used independently and must be confirmed with portable instrument measurements.
- *Optical Gas Imaging (OGI) instrumentation*
 - Provides a means to visualize leaks by using radiation absorption properties
 - Can also be used post-plugging to verify zero emissions
- *Column-Integrated concentration instrumentation*
 - Standoff laser-based, hand-held detectors

Screening techniques may not provide methane emission rates but do allow for categorizing MCWs into the following categories:

1. No emissions detected; no further investigation.
2. Emitting at a low or moderate level; more comprehensive emission measurement may or may not be desired.
3. High emitter; requires more comprehensive emission rate measurement.
4. Well is high priority for plugging for other reasons; more comprehensive emission measurement may or may not be required.

These techniques should be observed for a 3–5-minute evaluation period at all potential emission points.

The following information should be recorded at the time of measurement:

- Date and time of day
- Measurement approach
- Wellsite description to include equipment on site (to include picture/diagram of site equipment)
- Listing of all emission points
- Results at each emission point (specifying concentration in units such as ppm or percent volume)
- Name of qualified person performing measurement

Pre-Plugging Methane Measurement

It is important to quantify mitigated methane emissions. To properly accomplish this, an accurate quantitative emission measurement is imperative. As outlined in the Methane Measurement Guidelines for Marginal Conventional Wells, quantitative approaches should have a minimum detection limit (MDL) of less than 100 grams/hour with a 90% probability of detection.

In accordance with the applicable federal guidelines developed specifically for this MERP pertaining to MCW sites as outlined in DOE MCW Measurement Guidance, these readings can be achieved with the following:

- Direct source emission measurements such as High Flow Sampling, Flux Chambers, Bag Sampling, and others subject to pre-approval
- Near-field measurements that position analytical instruments at a distance
- Remote sensing techniques can be utilized, but data from aircraft surveys and satellites is not recommended at this time

The selected measurement approach should have a current, accurate, and traceable calibration.

Required Operator Measurement Plan

Each operator is required to submit a Methane Measurement Plan outlining their specific equipment and techniques. This plan must be approved by Virginia Energy prior to moving forward with plugging operations.

The Plan must include a detailed description of the method, equipment, personnel, safety protocols, and calibration information. Additionally, the following should be followed:

- The weather/environmental conditions, under which the method is effective, should be documented (i.e., wind speed, temperature, and cloud cover)
- MDLs for emissions measurements resulting in a 'non-detect' classification, should be no more than 100 g/h with a 90% probability of detection

- Measurements must be performed by a qualified measurement specialist.
- A quality assurance (QA)/quality control (QC) process is required where the contractor or qualified measurement specialist makes a second set of measurements at ~5% of randomly chosen wells to verify the precision of the selected methodology. These repeat measurements should be made on the same day because of possible longer-term, temporal variability in emission rates
- Background methane measurements must be taken upwind of the MCW to ensure accurate background concentrations. The location of the background reading will be noted (either in narrative or on a site map).

Data Reporting Requirements

Virginia Energy will publish information about the methane emissions measurements from wells plugged utilizing grant funds on its public Methane Grant website. The website will be updated to include this data at a minimum of once per month in addition to the separate reporting requirements that are in the Quarterly Progress Report. The website will include the following information relevant to the methane emissions measurements:

- Wellhead location (decimal degrees, 5–7 decimal places, WGS84) and the American Petroleum Institute (API) number
- Estimated annual reduction of methane emissions from each plugged well
- Total estimated annual reduction of methane emissions from all plugged wells

Note: The estimated annual reduction of methane emitted is equal to a year of pre-plugging emissions (calculated assuming the pre-plugging measurement is constant over a year) minus a year of emissions from the post-plugged well (calculated assuming the post-plugging measurement is constant over a year)

The following information is also recommended to be documented while performing methane measurement activities.

- Date(s) and time(s) of the emissions measurements for pre-and post-plugging
- Background methane concentrations with a description of how/when the measurement was taken
- Weather conditions at the time of measurements (temperature, barometric pressure, etc.)
- Name and affiliation of the qualified measurement specialist(s)
- Observations from any audio, visual, and olfactory (AVO) inspection
- Description of the measurement approach, including instrumentation and calibration protocols
- Well status (i.e., shut-in, idle, producing, etc.)
- Pre- and post-plugging well site description (listing of equipment on site; photographs recommended)
- A description and listing of the sources of emissions
- Pre-plugging individual and aggregated methane emissions rate in g/h. If multiple measurements have been collected, either to characterize temporal variability or accuracy of the

methodology, all results should be documented as well as the approach and results to arrive at an average emission rate (to include background measurement location)

- Approach and results for post-plugging and verification/quantification of methane emissions reductions (noting date of plugging for timeframe)
- Abnormal site conditions (e.g., dilapidated equipment, open tank valves)
- If there is any uncertainty or variability in detected emission rate, a description of attempts to characterize (i.e., repeated measurements on multiple dates/times, measurements for an extended time period, or measurements using multiple approaches)
- Documentation of challenges and solutions
- Note any gas compositional analysis or soil gas surveys
- Future plans for the site (reclamation, additional wells on site, etc.)

Safety Considerations

MCW sites and plugging operations present safety considerations that may vary substantially. MCW sites are permitted through Virginia Energy, and all safety requirements remain in place during plugging operations. Operators may impose their own, higher levels of safety requirements. At a minimum, workers should have proper personal protective equipment to include hard hat, safety glasses, fire retardant clothing, steel-toed boots, and relevant personal gas detection equipment. Operators will inform all workers of potential risks prior to commencement of plugging operations and develop a site safety plan. Operators are required to review and, where applicable, put into effect the “Safety Considerations” included in the DOE MCW Measurement Guidance.

References

U.S. Department of Energy, National Energy Technology Laboratory. (2024). *Methane Measurement Guidelines for Marginal Conventional Wells*.