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Executive Summary

Substantial technological advances, particularly those affecting the production of oil and gas, have, over the past decade, significantly altered the mix of energy utilization in the United States and elsewhere in the developed world. Notably, power production in the United States has shifted away from oil-, coal-, and nuclear-powered electricity generation toward natural-gas powered generation; furthermore, the United States is on the verge of becoming a net exporter of natural gas. This shift presents both opportunities and challenges.

Several states have recently adopted or are considering regulations of methane emissions related to natural gas production and distribution. Moreover, the United States Environmental Protection Agency (USEPA) and the Department of the Interior (DOI) have released proposed regulations for methane leaks at new sources and on Bureau of Land Management (BLM) lands. However, there is currently no standard methodology to evaluate equivalency or superiority of new methane detection and quantification technologies compared with those already approved for a specific purpose. The purpose of this document is to provide an overview of existing and emerging methane detection and quantification technologies, as well as guidance regarding performance characteristics and parameters to consider in technology evaluation. It also endeavors to identify regulatory barriers to the use and adoption of new or innovative technologies that have the potential to reduce methane emissions. It is intended to enable regulators, facility owners and operators, and other users to evaluate, compare, and select suitable technologies that detect and quantify methane emissions from various segments of the oil and gas supply chain for compliance with existing and forthcoming methane emission (leak) regulations, monitor inventories, and enhance workforce and public safety.

Methane is the primary component in natural gas. The most significant segment in the oil and gas production and supply chain for methane emissions is natural gas field production (over 50%), followed by petroleum systems as a whole (over one-third), which in turn is followed by natural gas transmission and storage, natural gas processing, and natural gas distribution (USEPA 2017a). State and federal regulation of emissions is broken down according to these segments. At the federal level, the USEPA and BLM provide regulatory oversight primarily for the production and processing segments of the oil and gas sector, whereas the Pipeline and Hazardous Materials Safety Administration (PHMSA) oversees natural gas transmission, storage and distribution. The basis for these regulations varies from public health and environmental protection (USEPA) to resource conservation (BLM), safety (PHMSA) and utility ratemaking (state public utility commissions). Delegated authority for these regulations is generally given to states to implement and is typically accomplished through a state's environmental or air quality department for production and processing, and the public utility commissions (PUC) or state pipeline safety agencies for intrastate transmission, storage and distribution. States may also adopt their own regulations that are stricter than federal regulations.

There are currently only two main technologies for leak detection: USEPA Method 21 (Method 21) and optical gas imaging (OGI), with each offering advantages and disadvantages. Method 21 is an EPA-established procedure used to detect volatile organic compound (VOC) leaks from process equipment using a portable detection instrument. The instrument detector responds to the compounds being processed and is capable of measuring the leak definition concentration specified in the applicable regulation (USEPA 2017a). Detector types that may meet this requirement include, but are not limited to, catalytic oxidation, flame ionization, infrared absorption, and photoionization.

Commercial enterprises have also produced new detection techniques, such as OGI cameras, beginning in the early 2000s. These handheld cameras make detection possible by allowing visualization of a gas plume on a screen that is otherwise invisible to the naked eye. Method 21 is based on enforceable concentration standards but can be time- and labor-intensive. In contrast, OGI offers a quicker, more efficient approach and can be used to monitor hard-to-reach or unsafe equipment but has a higher detection limit, does not quantify the leak, and lacks a written monitoring protocol.

The main objective for air quality related regulations is to reduce emissions to protect human health and the environment while considering impacts such as cost, enforceability, and community concerns. In developing and amending regulations, regulators need significant levels of information on the technology or method being evaluated. Furthermore, regulations with alternative compliance methods include the challenge of establishing equivalent compliance criteria for evaluating and approving a new method or technology.

Many technologies for methane detection and quantification exist in the market or are under development, and are evolving more rapidly in recent years. Performance criteria are needed to characterize these technologies according to their capabilities, limitations, costs, and uncertainties. The classification scheme presented in this document includes the following categories: primary data type (qualitative vs. quantitative); result type (concentration or emission vs. image); detection range (high to low); specificity to methane/interference (specific vs. non-specific/high to low); other benefits; measurement temporal resolution; size (small, handheld, large); typical deployment method (walking, vehicle path, or fixed location); environmental limitations (humidity, temperature, etc.); calibration procedure; maturity (developing, newly available, mature); and miscellaneous.

The methane detection and quantification technologies that are either currently available or under development fall into the following general categories:

- Optical
- Electrochemical
- Mass spectrometry/ gas chromatography

A technology user’s goals, scale of application, accuracy and frequency of measurement, and the assumed distribution of methane emissions must be ascertained in order to select an appropriate technology. The following questions may be used to guide technology selection:

- What type of methane emissions are we trying to detect?
- How do the target emissions behave?
- What do we need to determine about the emission source?
- When and with what frequency do we want to inspect?
- At what scale are we applying the detection?

After defining the primary goal of a methane detection and quantification system, primary and secondary metrics must be developed, such as duration and location of a specific methane concentration, which in turn may depend on a sensor’s detection limit and response time.

The concerns of stakeholders who may be asked to participate, or comment on specific technologies must be considered in this process. The ITRC broadly defines stakeholder as members of environmental organizations, community advocacy groups, tribal entities or other groups that deal with environmental issues, or a concerned individual who is not a member of any organization or group.

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