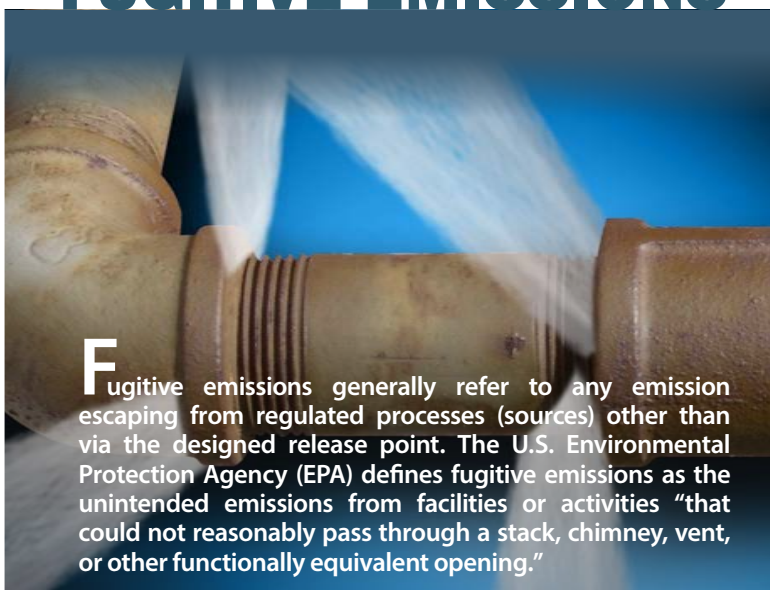
FUGITIVE EMISSIONS



Fugitive emissions generally refer to any emission escaping from regulated processes (sources) other than via the designed release point. The U.S. Environmental Protection Agency (EPA) defines fugitive emissions as the unintended emissions from facilities or activities "that could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening."

What Are the Sources of Fugitive Emissions at Oil Production Facilities?

Fugitive emissions are most often associated with the equipment necessary for the movement of process fluids and gases. At an oil and gas production facility, there are a number of potential leak points:

- Tank vents
- Treater flares
- Truck loading racks
- Pneumatic pumps and controllers
- Pipeline fittings, unions, valves, and connections

Why Do Fugitive Emissions Occur?

At a typical wellsite, a mixture of oil, gas, and water is extracted from the ground through the wellhead and delivered to a processing unit known as a separator or heater treater. The mixture is separated into streams of hydrocarbon liquids, associated gas, and water. The hydrocarbon liquids are sent to a storage tank at atmospheric pressure. Just as when a bottle of soda that has been shaken is opened, gases dissolved in the oil "flash" off when they enter the low-pressure storage tank.

Fugitive emissions can occur anywhere along the production process where the equipment is not sealed or some type of process upset causes fluids or gases to be released to the atmosphere. Poorly sealed process equipment, faulty seals, or leaking connections can allow hydrocarbon vapors to vent to the atmosphere.

Wellsite tanks are one source of fugitive emissions. These tanks are fitted with systems that capture hydrocarbon vapors, preventing their release to the environment. As crude oil is transported to the tanks and pumped to truck or pipeline, hydrocarbon vapors that accumulate in the headspace can exceed the capacity of the vapor recovery systems and potentialy leak out thief hatches or pressure relief devices (PRDs).

Thief hatches are used to check tank levels, take samples, and protect the tank from over- or underpressure conditions via an integral PRD. Thief hatches can be a source of fugitive emissions when they are not closed properly after tank unloading or gauging. They can also be source of emissions when the PRD fails to reseal after opening. A failure to seal may be caused by a faulty gasket or an inappropriate pressure set point.

How Are Fugitive Emissions Detected?

Because the main components of produced gas (methane, ethane, and propane) are odorless and colorless, audio, visual, and olfactory (AVO) techniques are not effective detection methods.

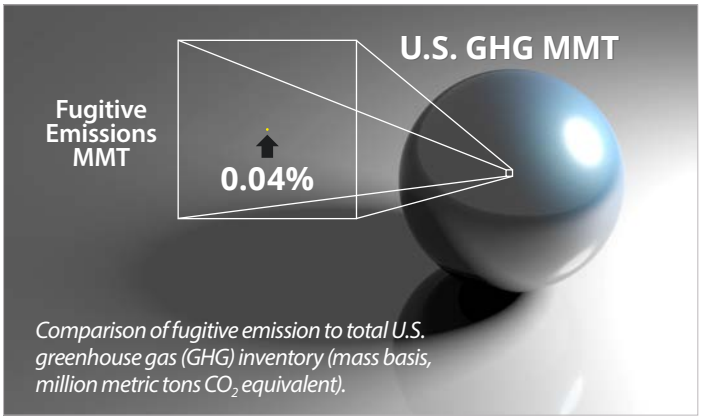
An EPA-accepted method of detecting fugitive emissions at wellsites is the use of forward-looking infrared (FLIR) cameras. For these cameras to work, there must be a temperature difference between the leaking gas and the atmosphere or background. The portable cameras must also be calibrated and tuned to match the spectra of the gases of interest. FLIR technology cannot identify specific gases, nor can it quantify the amount of gas emitted. FLIR cameras are not intended for continuous monitoring but rather for spot-checking of fugitive emissions. EPA rules do not require that the gas be quantified, but rather that no fugitive emissions are permitted.

Methane plume viewed in FLIR camera.

Another technology, time-integrated passive sampling, utilizes diffusion tubes to collect a sample. After a predetermined collection time, the sample is sent to a laboratory for analysis. These samplers are easy to use, robust, sensitive, and relatively inexpensive. However, they do not provide real-time data on emissions.

New technology in development stages may improve leak detection, gas species identification, and gas quantification. The U.S. Department of Energy is funding technology development in this area. These technologies include:

- SPods – solar-powered fenceline sensors linked through a wireless network to offer real-time monitoring. When combined with a wind anemometer and computer algorithms, SPods can be used to detect and pinpoint leaks.
- QL100 – software-based system used in conjunction with a FLIR camera to provide quantitative data on fugitive emissions.
- Geospatial measurement of air pollutants (GMAP) – integrates fast response instruments with a global positioning system to map air pollution patterns in areas around sources.
- Differential absorption lidar (DIAL) or integrated path differential absorption (IPDA) lidar – used to detect emissions across long distances.



Comparison of fugitive emission to total U.S. greenhouse gas (GHG) inventory (mass basis, million metric tons CO_2 equivalent).

How Are Fugitive Emissions Regulated?

In EPA's New Source Performance Standards (NSPS) Subpart OOOOa rulemaking, EPA finalizes emission standards for greenhouse gases in the form of limitations on methane and volatile organic compound (VOC) emissions for new, modified, and reconstructed oil and gas sources with potential to emit. The new regulations will also require owners and operators to find and repair leaks which result in fugitive emissions of both VOCs and methane.

North Dakota regulations specifically pertaining to fugitive emissions are found in the North Dakota Air Pollution Control Rules (Administrative Code Chapter 33-15 and Century Code Chapter 23-25) and can be summarized as follows:

- VOCs cannot be emitted in any quantity unless burned in a flare.
- Major source emissions cannot exceed 100 tons/yr (including fugitive emissions) (does not include GHGs).
- Fugitive emissions are treated as stack emissions when a company applies for major source or minor source permits.

What Should the Public Know?

"Fugitive emissions" is a term used to describe stray methane, ethane, and VOCs that escape from equipment designed to process hydrocarbons in the oil field.

EPA is currently increasing regulatory pressure on the oil and gas industry to limit fugitive emissions.

Fugitive methane emissions from the petroleum production sector were estimated to be approximately 0.04% of total U.S. GHG emissions in 2013.

Technology to identify and quantify fugitive emissions in real time is currently being developed but is not yet commercially available.

North Dakota industry is working to reduce fugitive emissions by:

- **Installing warning "gates" to remind operators to close thief hatches.**
- **Installing large lines between tanks and flares to handle a higher flow of flash gases.**
- **Increasing the set point on thief hatch pressure relief valves.**
- **Working with vendors to improve seals on thief hatches.**
- **Increasing the operating temperature of heater treaters to separate more gases from the oil before it reaches the holding tanks.**

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