

# Enforcement Alert

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## EPA Observes Air Emissions from Natural Gas Gathering Operations in Violation of the Clean Air Act

### Purpose

EPA and state investigations have identified Clean Air Act (CAA) non compliance caused by unauthorized and/or excess emissions from depressurizing pig launchers and receivers in natural gas gathering operations. For example, EPA and Pennsylvania resolved CAA violations by MarkWest (described at the end of this Alert) in a consent decree in April 2018. The settlement provides an example of potential compliance issues that operators may experience if Volatile Organic Compound (VOC) emissions from depressurizing pig launchers and receivers in natural gas gathering operations are not properly controlled. This Alert discusses engineering, design, operations, and maintenance practices that EPA and state inspectors have found that can cause non-compliance and summarizes engineering solutions to reduce emissions and help alleviate potential safety issues. While this Alert provides information intended to help operators and state regulators identify and address compliance concerns, the solutions discussed in this Alert do not guarantee compliance with federal and state regulations, including, but not limited to requirements to obtain an air permit, keep records, and/or control emissions.

### Non-Compliance Concerns

State and federal laws require owners and operators of certain facilities to register air emission sources, obtain



**Infrared Image of Compressor Station Pig Receiver  
Depressurization Event**

authorization to emit from a registered source, including natural gas gathering operations, and design, install, operate, and maintain effective emission control measures. Such laws include state permitting and air pollution regulations—many of which are federally-enforceable and collectively referred to as the State Implementation Plan or “SIP”—and the federal New Source Review (NSR) air permitting regulations including the Prevention of Significant Deterioration (PSD) requirements.

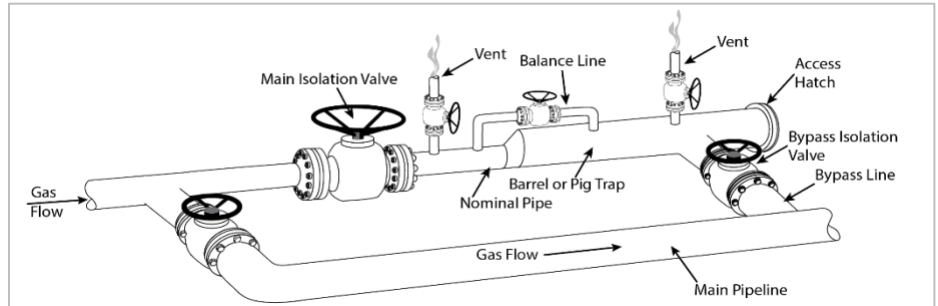
EPA and state inspectors have observed numerous instances where depressurizing pig launchers and receivers in natural gas gathering operations emit unauthorized or excess VOC emissions, due to the company’s failure to obtain an air permit for the pigging

equipment, to address deficiencies in the design of the pigging equipment, or to operate the pigging equipment in accordance with an air permit, air permit application or air permit registration.

In most jurisdictions, a company must determine the mass emissions of pollutants when registering a source, applying for an air permit, and/or claiming an air permit exemption; which are prerequisites to constructing a source. Failing to calculate the potential for VOC or HAP emissions from pigging operations or otherwise underestimating the mass of the pollutants released may result in a misrepresentation to the permit authority when the company applies for a permit or permit exemption. Depending on the state and local air permitting rules and regulations, a company's misrepresentation to the permit authority may mean that the emissions from the pigging operations are considered unauthorized or excess. In this situation, the non-compliance is caused by a company's failure to comply with federal and state permitting requirements, including, but not limited to: failure to register an air emission source, failure to obtain an air permit or obtain the correct air permit, or failure to adhere to representations in the air permit registration, failure to maintain records, and/or failure to control emissions. See, e.g., 40 C.F.R. §§ 51.165 and 70.7(b); 25 Pa. Code §§ 127.11 and 127.402(a); Ohio Admin. Code 3745-31-02(A)(1)(a)-(b) and 3745-15-05(B), (D) and (E).

## Emissions from Pigging Operations

Raw natural gas is transported from production wells to processing plants through networks of gathering pipelines. Although liquid separation may occur at the well pad, much of the raw natural gas passing through



**Figure 1. Conventional pig receiver.**

the gathering pipelines is saturated with hydrocarbons other than methane and may contain other components such as water, carbon dioxide, and hydrogen sulfide. During the transportation of this gas through gathering pipeline systems, the gas often experiences a temperature drop and pressure change that causes the hydrocarbons and other components to condense to a liquid phase. These natural gas condensates can accumulate in low elevation segments of the gathering pipelines, impeding the flow of natural gas. To maintain gas flow and operational integrity of the gathering pipelines, operators mechanically push these condensates out of the low elevations and down the pipeline by an operation called "pigging," which involves first inserting a device called a pig into a pig launcher upstream of the pipeline segment where condensates have accumulated. The gas flowing through the pipeline then pushes the pig through the pipeline, allowing the pig to sweep along the accumulated condensates. The pig is removed from the pipeline segment when it is caught in a pig receiver.

A conventional pig receiver is shown in Figure 1. Pig launchers are very similar in design. The pipeline at the rear of the barrel is called a "kicker line" on pig launchers and a "bypass line" on pig receivers; these lines direct the main gas flow through the barrel to launch or receive a pig, respectively.

Before a pig can be inserted or removed through the hatch of a pig launcher or a pig receiver, the pipeline gas in the launcher or receiver barrel must be removed, leading to potential emissions. This gas is under the same pressure as the pipeline and contains methane, ethane, and VOCs including benzene, toluene, ethylbenzene, and xylene. Pig receivers can also contain collected condensate liquid that had accumulated in the pipeline.

When the launcher and receiver barrels are depressurized (via a vent as shown in Figure 1) prior to opening the hatch for pig insertion or removal, the depressurization gases contain mixtures of methane, ethane, VOCs and hazardous air pollutants (HAPs). The barrel depressurization gases are often vented to the atmosphere but can be controlled or recovered to reduce emissions. When the hatch is opened, additional gas is released, and any liquids collected in a pig receiver that did not volatilize in the depressurization process may be spilled from the open hatch as the pig is withdrawn. These spilled liquids can fall to the ground or be collected in an open tub, either of which allow for further evaporation that contributes to emissions.

The amount of potential emissions from pigging operations depends on several factors including the launcher or receiver volume, pipeline pressure (higher pressure correlating with higher potential emissions), amount of liquid trapped in the pig receiver barrel prior to depressurization, frequency of pigging, and gas composition.

Depending on these system characteristics, the pigging operation may emit VOCs or HAPs in excess of federal or state limits.

## Engineering Solutions

EPA inspectors have identified general characteristics of a pig launcher and receiver system that control and reduce emissions of air pollutants and may require less management. These systems: (1) minimize the total volume between the kicker and/or bypass isolation valves and the main isolation valve, so that less gas is trapped in the barrel; and (2) minimize the potential for liquid accumulation or hold-up in the receiver, and include features such as sloped receiver barrels and piping so that liquids collected in the barrel are gravity-drained through the bypass piping into the main pipeline for collection downstream. However, depending on the quantity of emissions released, a company may be required to implement additional design measures, and emissions capture and control approaches to comply with federal and state regulations.

The following sections discuss design alternatives to the conventional launcher/receiver system (i.e., pig ball valves and multi-pig launcher systems), considerations for receiver barrel design (i.e., condensate drains and pig ramps), and additional site modifications to capture or control emissions (i.e., jumper lines, combustion devices, rerouting low pressure systems, barrel pump-down systems, and enhanced liquid containment). In addition to reducing potential VOC emissions to alleviate potential non-compliance, application of these solutions reduces methane (a potent greenhouse gas) and generally improves safety of the pigging operation. The applicability and effectiveness of these engineering solutions are site-specific; solutions can generally be combined to effectively reduce emissions.

### ***Install Pig Ball Valves***

Pig ball valves are a design alternative to conventional launcher/receiver systems that result in fewer emissions

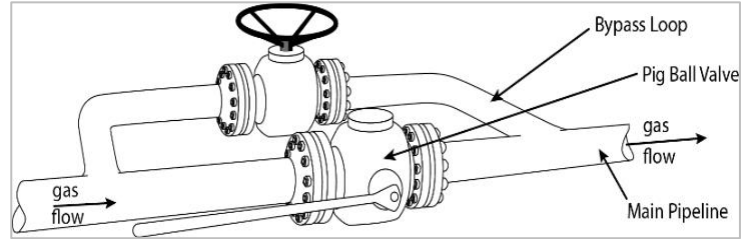
from pigging operations due to a smaller sized barrel (or chamber) that launches and receives the pig. A conventional pig launcher or receiver system can be retrofitted by replacing the conventional launcher and receiver barrels with special ball valves used to insert and remove the pig directly from the main pipeline. Figure 2 shows a pig ball valve installed in a pipeline, with a bypass loop around the pig ball valve for use when the pig ball valve is closed. By replacing the large volume barrel with the much smaller volume ball valve, the volume of gas vented during each pigging operation can be reduced by as much as 80% to 95% with a corresponding reduction in emissions and other risks associated with pipeline pigging operations.

**Install Multi-Pig Launcher Systems**

Multi-pig launcher systems are a design alternative to conventional launcher/receiver systems and reduce pigging emissions by reducing the frequency that launchers and receivers must be vented prior to pig insertion and removal. An example manufacturer design for a multi-pig launcher system is shown in Figure 3. The launcher barrel is designed to hold multiple spherical pigs, which are each held in place by gates or pins prior to release. Emission reductions are approximately proportional to the reduction in frequency of opening the launcher and receiver hatch.

**Receiver Barrel Design: Condensate Drains**

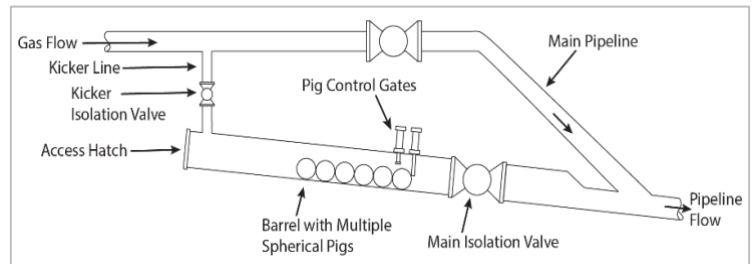
Drains can be installed in the bottom of receiver barrels and pig ball valves to ensure that all condensate is drained from the system prior to depressurization. These drains generally route the condensate back into the main pipelines, to onsite storage tanks, or to onsite processes via enclosed piping. Two drains are shown in Figure 4 which



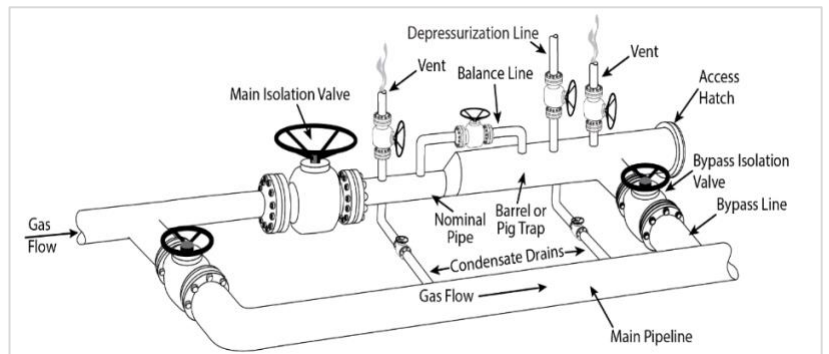
**Figure 2. Pig Ball Valve Installation**

depicts a conventional receiver design, but additional drains can be used. These drains can be retrofitted to existing systems.

The effectiveness of condensate drains in controlling pigging emissions is based on the quantity of condensate trapped in the receiver system, and the subsequent ability of the drain to recover the full quantity of this condensate during each pigging operation, thereby preventing its volatilization during pig receiver depressurization or hatch opening.



**Figure 3. Multi-Pig Launcher System**



**Figure 4. Conventional Pig Receiver with Condensate and Vapor Recovery**

### ***Receiver Barrel Design: Pig Ramps***

A pig ramp is a device that can be installed inside a receiver barrel to minimize the accumulation of condensate, or VOCs in the condensed liquid phase, in the receiver by directing the movement of the pig and liquid in the barrel. The pig ramp promotes the flow of liquid through the barrel and into the bypass line by preventing the pig from creating blockages in the receiver. By promoting the flow of liquid back into the pipeline system while the receiver is under pressure, pig ramps reduce the amount of condensed VOCs trapped in the barrel prior to depressurization which reduces the air emission that occur during depressurization and removal of the pig from the receiver. As part of MarkWest's recent settlement with EPA, pig ramps were installed at hundreds of barrels in its wet gas midstream pipeline systems. As discussed below, MarkWest will provide a royalty-free license to others interested in using their proprietary pig ramp design.

### ***Route High Pressure Systems to Lower Pressure Lines (Install Jumper Lines)***

The depressurization emissions from high pressure launchers and receivers can be reduced by routing the gases to a lower pressure system before venting the remaining gases to the atmosphere or to control equipment. Routing to a lower pressure system is achieved with a depressurization line (or, "jumper line") exiting the top of the barrel, as shown in Figure 4, or exiting the top of the pig ball valve. Compressor stations and gas plants have low pressure lines on the site that can receive these depressurization gases and recycle them through the process. Similarly, launchers and receivers along high pressure pipelines are occasionally located near low pressure pipelines that can receive depressurization gases exiting the barrel or pig ball valve.

### ***Route Depressurization Gases to Combustion Devices***

Depressurization gases from barrels and pig ball valves can be routed through the depressurization line (see Figure 4) to onsite combustion devices. Well-designed and operated combustion devices can achieve vapor destruction efficiencies as high as 95% to 98%. Combustion devices can be used in conjunction with engineering solutions discussed above that first reduce accumulation of or recover as much natural gas and condensate as possible before destroying the remaining vapors in the combustion device. An example would be to route high pressure systems to low pressure lines and drain barrel condensate, then route the remaining vapors to a combustion device. Large, high capacity combustion devices are typically available at compressor stations and processing plants and can be used to control pigging gases while meeting the other flaring needs of the facility. There are also numerous low capacity combustion devices available for serving remote launcher/receiver sites.

### ***Route Low-Pressure Systems into Fuel Gas Systems or Vapor Recovery Unit (VRU)***

Gases that remain in high pressure barrels after venting to low pressure systems and gases in low pressure barrels can be recovered during depressurization by discharging the gases to very low-pressure systems at the site (e.g., 10-15 psig). Two examples of very low-pressure systems at compressor stations are a fuel gas system and a condensate tank vapor recovery unit (VRU). Applying such an approach can reduce the gas pressure in the barrels to the pressure of the very low-pressure system (e.g., 10 psig), with a corresponding reduction in depressurization emissions.



### **Barrel Pump-down Systems**

In barrel pump-down systems, small fixed or portable compressors are used to pump vapors in the receiver or a launcher barrel back into the main pipeline prior to venting and opening the barrel hatch. In barrel pump-down systems, the inlet of a gas compressor is connected to the receiver or launcher depressurization line, and the compressor discharge is connected into the main pipeline. Vapors exiting the depressurization line are pulled into the compression system and recovered back into the pipeline at system pressure. These control systems can recover greater than 99% of the depressurization vapors from pig launchers and receivers.

### **Enhanced Liquid Containment**

Covering containers that collect liquids remaining in a receiver barrel after depressurization with a fitted impermeable material will reduce emissions from evaporation. Use of grounded steel receptacles additionally helps ensure safety.

## **Estimating Potential Emissions from Pigging Activities in Natural Gas Gathering Operations**

The Real Gas Law has been used to estimate the emissions from depressurizing launcher and receiver barrels, where a gas compressibility factor is applied to account for non-ideal gas initial conditions (e.g., high pressure).

However, the fundamental assumption of the methodology guiding this approach is that the average pipeline gas profile accurately characterizes the contents of the barrel prior to depressurization. This assumption neglects changes in physical conditions along the pipeline which lead to compositional changes and potential formation of condensate liquid that can

accumulate in and/or is swept into the pig receiver during pigging.

Therefore, when considering emissions from pig receivers, the Real Gas Law methodology accounts for depressurizing the natural gas mixture from pressurized conditions to atmospheric; however, the equation does not address the potential flash emissions from volatilization of condensates during depressurization. Using the Real Gas Law alone in circumstances with liquid accumulation can result in an underestimation of the calculated VOC emissions from the receiver.

A complete emissions estimation methodology for receivers would account for the impact of any liquid accumulation in receivers, as a supplement to estimates based on the Real Gas Law.

## **Enforcement Settlement with MarkWest**

On April 24, 2018, the U.S. EPA, the U.S. Department of Justice, and the Pennsylvania Department of Environmental Protection announced a settlement with MarkWest that requires innovative solutions designed to evaluate and address VOC emissions from pigging operations at gathering compressor stations and stand-alone pigging stations. This settlement resulted from joint inspections conducted by the EPA and the Commonwealth of Pennsylvania. MarkWest failed to apply for, and comply with, the required permits and/or recordkeeping requirements under the Nonattainment New Source Review, Prevention of Significant Deterioration and Title V programs, and the Pennsylvania and Ohio State Implementation Plans, for natural gas pigging and venting activities that released excess VOC emissions. MarkWest is undertaking measures to help

ensure compliance with federal and state regulations and reduce emissions including:

- Operating jumper lines to depressurize launchers and receivers.
- Installing pig ramps in receivers.
- Using a mobile flare to control emissions during depressurization.
- Using shorter (smaller volume) barrels than those presently used in the system.
- Using liquid containers with grounded steel receptacles that are covered at all times when not in use.
- Using an estimation methodology that accounts for the flash emissions from condensates that accumulate in the pig barrel.

MarkWest additionally is performing the following environmental projects to further EPA's goal of protecting and enhancing the public health and the environment:

- Innovation transfer and emission control education: MarkWest will provide a royalty-free license and public educational sessions to promote rapid

adoption of its proprietary pig ramp design. This project is aimed at increasing awareness of the emissions from pigging operations and sharing cost-effective methods to reduce these emissions. The adoption of this technology by other midstream operators will further benefit the environment by reducing emissions from pigging operations.

- Ambient air monitoring: MarkWest will install and operate air sampling stations to analyze VOCs downstream of two compressor stations over a period of at least two years. Air monitoring at these facilities is not required by law, but MarkWest agreed to conduct these supplemental environmental projects as part of the settlement to provide local communities, industry, regulators, and other stakeholders valuable information about air emissions generated during midstream operation and maintenance activities, and their impacts on local air quality.

For more information, visit

<https://www.epa.gov/enforcement/markwest-clean-air-act-settlement-information-sheet>

*DISCLAIMER: This document aims to explain the application of certain EPA regulatory provisions using plain language. Nothing in this Alert revises or replaces any regulatory provisions, any other part of the Code of Federal Regulations, the Federal Register, or the Clean Air Act. Following the approaches as discussed in this Alert do not equate to or guarantee compliance with the Clean Air Act, its implementing regulations, and associated state/local requirements. For more information, visit: [www.epa.gov/compliance](http://www.epa.gov/compliance).*