What infrastructure does a controlled-release facility need?

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A controlled-release experiment sounds simple: release methane at a known rate, then compare that known value with those reported by the measurement teams. But getting that known value right takes a surprising amount of infrastructure. The easiest way to understand this experimental approach is to follow the gas from the trailer to the release points.

From trailer to release point

We start with a portable CNG trailer, where natural gas, our source of methane, is stored at very high pressure. From there it passes through a pressure reducing station (PRS), which brings it down to a stable working pressure the rest of the system can handle.

Next comes the flow control and metering system. In studies like this one, we have multiple release points to work with, each positioned in a different part of the experimental site. The gas is distributed across the site within a network of pipelines that feed individual release points. Each release point is configured with its own solenoid valve, flow meter, and isolation valve, all of which are remotely controlled.

The flow control and metering system allows the team to set levels for each release point, and to record exactly how much flow each one receives. In other words, we can switch any release point on or off, and know precisely how much methane it's releasing, without anyone walking out to check in person. For SIMFLEX-COAL, our system is designed for 1 Hz measurement and control, so there is a second-by-second record of the emission rate, both at each release point and in total.

The release points are built in two configurations, to mimic real emission sources from mining sites that may have point and diffuse area emissions:

- **Point source release points** have a pipe outlet at the surface and produce a concentrated plume, like might be found near a dragline excavator.
- **Area source release points** use perforated medium- or high-density polyethylene (MDPE/HDPE) pipe laid out over a defined footprint. The tubing is shallowly buried (~30 cm) in gravel. Methane fills the gravel across the whole area along the pipe, producing the kind of diffuse emission that might be found at the unworked mine surface.

In our system, we use the same industrial pipework and components that natural gas distribution utilities use. Because gas distribution systems are highly regulated for safety, we must pass the same safety tests.

Where infrastructure meets the atmosphere

In an open-cut mine, terrain can cause recirculation, pooling, and big changes in methane concentration for a given flow rate. For participants, this is a big part of the challenge. To help us understand different atmospheric situations, the site includes continuous reference measurements of wind, atmospheric stability, and methane concentration. This meteorological infrastructure consists of well-calibrated sensors and associated data-logging equipment positioned at up to six locations in and around the release area. Site-specific wind and dispersion models, built by our team, are also part of our computing infrastructure for this project. After all reporting is complete, we'll release all timeseries meteorological data, along with timeseries release system data (active release points and flow rates), for the benefit of modelers and technology developers.



Changing or steady emissions?

In the real world, emissions are rarely steady. Because our flow control runs at 1 Hz, we could create step changes, ramps and sequential source switching while keeping an independent record of the actual flow. That would let us test how quickly teams respond when the emission rate changes.

In practice, though, we hold releases steady within each experiment, so teams have a stable target to measure. We break up our days into experiments and pre-program each one, including the position of each solenoid and the flow each release point should receive. At the transition from one experiment to the next, we just press “go”, and the whole facility shifts to a new methane emissions “scene” almost instantaneously.

A single release can be observed at the same time by numerous participants: point sensors, open-path lasers, sensor networks, drones, vehicles, aircraft and satellites. But the experiment only works if everything is synchronized: the release system logs the true flow, the reference stations log the

atmosphere, and each team logs its own measurements and timing. Teams also need to be positioned where they are fully immersed in the plume they are asked to quantify.

But no matter how much time we put into pre-programming and synchronization, not everything runs like clockwork, mainly because of the weather, and in particular wind speed and direction. Sometimes "on-the-fly" adjustment is needed. It takes an experienced operations team to adapt during experiments, whether because the wind shifts, an aircraft is delayed, or a satellite overpass is coming up. Every change must guarantee safety, be traceable, and be properly recorded. FluxLab brings that operational experience from a rich pedigree of multipoint controlled-release studies in Canada.

Temporary by design

The SIMFLEX-COAL infrastructure is designed specifically for research and is not a permanent installation. The system is modular: pipeline routes and equipment can be adjusted to suit terrain and site requirements, and everything can be removed after the program. That flexibility also lets us apply lessons from the first campaign to later ones without rebuilding.

The takeaway

A controlled-release facility provides something real-world methane measurement usually lacks: a known quantity to measure. But that is only as good as the infrastructure behind it: gas metered precisely at every source, releases that represent both point and area emissions, and a clear record of atmospheric conditions. With those pieces in place, controlled releases test not just individual sensors but whole measurement methods, and show how well they work under real-world conditions.

That matters especially for open-pit mines. Satellite and airborne studies have often reported coal mine methane emissions well above inventory-based estimates. Yet while many studies have tested measurement approaches at oil and gas facilities and landfills, to our knowledge none has done so at an open-pit mine. SIMFLEX-COAL is designed to fill that gap.

SIMFLEX-COAL is supported by the UN Environment Programme's International Methane Emissions Observatory (IMEO), through funding from the Government of Australia.