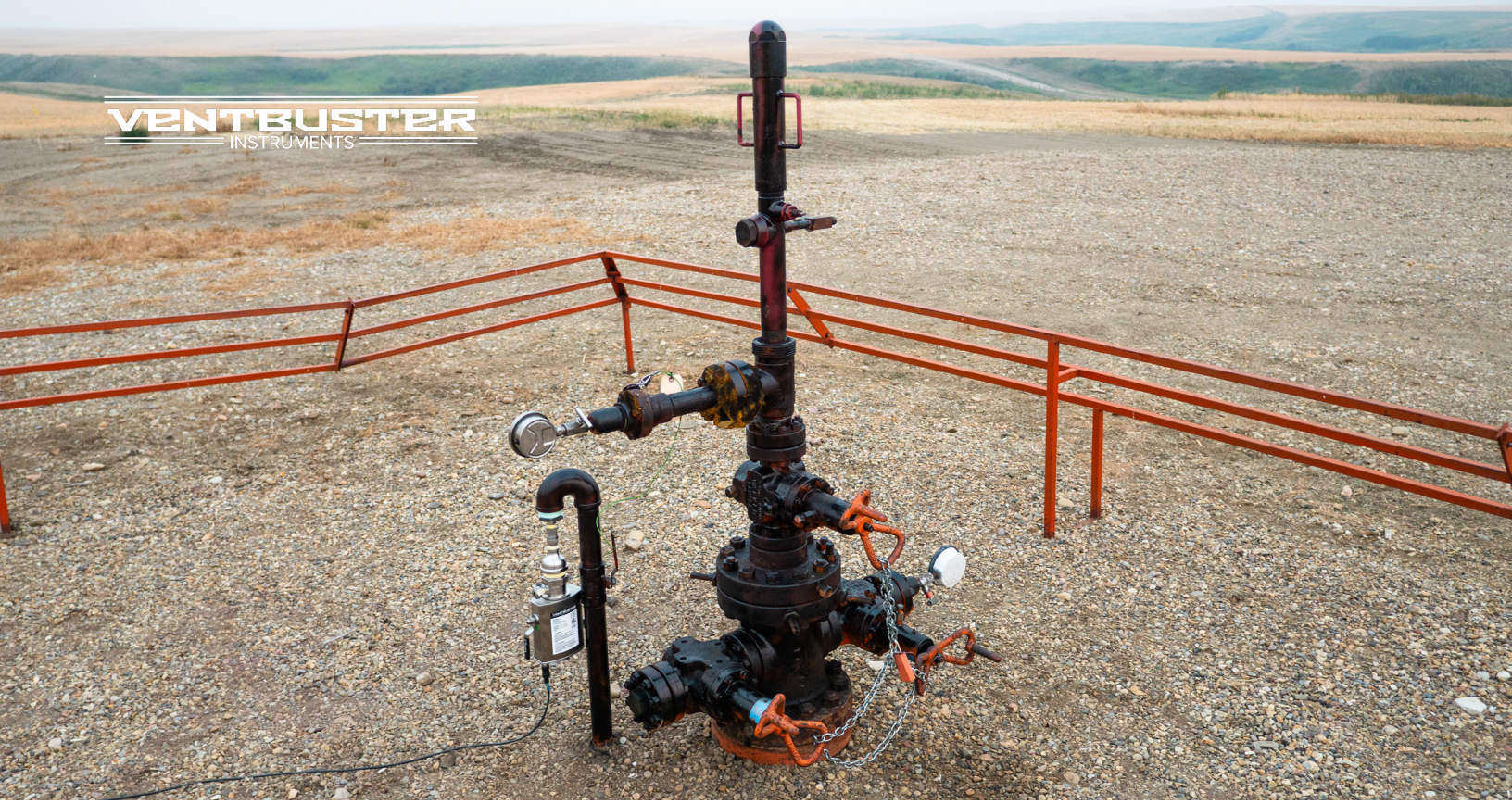

SURFACE CASING VENT FLOW TESTING PROTOCOL

Recommended Guidelines for Detecting, Monitoring, and Quanti ication

SUMMARY

The Ventbuster® is the most technologically advanced, build-for-purpose, point-source measurement device for Surface Casing Vent Flow (SCVF) testing. Its patented flow channel, enables industry to obtain the most accurate, intuitive, repeatable, and continuous, real-time, emissions quantification and reporting. The Ventbuster® performs in full compliance with Alberta Energy Regulator (AER) Directives 20 and 87.

OVERVIEW

Detrimental hydrocarbons, saline water or other greenhouse gas (GHG) emissions from surface casing vents, must be monitored, tested, and reported to jurisdictional energy regulators. Typically, if the vent leak is deemed serious in nature it must be repaired immediately and if deemed non-serious it must be repaired at the time of well plugging and abandonment or decommissioning.

A SCVF is an indication that down hole containment or zonal isolation of wellbore fluids and pressures have failed. This condition is often referred to as wellbore integrity failure. SCVF testing is conducted on oil and gas wells to monitor and report unrestrained vertical migration of gas, oil, and/or water from the well, manifesting as a surface leak from the SCV assembly. This wellbore integrity failure condition is typically a result of poor primary techniques or simply a lack of primary cement in the annular space inside the surface casing and outside the inner casing string. Indirectly, a positive SCVF can result from a production casing or intermediate casing leak, wellhead seal failure, or on occasion, decaying organics trapped within the casing vent assembly.

Ventbuster Instruments has been approached by clientele to provide a recommended procedure for SCVF testing. We elected to adopt the protocol of the AER Directives 20 and 87, and offer this only as a guideline to operate the Ventbuster® for SCVF point-source testing, monitoring, quantification and reporting.

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CLIENT BENEFITS

- **Precision detection of methane (CH_4), greenhouse gases (GHG), and pollutants venting into the atmosphere to enable sound engineering and planning for economic well integrity restoration.**
- **Accurate, repeatable, and auditable digital data transmitted to the Cloud for real-time monitoring and reporting.**
- **Continuous measurements and the most reliable quanti ication in the most diverse and extreme climates.**
- **Full regulatory compliance.**

PRECEDENCE

Prior to the Ventbuster®, low pressured emissions could never be accurately measured with positive displacement and differential pressure meters. Mass flow meters, require known and controlled gas flow conditions to achieve any kind of accuracy and as such, all are not appropriate for deploying into the field.

In an attempt to overcome this shortfall, service providers have contrived self-styled block and bleed schemes to build-up volume and pressure followed by a timed release to create a pseudo SCVF rates. If rates and pressures are still too low, it is reported as “too-small-to-measure” and regulators call for an evaluation using a “bubble-test” protocol. This “proof” for a positive SCVF test is where one or more bubbles are “observed” in a water filled vessel, over a random 10-minute duration. This technique is proven inept as it is highly susceptible to human mis-interpretation and subjective reporting, which leads to recording unquantifiable and erroneous positive or negative SCVF.

SCVF verification and quantification procedures are typically defined by the jurisdictional energy regulator and provision should be made to undertake such testing in compliance with such regulations. As stated, the following SCVF point-source testing procedure is modeled after the AER Directives 20 and 87. These Directives are generally accepted in Canada as the standard for SCVF testing of oil, gas, disposal, and injection wells. Many energy regulators in the United States and around the world are looking to model their SCVF testing protocols after AER Directives.

FOOTNOTES

- Methane (CH_4) is the primary gas emitted from SCVF leaks. It is an extremely potent GHG, trapping as high as 80 times as much atmospheric heat as carbon dioxide (CO_2) over the first 20-year period. It is 28 times more potent over a one-hundred year timescale.
- With a positive SCVF, jurisdictional regulators will dictate whether or not the SCV is to be left open to atmosphere or to be closed.
- If the SCV assembly is to be left in an open position, appropriate precautions must be adhered to, ensuring that there is no imminent danger or risk to the public, animals, property, or the environment.
- SCV assembly is left in a closed position, appropriate precautions must ensure that there will not be an excessive pressure build-up in the SCV annulus which may cause a mechanical wellbore failure. To assess this risk a stabilized shut-in pressure build-up test is critical.

VENTBUSTER INSTRUMENTS

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RECOMMENDED GUIDELINE - SCVF TESTING PROCEDURE

NOTE: The operator must follow and comply with the Well Owner's, the jurisdictional energy and workplace safety regulators' protocols when conducting SCVF testing.

1. Arrive on location and observe and note the lease condition. Perform a lease inspection, identifying, recording, and documenting all hazards prior to commencing work or any change of procedural or operational scope.
2. Conduct a safety meeting with all personnel on location. Ensure that the work scope is clearly discussed, and all risks are identified before proceeding.
3. All workers must be safety oriented, competent, and trained or certified to perform the necessary tasks, and fit for work.
4. Wear the necessary PPE as required by Well Owner's Safety Program, the well site conditions, by jurisdictional energy and workplace safety regulators.
5. Digital photographs of the well site and equipment are to be taken and submitted with the SCVF testing report:
   - At the well site entrance with well signage visible and readable, clearly showing the well access route and road conditions.
   - A full profile of the wellhead with well signage clearly visible and readable.
   - With a full profile of the wellhead in the foreground, take perspective views looking north, south, east and west.
   - Photograph any other surface or buried equipment on site and other items or structures that would be applicable to future well plugging and abandonment, decommissioning, or reclamation operations.
6. Read and record the shut-in or flowing casing and tubing pressure(s), as applicable.
7. Using a calibrated hydrocarbon gas detector/sensor, probe the well head and exhaust port of the SCV assembly to determine the presence of hydrocarbon gases, H_2S and CO_2.
8. Upon positive indication of the presence of hydrocarbon gas at the SCV exhaust port, collect a full gas sample, properly labeled in accordance with Well Owner protocol.
9. The sample should be sent into the laboratory for a prescribed chromatograph, hydrocarbon gas analysis and carbon isotope test.
10. Carbon isotope analysis may be required to "fingerprint" the vent gas geological age and potential stratigraphic source(s)

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This document is intended as a guide only and cannot possibly account for, nor predict, all potential situations, site conditions or wellbore parameters. It does not supersede due diligence, good judgement, experience, common sense or regulated practices. Always be aware and prepared to adapt to changing or unreported wellsite conditions and immediately inform the supervisory or regulatory personnel accordingly.

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RECOMMENDED GUIDELINE - SCVF TESTING PROCEDURE

11. If the initial SCVF detection indicates that a gas leak is present and potential for flow is validated, conduct a stabilized flow rate, flow pressure, flow temperature and a stabilized shut-in pressure test.
12. Close in the SCV assembly valve. Install the Ventbuster® Unit to the SCV assembly in accordance with Ventbuster Instruments' Operations Manual and Quick-Start Checklist.
13. Slowly open the SCV assembly valve.
14. Using a soap test kit, conduct a leak test of the SCV assembly valves, fittings and connections, plus the connections to the Ventbuster® Unit - repair any leaks as required.
15. Commence the flow test through the Ventbuster® Unit in accordance with with Ventbuster Instruments' Operations Manual and Quick-Start Checklist.
16. **Note: All SCVF test data is transmitted in real-time and can be live streamed on the Ventbuster® Dashboard.** A screenshot of the Dashboard may be taken at anytime, a downloadable PDF Test Summary Report and CSV Data are also available.
17. The flow test duration must be long enough to achieve flow stabilization over a continuous test flow period of at least 24-hours.
18. Upon achieving a stabilized flow rate, shut in the Ventbuster® Unit, for a pressure build-up test. The build-up test must be long enough to achieve pressure stabilization, which may take hours to several days.

CAUTION: jurisdictional regulators may have a limitation on the maximum allowable pressure build-up on the surface casing annulus. Ensure the Ventbuster® Unit is set to release pressure should it exceed this limitation. In accordance AER Directive 20 and 87, stabilized pressure is de ined as a change in pressure rise or fall of less than 2.0 kPa/hour over a 6-hour period.

19. Stop the SCVF test and rig out the Ventbuster® Unit and associated equipment in accordance with Ventbuster Instruments' Operations Manual and Quick-Start Checklist.
20. Collect a second full gas sample, properly labeled in accordance with Well Owner protocol.
21. The sample should be sent into the laboratory for a prescribed chromatograph, hydrocarbon gas analysis and carbon isotope test.
22. Carbon isotope analysis may be required to "fingerprint" the vent gas geological age and potential stratigraphic source(s)
23. Rig out and release all equipment. Ensure the well site is left in the same condition as observed upon arrival and all wellhead locks are re-installed, close access gates and secured the site as required.

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