BRITISH COLUMBIA ENERGY REGULATOR

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APPLICATION GUIDELINE FOR ACID GAS DISPOSAL WELL

Background

Disposal into a deep formation is an effective alternative to flaring hydrogen sulphide (H_2S) and venting carbon dioxide (CO_2), by-products of oil and gas production. Separated at gas processing plants, the mixture of H_2S and CO_2, termed acid gas, contains a small percentage of methane as a process stream carry-over. Acid gas deep disposal enables the economic production of sour gas while minimizing atmospheric emissions.

Acid gas may be disposed into a depleted hydrocarbon pool or deep saline aquifer containing water which is unusable for other purpose. A depleted natural gas pool demonstrates containment. A proposal to dispose into a deep saline water-saturated formation must be shown to have containment and no adverse effects on hydrocarbon potential or usable water. Thorough consideration must be given to the condition of existing or abandoned wells that the subsurface acid gas plume may contact. Ownership of petroleum and natural gas rights for a full gas spacing area in the disposal formation is required, and the completed portion of the disposal well must be no closer than 100m to lease line boundary. Acid gas disposal wells and related infrastructure must meet rigorous safety design, far above a normal production or service well. An approval to operate, as a Special Project Order under Section 75 of the *Energy Resources Activities Act*, contains numerous specific operational and reporting requirements. Progress Reports must be submitted to the at specified date intervals, reporting details as outline in the approval Order.

Acid gas disposal wells are located close to source gas plants to minimize pipeline exposure. The operation of an acid gas disposal well requires specialized knowledge and understanding of the fluid phase behavior through the entire disposal cycle, at various operating conditions. Acid gas under injection may exhibit liquid or dense phase behavior or phase changes under the given temperature and pressure injection conditions. Detailed information regarding acid gas disposal wells, can be found in the Summary Information – Acid Gas Disposal Wells document located on the BCER's website.

Application

An application for approval to Dispose of Produced Acid Gas, as a Special Project under Section 75 of the *Oil and Gas Activities Act* should contain, when applicable:

Please Note:
All submissions made to the Regulator in support of an application or a regulatory requirement that include work relating to the practice of professional engineering or professional geoscience are expected to accord with the Professional Governance Act, [SBC 2018], c. 47 and the Bylaws of Engineers and Geoscientists British Columbia (EGBC). This includes any requirements relating to authentication of documents.

GENERAL INFORMATION

- ❒ Well permit number, well name and location (surface and bottom, if different) of the proposed disposal well. Indicate if the well is deviated or horizontal.
- ❒ Discussion and justification for disposal of acid gas in the proposed well at the selected location, as expanded below.
- ❒ A map illustrating tenure and registered owners, in the disposal formation, within a 5-kilometre radius of the proposed disposal well.

❒ A map of the locations of surface rights owners within a 2-kilometre radius of the proposed disposal well.

WELL CHRONOLOGY

❒ Chronological summary of well events including drilling, rig release, completion and activity history. Include any production and re-completion, logging or testing work to prepare the disposal zone. Specify dates, durations, depths and outcomes as well as indicating which section of the application contains the test results. Table format preferable.

❒ Report of the existing and proposed disposal-well completion, including; wellbore schematic, completion intervals, squeeze details, casing and tubing details and packer depth.

❒ A schematic of the proposed disposal-well completion, including; existing and proposed completion intervals, squeeze details, casing and tubing details and packer depth.

CASING, CEMENTING AND HYDRAULIC ISOLATION

❒ A full length casing inspection log, required for any existing well greater than 10 years old being converted for disposal service. Include log interpretation. A recent log may be suitable if well has not undergone significant changes since conducted.

❒ Cement integrity/inspection logs (radial log displaying 3' amplitude, 5' VDL and cement map with non-pressure pass and pressure pass) – less than 10 years old.

❒ Evidence of hydraulic isolation of the disposal zone, typically a temperature log following a fluid injection test. Alternatives may be proposed by operator.

❒ Before disposal operations begin, a pressure integrity test is required. This is standard pressure testing requirement when any completion or workover is conducted on a well. The casing or casing/tubing annulus must be pressure tested to a minimum pressure of 7,000 kPa for 10 minutes prior to the commencement of injection or disposal operations. (See the Chapter 9 of the Oil and Gas Activity Operations Manual requirement for activating suspended wells and for suspending wells). A pressure test is considered successful if the pressure does not vary by more than three per cent during the test period. This pressure test is required before disposal begins but is not the same requirement as the annual packer isolation test.

❒ Table of surface casing vent flow (SCVF) test history including test dates and results. Must have tested in past 12 months.

❒ Plan for annulus fluid maintenance, to ensure corrosion and frost protection.

❒ A map illustrating the status, completion zones for all wells within 3 kilometers of the disposal well. For abandoned wells, include abandonment date.

❒ A table listing wellbores within 3 km radius, or further if penetrating the same mapped pool proposed for disposal containment, detailing casing age, OD, grade, weight, collapse and burst pressures. Order table by proximity to disposal location. The maximum collapse strength of wellbores intersecting the disposal formation in the area must be considered. Where disposal will be into a depleted hydrocarbon pool, with acid gas in a gas phase in the reservoir, the condition of all wells intersecting the pool must be considered for containment. Each well in the pool requires a review of cement coverage, cement depth, surface casing depth, surface casing vent flows test history, remedial cement squeeze records and anything else that may affect the integrity of offset wellbores. This report may assist in this review.

❒ Wellbore integrity testing on the application well, log results and interpretation, including;

- ❒ Evidence of hydraulic isolation of the disposal zone (temperature log, packer isolation test).
- ❒ Cement integrity/inspection logs – within last 10 years.

❒ A full length casing inspection log, required for any existing well greater than 10 years old being converted for disposal service.

❒ A pressure integrity test is required. The casing or casing/tubing annulus must be pressure tested to a minimum pressure of 7,000 kPa or Maximum Operating Pressure (MOP) for 15 minutes prior to the commencement of injection or disposal operations. A pressure test is considered successful if the pressure does not vary by more than three per cent during the test period.

GEOLOGY

❒ A discussion of the relevant geology and rock properties of the reservoir formation. Include:

_____average porosity _____permeability _____water saturation

_____gas-oil contact _____gas-water contact _____oil-water contact

❒ Cross-sections, structural contour and isopach maps with details of top and base of pay and net pay.

❒ Reservoir Seals - A discussion of the reservoir bounding base and caprock, including; rock properties, continuity and thickness, evidence of fracturing and effective pool boundaries. Include caprock formation fracture pressure, if available.

❒ Aquifer details - stratigraphic traps, dip and strike and estimates of the volume and areal extent of the aquifer.

❒ Maps showing known, or postulated, faults within 20 km of the proposed disposal location. Include 2 or 3-D seismic mapping, showing structures and faulting for the area.

❒ Any noted seismicity within a 20 km radius. Natural Resources Canada website is one source for this information.

❒ Discuss core sample and image log with respect to natural fractures.

RESERVOIR

❒ If depleted pool, include the producing history of the proposed disposal well and other wells in pool. As well, address remaining reserves, economic factors and rationale for pool selection.

❒ Initial reservoir pressure, citing data source, dates and calculations to convert to depth of disposal well.

❒ Proposed wellhead & bottom hole injection pressure, and formation fracture pressure (fracture closure pressure (FCP), or fracture parting pressure (FPP).

❒ A detailed report of one of the following:

- **(Preferred)** Mini-frac or DFIT stimulation of proposed well. Determine and interpret ISIP and fracture closure pressure. Calculation of maximum allowable wellhead injection pressure will include bottom hole fracture closure pressure (FCP), hydrostatic head, friction losses and a safety factor.
- Step-rate injectivity test performed to ascertain fracture parting pressure (FPP) of the formation. Must conform to test methods as outlined in AER Directive 65 Appendix O or SPE Paper 16798.

Data confirming the formation fracture gradient, from proximal analog wells, recommended where available.

❒ Proposed well testing schedule to monitor reservoir pressure in the disposal formation.

❒ Expected injectivity performance (rate and injection pressure) and life, based on maximum limiting average reservoir pressure value (120% of Pi) and available voidage capacity. Note that for a depleted pool, the maximum pressure limit is typically the pool discovery pressure, or less, depending in individual circumstances.

❒ Results of production testing for hydrocarbon potential in the proposed disposal zone.

- ❒ The analysis of the native reservoir fluid, and typical and maximum compositions of the acid gas stream, including phase behavior for the expected range of pressures and temperatures.
- ❒ Reservoir plume model prediction indicating vertical and lateral extent of fluid contact.
- ❒ If possible, a plan for monitoring potential disposal fluid migration to other formations. Typically, a program of production gas sampling and analysis of 3 wells nearest the disposal well, in the disposal formation and/or in an overlying producing formation.

FACILITES AND MEASUREMENT

- ❒ Method/type/facility for metering of injection fluid.
- ❒ Method of continuous measurement and recording of wellhead injection and casing annulus pressures, and temperature of injected fluid at the wellhead. Include a plan for alarming the casing pressures. Tubing pressure must not exceed the Order and casing pressure variance must be closely monitored.

GROUNDWATER

- ❒ Base of groundwater depth, using the methodology outlined in INDB 2016-09 Technical Guidance for Determining the "Base of Usable Groundwater"
- ❒ Discussion of fresh water wells within three km.

NOTE: Pro-active monitoring of penetrated shallow aquifers is recommended practice, though not required at present, and it is advisable to include a monitoring plan in the application.

EMERGENCY RESPONSE

- ❒ Estimated blowout release rates and temperatures – through tubing and casing
- ❒ A plan to ensure public safety including an emergency response plan (ERP) – an acid gas well Emergency Planning Zone must be calculated at the maximum H_2S release rate assuming the maximum wellhead release rate (AOF) at the maximum allowed reservoir pressure (120% of initial formation pressure) and the maximum expected H2S content.

LETTERS

- ➢ Written statements of no objection to the proposed scheme from all parties that may be affected, indicating their reaction to the proposed acid gas disposal scheme. Examples of such statements are provided here Consent to Inclusion in a Reservoir Project or here No Objection to Reservoir Project.

The application should be submitted to the Supervisor, Reservoir Engineering Department, BC Energy Regulator, via email at Reservoir@bc-er.ca.

Notice of an application is posted on the BCER's website for a 21-day period to solicit any potential technical objection. The applicant is responsible for providing a copy of the application, upon request, to third parties during the period of public notice. After the notice period ends, a copy of the application may be requested by the Regulator's Data Center