



HYDRAULIC FRACTURING
**GUIDING PRINCIPLES AND
OPERATING PRACTICES**



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GUIDING PRINCIPLES FOR HYDRAULIC FRACTURING

Canada's shale gas, tight gas and tight oil industry supports a responsible approach to hydraulic fracturing and water management, and is committed to continuous performance improvement. Protecting water resources during sourcing, use and handling is a key priority for our industry. We support and abide by all regulations governing hydraulic fracturing operations, water use and water protection. In addition, we commit to following these guiding principles:



1

We will safeguard the quality and quantity of regional surface and groundwater resources, through sound wellbore construction practices, sourcing fresh water alternatives where appropriate, and recycling water for reuse as much as practical.

2

We will measure and disclose our water use with the goal of continuing to reduce our effect on the environment.

3

We will support the development of fracturing fluid additives with the least environmental risks.

4

We will support the disclosure of fracturing fluid additives.

5

We will continue to advance, collaborate on and communicate technologies and best practices that reduce the potential environmental risks of hydraulic fracturing.

Shale gas, tight gas and tight oil for the purpose of these principles, refers to unconventional resources from low permeability reservoirs being developed using horizontal wells with multi-stage hydraulic fracturing.



CAPP HYDRAULIC FRACTURING GUIDING PRINCIPLES AND OPERATING PRACTICES INDUSTRY COLLABORATION

Canada's upstream petroleum industry has a strong track record as a safe and reliable producer of oil and natural gas. Recognizing the increasing importance for the energy industry to be more transparent and clearly demonstrate a commitment to responsible energy development, CAPP created Guiding Principles and Operating Practices for hydraulic fracturing. These principles and practices guide water management and drive improvements in shale gas, tight gas and tight oil operations across Canada. Many CAPP member companies contributed to this effort.



Canada's upstream petroleum industry has a strong track record as a safe and reliable producer of oil and natural gas. Recognizing the increasing importance for the energy industry to be more transparent and clearly demonstrate a commitment to responsible energy development, CAPP created Guiding Principles and Operating Practices for hydraulic fracturing. These principles and practices guide water management and drive improvements in shale gas, tight gas and tight oil operations across Canada. Many CAPP member companies contributed to this effort.



To focus on priority areas for environmental performance and to maintain industry's social licence to operate, it is important for industry to work collaboratively to advance and share new technologies and best practices. Members of CAPP continue to work together on hydraulic fracturing issues to foster and implement innovative ways to improve industry performance in operations across Canada.



Industry's goal is to continue augmenting these voluntary principles and practices, while advocating that they inform and compliment existing and future regulatory requirements.



CAPP HYDRAULIC FRACTURING GUIDING PRINCIPLES AND OPERATING PRACTICES

FRACTURING FLUID ADDITIVE DISCLOSURE

OVERVIEW: To support CAPP's Guiding Principles for Hydraulic Fracturing, seven Operating Practices have been developed in collaboration with CAPP member companies. These Operating Practices strengthen industry's commitment to continuous performance improvement in shale gas, tight gas and tight oil development.

What Does This Practice Mean?

CAPP and its member companies support and encourage greater transparency in industry development. To reassure Canadians about the safe application of hydraulic fracturing technology, this practice outlines the requirements for companies to disclose fluid additives and the chemical ingredients in those additives that are identified on the Material Safety Data Sheet (MSDS).

How Will This Work?

Under this Operating Practice, companies will disclose, either on their own websites or on a third-party website, those chemical ingredients in their fracturing fluid additives which are identified on the MSDS. The ingredients which must be listed on the MSDS are identified by federal law. The well-by-well disclosure includes:

- The trade name of each additive and its general purpose in the fracturing process.
- The name and the Chemical Abstracts Service number of each chemical ingredient listed on the MSDS for each additive.
- The concentration of each reportable chemical ingredient.

We continue to support action by provincial governments to make fracturing fluid disclosure a mandatory component of shale gas, tight gas and tight oil development.



The Fracturing Fluid Additive Disclosure Operating Practice supports the Guiding Principle:

"We will support the disclosure of fracturing fluid additives."



TECHNICAL DESCRIPTION: *The Purpose* of this practice is to describe minimum requirements for disclosure of fracturing fluid additives used in the development of shale gas, tight gas and tight oil resources.

The Objective of this practice is to enable and demonstrate conformance with the following CAPP Guiding Principle for Hydraulic Fracturing: We will support the disclosure of fracturing fluid additives.

Background

Hydraulic fracturing is a controlled operation that pumps a fluid and a propping agent through the wellbore to the target geological formation at high pressure in multiple intervals or stages, in order to create fractures in the formation and facilitate production of hydrocarbons. Hydraulic fracturing is a safe and proven way to develop natural gas and oil; it has been used throughout the oil and gas industry for about 60 years.

The public has expressed interest and concern about fracturing fluid additives used in shale gas, tight gas and tight oil development. To address the concerns, this practice defines the requirements for disclosing the fracturing fluid additives and the chemical ingredients in those additives.

Scope

This practice applies to CAPP member companies engaged in the development of shale gas, tight gas or tight oil resources through the application of hydraulic fracturing processes in Canada. While use of this practice is voluntary (subject to applicable laws and regulations), CAPP strongly encourages its use by member companies.

The practice is to be utilized to direct service companies regarding what information will be submitted to operators, and to inform operators what information will be disclosed and how it will be disclosed.

OPERATIONAL REQUIREMENTS: CAPP member companies meet or exceed the following requirements when disclosing fracturing fluid additives on their websites, or on a third party website:

- There is a brief description on the website of the intended use or function of each additive that is used in fracturing fluid such as acid, biocide, breaker, corrosion inhibitor, crosslinker, demulsifier, friction reducer, gel, iron control, oxygen scavenger, pH adjusting, etc.
- There is a link on the website to well-by-well disclosure of fracturing fluid additives. The information is presented on the CAPP-endorsed disclosure form.
- The type and volume of base fluid(s) used in the hydraulic fracturing treatment, expressed in cubic metres.
- The trade name of each additive and its general purpose in the fracturing process.
- The name of each chemical ingredient listed on the Material Safety Data Sheet (MSDS) for each additive, and the Chemical Abstracts Service registry number (CAS number) for each chemical ingredient. Where the specific identity of a chemical ingredient is considered a trade secret, a more general identification is to be used consistent with the MSDS.
- Disclosure of any compound that is incidental to the chemical manufacturing process is not required unless the compound is listed on the MSDS for the additive.
- The concentration of each chemical ingredient within the additive, expressed as a per cent of the total mass of the additive.
- The concentration of each chemical ingredient, expressed as a per cent of the total mass of the fracturing fluid including base fluid and additives.



PERFORMANCE MEASURES: Conformance with this practice will be confirmed by demonstrating that:

- Procedures are in place for the operator to collect the required information from service providers and for the operator to publicly disclose the information on its website or a third-party website, using the CAPP endorsed disclosure form.
- Procedures are in place to ensure the fracturing fluid additives and chemical ingredients of each well are disclosed on the operator's website or a third-party website, such as FracFocus.ca

REPORTING EXPECTATIONS: Companies are expected to make their process for fracturing fluid additive disclosure publicly available.

Definitions

ADDITIVE:

Any substance or combination of substances comprised of chemical ingredients found in a hydraulic fracturing fluid, including a proppant, which is added to a base fluid in the context of a hydraulic fracturing treatment. Each additive performs a certain function and is selected depending on the properties required.

BASE FLUID:

The base fluid type, such as water or nitrogen foam, used in a particular hydraulic fracturing treatment. Water includes fresh water, brackish or saline water, recycled water or produced water.

CHEMICAL ABSTRACTS SERVICE (CAS):

The chemical registry that is the authoritative collection of disclosed chemical substance information.

CHEMICAL ABSTRACTS SERVICE REGISTRY NUMBER (CAS NUMBER):

The unique identification number assigned by the Chemical Abstracts Service to a chemical constituent.

CHEMICAL INGREDIENT:

A discrete chemical constituent with its own specific name or identity, such as a CAS number, that is contained in an additive.

FRACTURING FLUID:

The fluid used to perform a particular hydraulic fracturing treatment and includes the applicable base fluid and all additives.

MATERIAL SAFETY DATA SHEET (MSDS):

A document, as required by the Controlled Products Regulations under the federal Hazardous Products Act, that contains information on the potential hazards (health, fire, reactivity and environmental) of an additive and its components.

PROPPING AGENT (PROPPANT):

Typically non-compressible material, most commonly sand, added to the fracturing fluid and pumped into the open fractures to prop them open once the fracturing pressures are removed.

SERVICE COMPANY:

A company that performs hydraulic fracturing treatments for an operator.

SHALE GAS, TIGHT GAS AND TIGHT OIL:

For the purposes of this practice, shale gas, tight gas and tight oil refers to unconventional resources from low permeability reservoirs being developed using horizontal wells with multi-stage hydraulic fracturing.

SUPPLIER:

A person, including an operator but excluding a service company, who sells or provides an additive directly to an operator for use in hydraulic fracturing treatments.

TRADE NAME:

The name under which an additive is sold or marketed.

TRADE SECRET:

Any confidential formula, pattern, process, device, information, or compilation of information entitled to protection as a trade secret under the applicable law which is used in a business and which gives the business an opportunity to obtain an advantage over competitors that do not know or use it.





CAPP HYDRAULIC FRACTURING GUIDING PRINCIPLES AND OPERATING PRACTICES

FRACTURING FLUID ADDITIVE RISK ASSESSMENT AND MANAGEMENT

OVERVIEW: To support CAPP's Guiding Principles for Hydraulic Fracturing, seven Operating Practices have been developed in collaboration with CAPP member companies. These Operating Practices strengthen industry's commitment to continuous performance improvement in shale gas, tight gas and tight oil development.

What Does This Practice Mean?

CAPP and its member companies are committed to reducing the environmental risks associated with the additives in fracturing fluids. Hydraulic fracturing fluids are primarily comprised of water, sand and a very small amount of chemical additives. This practice outlines the requirements for companies to better identify and manage the potential health and environmental risks associated with these additives; where possible, fracturing fluids with lower risk profiles can be selected.

Market demand for responsible fracturing fluids leads to the development of new, more environmentally sound products. These advances in technology help drive industry's environmental performance improvement. Collaboration is the key to the progression, development and implementation of new technologies that will reduce our industry's effect on the environment.



How Will This Work?

Under this Operating Practice, companies will assess the potential risks of fracturing fluid additives and create risk management plans to effectively manage the additives. This practice includes:

- Identifying chemical ingredients and characteristics of each additive.
- Assessing potential health and environmental risks of each additive.
- Defining operational procedures and controls for the identified risks.
- Incorporating risk management plans for each well fractured.

The Fracturing Fluid Additive Risk Assessment and Management Operating Practice supports the Guiding Principles:

"We will support the development of fracturing fluid additives with the least environmental risks"; and "We will continue to advance, collaborate on and communicate technologies and best practices that reduce the potential environmental risks of hydraulic fracturing."

TECHNICAL DESCRIPTION: *The Purpose* of this practice is to describe minimum requirements for the risk-based assessment and management of fracturing fluid additives used in the development of shale gas, tight gas and tight oil resources.

The Objective of this practice is to enable and demonstrate conformance with the following CAPP Guiding Principles for Hydraulic Fracturing: We will support the development of fracturing fluid additives with the least environmental risks.

We will continue to advance, collaborate on and communicate technologies and best practices that reduce the potential environmental risks of hydraulic fracturing.

Background

Hydraulic fracturing is a controlled operation that pumps a fluid and a propping agent through the wellbore to the target geological formation at high pressure in multiple intervals or stages, in order to create fractures in the formation and facilitate production of hydrocarbons. Hydraulic fracturing is a safe and proven way to develop natural gas and oil; it has been used throughout the oil and gas industry for about 60 years.

Fracturing fluids are designed to ensure effective fracturing of the target shale gas, tight gas or tight oil reservoir and recovery of fracturing fluids. The process breaks up the target formation to create pathways that allow the gas to flow from the very low permeability reservoir toward the wellbore.

Fracturing fluids are comprised primarily of water and sand. For each stage of the fracturing process, water, propping agent and a very small amount of additives is injected into the wellbore within the hydrocarbonbearing rock. Additives are used to improve the process. The make-up of fracturing fluid varies from one geological basin or formation to another and the difference between the formulations can be as small as a change in concentration of one specific compound. The number of chemical additives used in a typical fracture treatment also varies, depending on the conditions of the well being fractured. Each component serves a specific, engineered purpose.

Scope

This practice applies to CAPP member companies engaged in the development of shale gas, tight gas or tight oil resources through the application of hydraulic fracturing processes in Canada. While use of this practice is voluntary (subject to applicable laws and regulations), CAPP strongly encourages its use by member companies.

The practice is to be utilized to support the effective management of fracturing fluid additives during fracturing program design.

OPERATIONAL REQUIREMENTS: CAPP member companies meet or exceed the following requirements when using hydraulic fracturing additives:

- The chemical ingredients and the information regarding the chemical characteristics of each additive used, or proposed to be used, in hydraulic fracturing operations will be identified using the information provided by suppliers to the operating company, as required by regulation through the provision of Material Safety Data Sheets (MSDS).
- The potential health and environmental risks of each of the additives will be assessed by the operating company or suitably qualified third party selected by the operating company.
- Operational procedures and controls specific to the selected additive(s) will be determined to manage the potential health and environmental risks identified by the risk assessment, as appropriate.
- Written risk management plans will be incorporated into the well-specific hydraulic fracturing program.
- Execution of the risk management program and actual additives used will be confirmed prior to program initiation and at program completion.

PERFORMANCE MEASURES: Conformance with this practice will be confirmed by demonstrating that:

- Procedures are in place to identify and assess the chemical characteristics of fracturing fluid additives.
- Procedures are in place to ensure that identified risk mitigation plans are developed and executed for each well fractured.

REPORTING EXPECTATIONS: Companies are expected to make their process for developing well-specific risk management plans for fracturing fluid additives publicly available.



Definitions

ADDITIVE:

Any substance or combination of substances comprised of chemical ingredients found in a hydraulic fracturing fluid, including a proppant, which is added to a base fluid in the context of a hydraulic fracturing treatment. Each additive performs a certain function and is selected depending on the properties required.

BASE FLUID:

The base fluid type, such as water or nitrogen foam, used in a particular hydraulic fracturing treatment. Water includes fresh water, brackish or saline water, recycled water or produced water.

CHEMICAL ABSTRACTS SERVICE (CAS):

The chemical registry that is the authoritative collection of disclosed chemical substance information.

CHEMICAL ABSTRACTS SERVICE REGISTRY NUMBER (CAS NUMBER):

The unique identification number assigned by the Chemical Abstracts Service to a chemical constituent.

CHEMICAL INGREDIENT:

A discrete chemical constituent with its own specific name or identity, such as a CAS number, that is contained in an additive.

FRACTURING FLUID:

The fluid used to perform a particular hydraulic fracturing treatment and includes the applicable base fluid and all additives.

MATERIAL SAFETY DATA SHEET (MSDS):

A document, as required by the Controlled Products Regulations under the federal Hazardous Products Act, that contains information on the potential hazards (health, fire, reactivity and environmental) of an additive and its components.

PROPPING AGENT (PROPPANT):

Typically non-compressible material, most commonly sand, added to the fracturing fluid and pumped into the open fractures to prop them open once the fracturing pressures are removed.

SHALE GAS, TIGHT GAS AND TIGHT OIL:

For the purposes of this practice, shale gas, tight gas and tight oil refers to unconventional resources from low permeability reservoirs being developed using horizontal wells with multi-stage hydraulic fracturing.

SUPPLIER:

A person, including an operator but excluding a service company, who sells or provides an additive directly to an operator for use in hydraulic fracturing treatments.



CAPP HYDRAULIC FRACTURING GUIDING PRINCIPLES AND OPERATING PRACTICES

BASELINE GROUNDWATER TESTING

OVERVIEW: To support CAPP’s Guiding Principles for Hydraulic Fracturing, seven Operating Practices have been developed in collaboration with CAPP member companies. These Operating Practices strengthen industry’s commitment to continuous performance improvement in shale gas, tight gas, and tight oil development.

The Baseline Groundwater Testing Operating Practice supports the Guiding Principles:

“We will safeguard the quality and quantity of regional surface and groundwater resources, through sound wellbore construction practices, sourcing fresh water alternatives where appropriate, and recycling water for reuse as much as practical”; and “We will continue to advance, collaborate on and communicate technologies and best practices that reduce the potential environmental risks of hydraulic fracturing.”

What Does This Practice Mean?

CAPP and its member companies are committed to protecting fresh groundwater sources. This practice outlines the requirements for companies to test domestic water wells within 250 metres of shale gas, tight gas and tight oil development, and to participate in longer term regional groundwater monitoring programs. The purpose of these programs is to establish baseline characteristics of the groundwater predevelopment, and to analyze whether there have been changes over time.

This practice includes two aspects: domestic water well testing, where companies will develop programs to test existing camp wells, domestic wells and natural springs with landowner consent; and regional groundwater monitoring, where industry will work with government and regulators to design and implement regional groundwater monitoring programs.



How Will This Work?

Under this Operating Practice, companies will undertake domestic water well sampling programs and participate in regional groundwater monitoring programs. This practice includes:

- Testing water wells within 250 metres, or as specified by regulation, of a wellhead before drilling shale gas, tight gas or tight oil wells.
- Establishing procedures to address and track stakeholder concerns that pertain to water well performance, including notifying the appropriate regulator.
- Collaborating with government and other industry operators in nearby regions to broadly understand regional groundwater quality and quantity through monitoring programs or studies that reflect good judgment and sound science.

TECHNICAL DESCRIPTION: *The Purpose* of this practice is to describe minimum requirements for baseline testing of fresh (non-saline) groundwater in shale gas, tight gas and tight oil development areas.

The Objective of this practice is to enable and demonstrate conformance with the following CAPP Guiding Principles for Hydraulic Fracturing: We will safeguard the quality and quantity of regional surface and groundwater resources, through sound wellbore construction practices, sourcing fresh water alternatives where appropriate, and recycling water for reuse as much as practical.

We will continue to advance, collaborate on and communicate technologies and best practices that reduce the potential environmental risks of hydraulic fracturing.

Background

Hydraulic fracturing is a controlled operation that pumps a fluid and a propping agent through the wellbore to the target geological formation at high pressure in multiple intervals or stages, in order to create fractures in the formation and facilitate production of hydrocarbons. Hydraulic fracturing is a safe and proven way to develop natural gas and oil; it has been used throughout the oil and gas industry for about 60 years.

Baseline testing establishes the characteristics of groundwater prior to shale gas, tight gas or tight oil development, and enables the assessment of potential changes in fresh groundwater characteristics over time. Appropriately designed regional groundwater studies can be useful in assessing broader groundwater characteristics and behaviour, and are typically conducted co-operatively with government agencies or other third-party professionals. For example, industry is working with Geoscience BC to complete regional water assessments within the Horn River and Montney basins in British Columbia.

Scope

This practice applies to CAPP member companies engaged in the development of shale gas, tight gas or tight oil resources through the application of hydraulic fracturing processes in Canada. While use of this practice is voluntary (subject to applicable laws and regulations), CAPP strongly encourages its use by member companies.

The practice is to be utilized to guide the effective design, execution and quality assurance aspects of baseline fresh groundwater testing programs associated with shale gas, tight gas or tight oil development. This includes both those conducted on a domestic water well basis by individual operators, and those conducted on a regional basis by government and industry co-operatively, in support of hydraulic fracturing operations.

OPERATIONAL REQUIREMENTS: CAPP member companies meet or exceed the following requirements for domestic water well testing and regional groundwater monitoring:

- Baseline groundwater testing programs must be designed and carried out under the direction of a qualified groundwater professional.
- All monitoring, purging, sampling methods and testing equipment must be selected based on the parameters being monitored and be consistent with established protocols for testing, sampling and analyzing groundwater.

Domestic Water Well Testing

Individual companies will develop sampling programs for existing camp wells, and domestic wells and natural springs with landowner consent.

1. Domestic water wells within 250 metres of the wellhead, or as required by regulation, will be tested once prior to drilling of shale gas, tight gas or tight oil wells.
2. Baseline water quality testing should include analyses to allow comparison with appropriate water quality standards. This testing will at a minimum include:
 - a. Relevant inorganic and organic constituents identified in the Guidelines for Canadian Drinking Water Quality, published by Health Canada on behalf of the Federal-Provincial-Territorial Committee on Drinking Water (CDW). This summary table is updated regularly and published on Health Canada's website: (www.healthcanada.gc.ca/waterquality).
 - b. The presence or absence of free natural gas in the water. If appropriate, gas in water analyses should include isotopic fingerprinting.
3. A water deliverability test will be conducted to establish well yield.
4. Each individual company will have a procedure in place to address concerns from stakeholders related to changes in water well performance. This procedure will include notification to the appropriate regulatory agency, the tracking of concerns and documentation of how they were addressed.

Regional Groundwater Monitoring

In the absence of existing programs, or regional studies, industry will work with government and regulators to scope, design, develop and implement regional groundwater monitoring programs.

1. The extent and intensity of the groundwater monitoring program shall reflect good judgment and sound scientific analysis.
2. Where feasible, collaboration between government and operators in geographically similar regions will be encouraged. This is intended to improve efficiency and expand monitoring program scope to enhance understanding of groundwater quantity and quality at a broader scale.
3. Baseline water quality testing should include analyses to allow comparison with appropriate water quality standards. This testing will at a minimum include:
 - a. Relevant inorganic and organic constituents identified in the Guidelines for Canadian Drinking Water Quality, published by Health Canada on behalf of the Federal-Provincial-Territorial Committee on Drinking Water (CDW). This summary table is updated regularly and published on Health Canada's website (www.healthcanada.gc.ca/waterquality).
 - b. The presence or absence of free natural gas in the water. If appropriate, gas in water analyses should include isotopic fingerprinting.
4. Each monitoring well will be instrumented with a dedicated data-logger or some other means for periodic water level monitoring.



PERFORMANCE MEASURES: Conformance with this practice will be confirmed by demonstrating that procedures are in place to ensure a baseline groundwater testing program is conducted prior to drilling.

REPORTING EXPECTATIONS: To the extent permitted by privacy legislation and with proper consent, data collected from baseline groundwater testing will be shared with landowners who have the right to use the water and other CAPP member companies upon request. This data will be a component of a program to assess regional groundwater quality and will be shared with the appropriate agencies who undertake such a program.

Definitions

DOMESTIC WATER WELL:

An opening in the ground, whether drilled or altered from its natural state, for the production of groundwater used for drinking, cooking, washing, yard or livestock use.

FREE NATURAL GAS:

Free gas is defined as gas that readily comes out of solution at atmospheric pressure and ambient temperature.

FRESH (NON-SALINE)

GROUNDWATER:

Groundwater that has a total dissolved solids (TDS) content less than or equal to 4,000 mg/L or as defined by the jurisdiction.

PROPPING AGENT (PROPPANT):

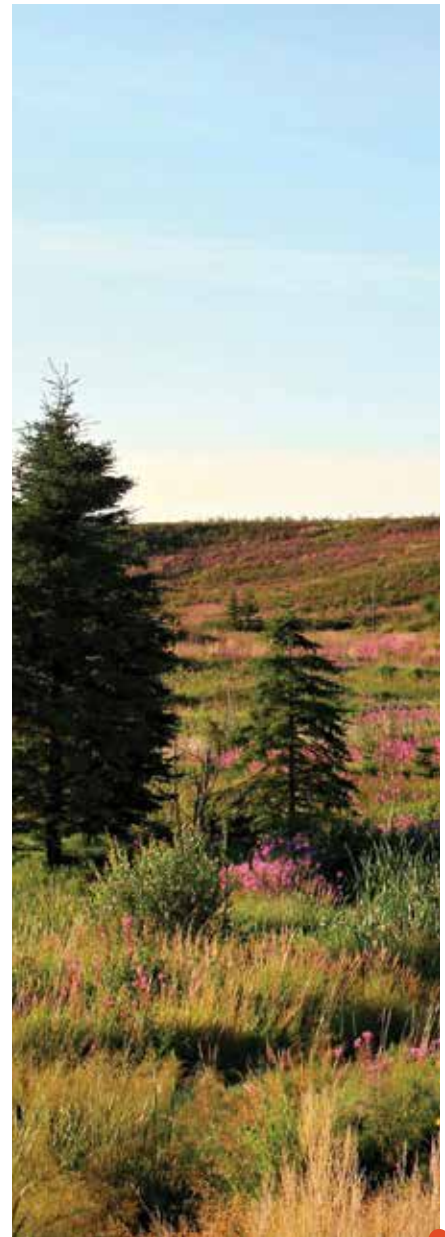
Typically non-compressible material, most commonly sand, added to the fracturing fluid and pumped into the open fractures to prop them open once the fracturing pressures are removed.

SHALE GAS, TIGHT GAS AND TIGHT OIL:

For the purposes of this practice, shale gas, tight gas and tight oil refers to unconventional resources from low permeability reservoirs being developed using horizontal wells with multi-stage hydraulic fracturing.

WATER DELIVERABILITY TEST:

A field test to estimate the flow capacity of the water well under existing conditions (e.g., using the landowner's pump). Water is withdrawn from the well for a fixed duration (usually 1 hour) before the pump is turned off and the water level is allowed to recover.





CAPP HYDRAULIC FRACTURING GUIDING PRINCIPLES AND OPERATING PRACTICES

WELLBORE CONSTRUCTION AND QUALITY ASSURANCE

OVERVIEW: To support CAPP's Guiding Principles for Hydraulic Fracturing, seven Operating Practices have been developed in collaboration with CAPP member companies. These Operating Practices strengthen industry's commitment to continuous performance improvement in shale gas, tight gas or tight oil development.

What Does This Practice Mean?

CAPP and its member companies recognize that sound wellbore design and construction is fundamental to protecting groundwater resources and to responsible oil and gas development. This practice outlines the requirements for companies to design, install and maintain wellbores. Each wellbore has steel casing that is cemented to prevent any fluids from migrating into groundwater. Wellbore design is strictly controlled by individual provincial regulators, and companies have procedures in place to ensure wellbore integrity prior to initiating hydraulic fracturing operations.



How Will This Work?

Under this Operating Practice, companies will demonstrate that procedures are in place to ensure proper design and installation of the wellbore, and to ensure the integrity of the wellbore prior to initiation of hydraulic fracturing. This practice includes:

- Complying with applicable regulatory requirements and using good engineering practice for wellbore design.
- Installing and cementing surface casing to surface to create a continuous cement barrier, which is assessed to ensure integrity of the wellbore.
- Designing the wellbore to withstand minimum and maximum loads anticipated during hydraulic fracturing, confirming wellbore integrity with a pressure test where possible.
- Determining the cause and developing appropriate remedial plans to restore wellbore integrity in the unlikely event that it is compromised, such as surface casing vent flow or gas migration.

The Wellbore Construction and Quality Assurance Operating Practice supports the Guiding Principles:

"We will safeguard the quality and quantity of regional surface and groundwater resources, through sound wellbore construction practices, sourcing fresh water alternatives where appropriate, and recycling water for reuse as much as practical"; and "We will continue to advance, collaborate on and communicate technologies and best practices that reduce the potential environmental risks of hydraulic fracturing."

TECHNICAL DESCRIPTION: *The Purpose* of this practice is to describe minimum requirements for wellbore construction and quality assurance in shale gas, tight gas and tight oil hydraulic fracturing operations.

The Objective of this practice is to enable and demonstrate conformance with the following CAPP Guiding Principles for Hydraulic Fracturing: We will safeguard the quality and quantity of regional surface and groundwater resources, through sound wellbore construction practices, sourcing fresh water alternatives where appropriate, and recycling water for reuse as much as practical.

We will continue to advance, collaborate on and communicate technologies and best practices that reduce the potential environmental risks of hydraulic fracturing.

Background

Hydraulic fracturing is a controlled operation that pumps a fluid and a propping agent through the wellbore to the target geological formation at high pressure in multiple intervals or stages, in order to create fractures in the formation and facilitate production of hydrocarbons. Hydraulic fracturing is a safe and proven way to develop natural gas and oil; it has been used throughout the oil and gas industry for about 60 years.

Wellbore design is regulated by the appropriate government agency. Some of the key design considerations include: protection and isolation of groundwater resources; isolation of hydrocarbon-bearing formations; and containment of all operational fluids and pressures.

Protection of groundwater starts with effective wellbore design and the proper execution of wellbore construction procedures. Every wellbore has an engineered steel casing system that is cemented externally to prevent any fluids from migrating from the wellbore to groundwater aquifers. As with all aspects of the drilling program, the casing design and cementing program conform to a well-specific, written engineered design prepared by the well operator and installed by independent, competent specialist contractors in coordination with the operator. The integrity of the casing and cement system can be evaluated through field inspection and wellbore logging at any point in the life of the well. Hydraulic fracturing processes are strictly regulated by various provincial government agencies.

Scope

This practice applies to CAPP member companies engaged in the development of shale gas, tight gas or tight oil resources through the application of hydraulic fracturing processes in Canada. While use of this practice is voluntary (subject to applicable laws and regulations), CAPP strongly encourages its use by member companies. The practice is to be utilized to ensure the effective design, installation and quality assurance of wellbores utilized in hydraulic fracturing operations.



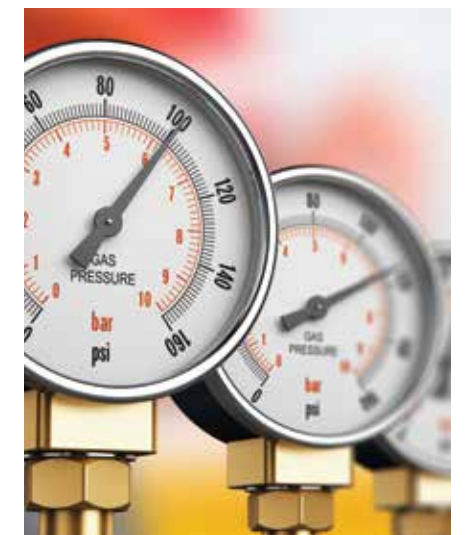
OPERATIONAL REQUIREMENTS: CAPP member companies meet or exceed the following requirements for the design, installation and quality assurance of wellbores utilized in hydraulic fracturing operations:

- Wellbore design will be conducted using good engineering practice, in strict conformance with jurisdictional regulations, and under the supervision of a competent individual.
- Surface casing will be installed and cemented to surface. The final casing string will be appropriately centralized and cemented from the top of the target zone back into the next casing string annulus, creating a continuous cement barrier from surface to the top of the target zone.
- In the event that cement returns are not obtained at the surface, or the cement level in the annulus drops below the next casing string, then a cement evaluation log will be run. After assessing the results, appropriate action will be taken consistent with good engineering practice and regulatory requirements to ensure the adequacy of the wellbore's integrity.
- Wellbore must be designed to withstand the maximum burst and collapse loads anticipated during hydraulic fracturing operations. Where possible, the integrity of the wellbore should be confirmed by an appropriately designed and conducted pressure test. If the integrity of the wellbore is compromised, the cause must be identified and an appropriate remedial plan must be developed to restore wellbore integrity.
- In the event of an identified surface vent casing flow or gas migration, the flow must be managed in accordance with jurisdictional regulatory requirements.

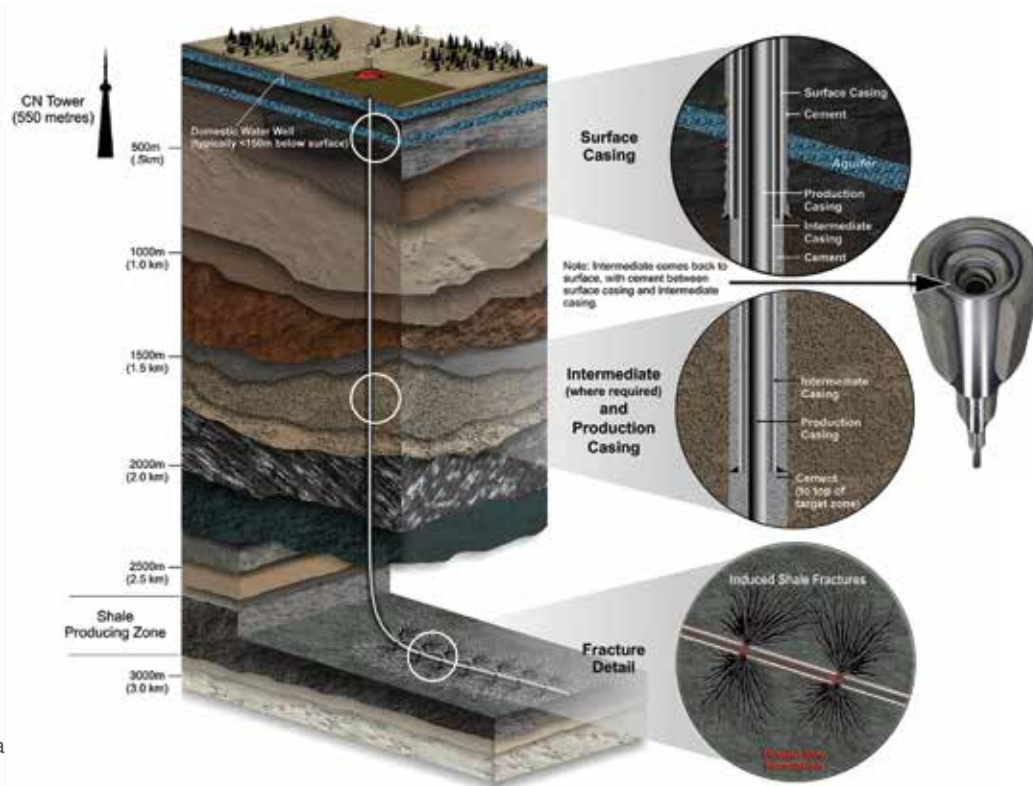
PERFORMANCE MEASURES: Conformance with this practice will be confirmed by demonstrating that:

- Procedures are in place to ensure the proper design and installation of the wellbore will result in the effective isolation of the producing zones from groundwater.
- Appropriate cementing practices and procedures are in place to ensure the integrity of the wellbore prior to the initiation of hydraulic fracturing operations.

REPORTING EXPECTATIONS: Companies are expected to make their process for wellbore construction and quality assurance publicly available, as it relates to this practice.



Typical Horizontal Shale Gas Well



Source: Encana

Definitions

ANNULUS:

The space between the wellbore and casing, or between casing and tubing, where fluid can flow.

CASING STRING:

An assembled length of steel pipe configured to suit a specific wellbore. The sections of pipe are connected and lowered into a wellbore, then cemented in place.

CEMENT EVALUATION LOG:

A representation of the integrity of the cement job, especially whether the cement is adhering solidly to the outside of the casing.

CEMENT JOB:

The application of a liquid slurry of cement and water to various points inside or outside the casing.

COMPETENT INDIVIDUAL:

A competent individual is a person who is trained and experienced to perform the required duties.

GAS MIGRATION:

A flow of gas that is detectable at surface outside of the outermost casing string. It refers to all possible routes for annular gas entry and propagation through and around the cement sheath.

PRODUCING ZONE:

The zone or formation from which natural gas or oil is produced.

SHALE GAS, TIGHT GAS AND TIGHT OIL:

For the purposes of this practice, shale gas, tight gas and tight oil refers to unconventional resources from low permeability reservoirs being developed using horizontal wells with multi-stage hydraulic fracturing.

SURFACE CASING VENT FLOW:

The flow of gas and/or liquid or any combination out of the surface casing/ casing annulus.

WELLBORE:

For the purposes of this practice, a wellbore is defined as the open hole that is drilled prior to the installation of casing and cement.



CAPP HYDRAULIC FRACTURING GUIDING PRINCIPLES AND OPERATING PRACTICES

WATER SOURCING, MEASUREMENT AND REUSE

OVERVIEW: To support CAPP's Guiding Principles for Hydraulic Fracturing, seven Operating Practices have been developed in collaboration with CAPP member companies. These Operating Practices strengthen industry's commitment to continuous performance improvement in shale gas, tight gas, and tight oil development.

The Water Sourcing, Measurement and Reuse Operating Practice supports the Guiding Principles:

"We will safeguard the quality and quantity of regional surface and groundwater resources, through sound wellbore construction practices, sourcing fresh water alternatives where appropriate, and recycling water for reuse as much as practical"; "We will measure and disclose our water use with the goal of continuing to reduce our effect on the environment"; and "We will continue to advance, collaborate on and communicate technologies and best practices that reduce the potential environmental risks of hydraulic fracturing."

What Does This Practice Mean?

CAPP and its member companies recognize that water is a resource we all share. We put great emphasis on the need to use and manage water responsibly in our operations. For shale gas, tight gas and tight oil developments, water is typically only required for well drilling and completion and not for the actual production of the gas and oil. Some of the water injected during fracturing operations is recovered with the hydrocarbon, and is either recycled for reuse in another operation or disposed of according to regulations. This practice outlines the requirements for companies to evaluate available water supply sources, measure water use and reuse water as much as practical in hydraulic fracturing operations.

How Will This Work?

Under this Operating Practice, companies will safeguard water quantity through assessment and measurement of water sources (including recycled water). As with all industrial operations, the volume of water that can be withdrawn is approved by the provincial regulator to ensure sustainability of the resource.

This practice includes:

- Complying with withdrawal limits and reporting requirements of water licences/permits. Also, collecting and reporting water use data through CAPP's Responsible Canadian Energy™ Program.
- Implementing a decision-making framework to evaluate and understand available water sources.
- Monitoring surface water and groundwater quantity data, as required to demonstrate sustainability of the water source; and collaborating with other companies on best practices.



TECHNICAL DESCRIPTION: *The Purpose* of this practice is to describe minimum requirements for safeguarding water quantity through assessment and measurement of water sources, including recycled water, in shale gas, tight gas and tight oil hydraulic fracturing operations.

The Objective of this practice is to enable and demonstrate conformance with the following CAPP Guiding Principles for Hydraulic Fracturing: We will safeguard the quality and quantity of regional surface and groundwater resources, through sound wellbore construction practices, sourcing fresh water alternatives where appropriate, and recycling water for reuse as much as practical.

We will measure and disclose our water use with the goal of continuing to reduce our effect on the environment.

We will continue to advance, collaborate on and communicate technologies and best practices that reduce the potential environmental risks of hydraulic fracturing.

Background

Hydraulic fracturing is a controlled operation that pumps a fluid and a propping agent through the wellbore to the target geological formation at high pressure in multiple intervals or stages, in order to create fractures in the formation and facilitate production of hydrocarbons. Hydraulic fracturing is a safe and proven way to develop natural gas and oil; it has been used throughout the oil and gas industry for about 60 years.

Fracturing fluids are comprised primarily of water and propping agent, with a very small amount of additives. The volume of water used depends on the number of fractures, the number of wells, and the characteristics of the rock in the reservoir. Unlike many enhanced oil recovery techniques where water is injected into the reservoir over the life of the well, once a shale gas, tight gas or tight oil well is completed, it typically does not require any additional water for production. Some of the water used for hydraulic fracturing in the reservoirs is recovered with the hydrocarbon, and is either recycled for reuse in another operation or disposed of according to appropriate environmental regulations.



Scope

This practice applies to CAPP member companies engaged in the development of shale gas, tight gas or tight oil resources through the application of hydraulic fracturing processes in Canada. While use of this practice is voluntary (subject to applicable laws and regulations), CAPP strongly encourages its use by member companies.

The practice is to be utilized to support the evaluation of available water supply sources, measurement of water use, and reuse of flowback and produced water.

OPERATIONAL REQUIREMENTS: CAPP member companies meet or exceed the following requirements when sourcing, measuring or reusing water:

Required licences/permits will be obtained for water that is withdrawn, as these provide limits and reporting requirements established by the regulator to protect the water resource.

Potential sources of water (both temporary and permanent) for hydraulic fracturing will be evaluated to ensure sustainability of the water resource while balancing social and economic considerations. These may include:

- | | | |
|-------------------|-----------------------|---------------------------|
| a. Flowback | c. Saline groundwater | e. Non-saline groundwater |
| b. Produced water | d. Wastewater | f. Surface water |

The sustainability and safeguarding of surface water and groundwater quantity will be demonstrated by monitoring appropriate parameters (e.g. pressure, volume, water levels, precipitation data), as required for the following water sources:

- | | | |
|-----------------------|---------------------------|------------------|
| a. Saline groundwater | b. Non-saline groundwater | c. Surface water |
|-----------------------|---------------------------|------------------|

Measurement data related to water use will be collected for:

- | | | |
|------------------|--------------------------------|--------------------------------------|
| a. Water sourced | b. Water injected and disposed | c. Produced water/flowback generated |
|------------------|--------------------------------|--------------------------------------|

Permanent surface water allocations will be based on flow or water level monitoring, as approved by the jurisdiction; i.e., the amount of water that can be withdrawn is dependent on how much water is actually available.

Demonstrate collaboration and sharing of best practices with other operators regarding water sourcing, measurement and reuse, and reporting of data.

PERFORMANCE MEASURES: Conformance with this practice will be confirmed by demonstrating that:

- A decision-making framework is in place to ensure water source options are assessed and understood, including recycling flowback/produced water for reuse.
- Procedures are in place for the collection of monitoring and measurement data related to water quantity and use.
- Procedures are in place for the measurement and reporting of key water management metrics as identified in CAPP's Responsible Canadian Energy™ program.

REPORTING EXPECTATIONS: Companies are expected to make their process for water sourcing, measurement and reuse publicly available.



Definitions

FLOWBACK:

The flow of fracturing fluid back to the wellbore after treatment is completed.

FRESH (NON-SALINE)

GROUNDWATER:

Groundwater that has a total dissolved solids (TDS) content less than or equal to 4,000 mg/L or as defined by the jurisdiction.

PRODUCED WATER:

Water naturally present in the reservoir or injected into the reservoir to enhance production, produced as a co-product when gas or oil is produced.

PROPPING AGENT (PROPPANT):

Typically non-compressible material, most commonly sand, added to the fracturing fluid and pumped into the open fractures to prop them open once the fracturing pressures are removed.

RECYCLE:

The process of treating flowback or produced water to allow it to be reused either for hydraulic fracturing or for another purpose.

REUSE:

The process of using water multiple times for similar purposes.

SALINE GROUNDWATER:

Groundwater that has a total dissolved solids (TDS) content more than 4,000 mg/L or as defined by the jurisdiction.

SHALE GAS, TIGHT GAS AND TIGHT OIL:

For the purposes of this practice, shale gas, tight gas and tight oil refers to unconventional resources from low permeability reservoirs being developed using horizontal wells with multi-stage hydraulic fracturing.

SURFACE WATER:

Water collecting on the ground or in a stream, river, lake, sea or ocean, as opposed to groundwater.

WASTEWATER:

Spent or used water with dissolved or suspended solids, discharged from homes, commercial establishments, farms and industries.





CAPP HYDRAULIC FRACTURING GUIDING PRINCIPLES AND OPERATING PRACTICES

FLUID TRANSPORT, HANDLING, STORAGE AND DISPOSAL

OVERVIEW: To support CAPP's Guiding Principles for Hydraulic Fracturing, seven Operating Practices have been developed in collaboration with CAPP member companies. These Operating Practices strengthen industry's commitment to continuous performance improvement in shale gas, tight gas and tight oil development.

What Does This Practice Mean?

CAPP and its member companies are committed to reducing the risk of potential spills of fracturing fluids, produced water, flowback water and fracturing fluid wastes (referred to hereafter as "fluids") associated with the hydraulic fracturing process. This practice outlines the requirements for companies to transport, handle, store and dispose of all fluids in a manner that is safe and environmentally responsible.



The Fluid Transport, Handling, Storage and Disposal Operating Practice supports the Guiding Principle:

"We will continue to advance, collaborate on and communicate technologies and best practices that reduce the potential environmental risks of hydraulic fracturing."

How Will This Work?

Under this Operating Practice, companies will implement practices and procedures to identify, evaluate and mitigate potential risks related to fluid transport, handling, storage and disposal, and respond quickly and effectively to an accidental spill of fluids (including remediation of the spill site). This practice includes:

- Following applicable federal, provincial and municipal regulations for fluid transport, including Transportation of Dangerous Goods (TDG) regulations.
- Ensure maintenance and safety protocols are in place to address the risks associated with fluid transport by road, rail or pipeline.
- Reducing fluid transport by road in large-scale development projects where possible.
- Constructing and operating pipelines that transport fluids in accordance with applicable regulations.
- Removing natural gas from flowback prior to storage.
- Following applicable regulatory requirements for fluid storage.
- Restricting wildlife access to fluid storage sites.
- Safely disposing of fluids that are no longer needed at approved waste management facilities, including disposal wells.

TECHNICAL DESCRIPTION: *The Purpose* of this practice is to describe minimum requirements for fluid transport, handling, storage and disposal in shale gas, tight gas and tight oil hydraulic fracturing operations.

The Objective of this practice is to enable and demonstrate conformance with the following CAPP Guiding Principles for Hydraulic Fracturing:

We will continue to advance, collaborate on and communicate technologies and best practices that reduce the potential environmental risks of hydraulic fracturing.

Background

Hydraulic fracturing is a controlled operation that pumps fluid and a propping agent through the wellbore to the target geological formation at high pressure in multiple intervals or stages, in order to create fractures in the formation and facilitate production of hydrocarbons. Hydraulic fracturing is a safe and proven way to develop natural gas and oil; it has been used throughout the oil and gas industry for about 60 years.

To mitigate the risk of a surface release of fracturing fluids, flowback and fracturing fluid waste, a set of operating practices that address the transport, handling, storage and disposal of these fluids has been developed. The practices outlined in this document will address this risk and reduce the potential of the environment being impacted by a surface release of fracturing fluids, produced water, flowback or fracturing fluid waste.

Scope

This practice applies to CAPP member companies engaged in the development of shale gas, tight gas or tight oil resources through the application of hydraulic fracturing processes in Canada. While use of this practice is voluntary (subject to applicable laws and regulations), CAPP strongly encourages its use by member companies.

The practice is to be utilized to direct the safe transport, handling, storage and disposal of fracturing fluids, produced water, flowback and fracturing fluid waste.



OPERATIONAL REQUIREMENTS: CAPP member companies meet or exceed the following requirements when transporting, handling, storing and disposing of fracturing fluids, produced water, flowback and fracturing fluid waste:

- All road transportation of fracturing fluids, produced water, flowback and fracturing fluid waste will conform to the applicable federal, provincial and municipal regulations, including Transportation of Dangerous Goods (TDG) regulations where required.
- Maintenance and safety protocols will be in place to address the risks associated with the transport of fracturing fluids, produced water, flowback and fracturing fluid waste by road, rail or pipeline. Preventative maintenance programs and safety checks will be in place for fluid transport vessels.
- On large-scale development projects, implement mechanisms and/or procedures, where practical, to reduce road transportation of fracturing fluids, produced water, flowback and fracturing fluid waste.
- Pipeline construction and operation will follow the applicable regulations in the operating jurisdiction.
- Prior to the storage of flowback, entrained gases will be separated and removed from the fluid.
- Storage of fracturing fluids, produced water, flowback and fracturing fluid waste will follow the applicable storage regulations in the operating jurisdiction.
- Fracturing fluids, produced water, flowback and fracturing fluid waste will be stored in a manner which restricts wildlife in the area from accessing it.
- Spent fracturing fluids, produced water, flowback and fracturing fluid waste will be safely disposed of at approved waste management facilities, including disposal wells.
- Disposal well design and construction will follow the applicable regulations in the operating jurisdiction.

PERFORMANCE MEASURES: Conformance with this practice will be confirmed by demonstrating that:

- Procedures are in place which identify, evaluate and mitigate potential risks associated with the transport, handling, storage and disposal of fracturing fluids, produced water, flowback and fracturing fluid waste.
- Procedures are in place to respond quickly and efficiently to an accidental surface release of fracturing fluids, produced water, flowback and fracturing fluid waste, including remediation of the spill site.

REPORTING EXPECTATIONS: Companies are expected to make their process for fluid transport, handling, storage and disposal publicly available.





Definitions

ADDITIVE:

Any substance or combination of substances comprised of chemical ingredients found in a hydraulic fracturing fluid, including a proppant, which is added to a base fluid in the context of a hydraulic fracturing treatment. Each additive performs a certain function and is selected depending on the properties required.

BASE FLUID:

The base fluid type, such as water or nitrogen foam, used in a particular hydraulic fracturing treatment. Water includes fresh water, brackish or saline water, recycled water or produced water.

FLOWBACK:

The flow of fracturing fluid back to the wellbore after treatment is completed.

FRACTURING FLUID:

The fluid used to perform a particular hydraulic fracturing treatment and includes the applicable base fluid and all additives.

FRACTURING FLUID WASTE:

An unwanted substance or mixture of substances that results from the hydraulic fracturing operation, not including flowback.

PRODUCED WATER:

Water naturally present in the reservoir or injected into the reservoir to enhance production, produced as a co-product when gas or oil is produced.

PROPPING AGENT (PROPPANT):

Typically non-compressible material, most commonly sand, added to the fracturing fluid and pumped into the open fractures to prop them open once the fracturing pressures are removed.

SHALE GAS, TIGHT GAS AND TIGHT OIL:

For the purposes of this practice, shale gas, tight gas and tight oil refers to unconventional resources from low permeability reservoirs being developed using horizontal wells with multi-stage hydraulic fracturing.

TRANSPORTATION OF DANGEROUS GOODS (TDG) REGULATIONS:

The Transportation of Dangerous Goods Act, administered by Transport Canada, contains regulations designed to promote public safety when handling or transporting dangerous goods via road, rail, air and marine.



CAPP HYDRAULIC FRACTURING GUIDING PRINCIPLES AND OPERATING PRACTICES

ANOMALOUS INDUCED SEISMICITY: ASSESSMENT, MONITORING, MITIGATION AND RESPONSE

OVERVIEW: To support CAPP's Guiding Principles for Hydraulic Fracturing, seven Operating Practices have been developed in collaboration with CAPP member companies. These Operating Practices strengthen industry's commitment to continuous performance improvement in shale gas, tight gas and tight oil development.

What Does This Practice Mean?

CAPP and its member companies support and encourage greater transparency in industry development. To reassure Canadians about the safe application of hydraulic fracturing technology, this practice outlines the requirements of companies to assess the potential for anomalous induced seismicity and, where necessary, establish appropriate monitoring procedures, and procedures to mitigate and respond to anomalous induced seismicity in shale gas, tight gas and tight oil development areas.

How Will This Work?

Under this Operating Practice, companies will assess the potential for anomalous induced seismicity for each hydraulic fracturing program. Given the unique geologies where hydraulic fracturing takes place, each hydraulic fracturing program or location requires a tailored approach that draws from this practice.

This practice includes:

- Assessing the potential for anomalous induced seismicity using available engineering, geologic and geophysical data.
- Complying with applicable regulatory requirements and employing sound wellbore construction practices.

Where assessment indicates the potential for anomalous induced seismicity exists:

- Evaluating wellbore placement and drilling design to account for geologic conditions.
- Communicating with onsite personnel; establishing procedures and preparedness for the possibility of anomalous induced seismicity.
- Establishing procedures to monitor for induced seismicity during hydraulic fracturing operations.
- Establishing procedures to mitigate and respond to anomalous induced seismicity.

The Anomalous Induced Seismicity: Assessment, Monitoring, Response and Mitigation Operating Practice supports the Guiding Principle:

"We will continue to advance, collaborate on and communicate technologies and best practices that reduce the potential environmental risks of hydraulic fracturing."

TECHNICAL DESCRIPTION: *The Purpose* of this practice is to describe minimum requirements for assessing, monitoring, responding to and mitigating anomalous induced seismicity in shale gas, tight gas and tight oil development areas.

The Objective of this practice is to enable and demonstrate conformance with the following CAPP Guiding Principle for Hydraulic Fracturing:

We will continue to advance, collaborate on, and communicate technologies and best practices that reduce the potential environmental risks of hydraulic fracturing.

Background

Hydraulic fracturing is a controlled operation that pumps a fluid and a propping agent through the wellbore to the target geologic formation at high pressure. This is done in multiple intervals, or stages, to create fractures in the formation and facilitate production of hydrocarbons. Hydraulic fracturing is a safe and proven way to develop natural gas and oil. It has been extensively used throughout the oil and gas industry for about 60 years.

It is known that certain oil and gas basins, such as the Horn River Basin of British Columbia, have a distinctive geology, and hydraulic fracturing has caused rare and minor anomalous seismicity. None of the events recorded in the Horn River Basin have caused any injury, property damage or posed any harm to public safety or the environment. Scientific research concludes hydraulic fracturing can safely proceed under current regulations, which ensure activities are carefully monitored and appropriate precautions are taken. After decades of experience with hydraulic fracturing, there has been no demonstrated evidence of harm to the public or workers, damage to local property and structures, or impact on surface and groundwater from induced seismicity.

OPERATIONAL REQUIREMENTS: CAPP member companies meet or exceed the following requirements to have procedures to assess the potential for anomalous induced seismicity. Where this assessment indicates there is a possibility of anomalous induced seismicity, such as in the Horn River Basin, member companies meet or exceed the following requirements: appropriately evaluate wellbore placement and drilling design to account for geologic conditions; communicate and prepare onsite personnel for the possibility of anomalous induced seismicity; have procedures established to monitor for induced seismicity; and have procedures to mitigate and respond to anomalous induced seismicity.

Scope

This practice applies to CAPP member companies engaged in the development of shale gas, tight gas and tight oil resources through the application of hydraulic fracturing processes in Canada. While use of this practice is voluntary (subject to applicable laws and regulations, and where the assessments of geologic conditions are indicative), CAPP strongly encourages its integration into existing management systems by member companies.



Assess the Potential for Anomalous Induced Seismicity

When assessing the potential for anomalous induced seismicity, CAPP member companies will appropriately consider the public interest, well type, local surface conditions and geology, past operating experience, historical seismicity and the anticipated scope of operations. Each hydraulic fracturing program or location requires a tailored approach that draws from these measures.

Operators will assess the potential for anomalous induced seismicity for each hydraulic fracturing program, which may include:

1. The use of available engineering, geologic and geophysical data to describe the geological setting (including pre-existing faults and lineaments) and historical seismicity in the area.
2. Communication with area operators and the regulator to determine if seismicity has been experienced and at what intensities.
3. Understanding the local context by considering:
 - a. Population and communities.
 - b. Buildings and structures.
 - c. Infrastructure.
 - d. Environment.

Where assessment indicates the potential for anomalous induced seismicity exists, CAPP member companies will implement practices as follows:

Wellbore Placement and Drilling Design; Personnel Preparedness and Monitoring Procedures for Anomalous Induced Seismicity

For each hydraulic fracturing program or location, CAPP member companies will consider conditions identified by the seismic potential assessment when evaluating wellbore placement and drilling design, and establishing personnel preparedness and monitoring procedures. Companies will:

1. Evaluate wellbore placement and drilling design to account for local surface and geological conditions (including pre-existing faults and lineaments).
2. Communicate with onsite personnel to recognize and be prepared for the possibility of anomalous induced seismicity detectable to people on the surface.
3. Authorize onsite personnel to suspend operations if unusual conditions are experienced or suspected.
4. Establish an appropriate monitoring procedure based on the assessment of the potential for anomalous induced seismicity. Monitoring procedures may include:
 - a. Review of data from Natural Resources Canada seismic array.
 - b. Observations by onsite personnel.
 - c. Use of existing micro-seismic arrays and surface monitoring.

Mitigation and Response Procedures to Anomalous Induced Seismicity

Based on the assessment and monitoring procedures, companies will have procedures in place to mitigate and response to anomalous induced seismicity. As well, onsite personnel are required to suspend operations if they have reason to believe that conditions are unsafe.

1. If anomalous seismicity is monitored at the threshold of general detectability by available detection equipment – including the Natural Resources Canada monitoring system – or by onsite personnel, a company's mitigation procedures will be undertaken. These may include:
 - a. Assess the situation.
 - b. Increase monitoring activities.
 - c. Evaluate operating conditions.
 - d. Pumping proceeds with caution or is temporarily suspended.
 - e. Engage engineers, subsurface geological and geophysical staff and/or third-party experts to review available subsurface data and, if deemed necessary, design and conduct engineered trials to adjust operating procedures as appropriate with respect to injection volumes, rates, locations, etc.
 - f. Report and discuss occurrence with the regulator.
 - g. Share learnings with other area operators.

If seismicity, measured using available detection equipment, escalates to an unacceptable level, or if anomalous seismicity is detected at unanticipated levels which could present harm, the onsite personnel will immediately suspend operations and report to the regulator. Specific and appropriate thresholds may be developed in concert with the regulator for a basin or location based on local context, the geologic setting, pre-existing faults and lineaments and historical seismicity. The company will consult with the regulator to establish amended procedures to restart the program.

PERFORMANCE MEASURES: Conformance with this practice will be confirmed by demonstrating that:

- Procedures are in place to assess the potential for anomalous induced seismicity.

Where assessment indicates a potential for anomalous induced seismicity exists:

- Procedures are in place to account for geologic conditions when evaluating wellbore placement and drilling design.
- Procedures are in place to communicate and prepare onsite personnel for the possibility of anomalous seismicity.
- Procedures are in place to appropriately monitor for induced seismicity during hydraulic fracturing.
- Procedures are in place to appropriately respond to and mitigate anomalous induced seismicity.

REPORTING EXPECTATIONS: Companies are expected to make their process for assessment, monitoring, mitigation and response to anomalous induced seismicity during hydraulic fracturing available to the public.

Definitions

ANOMALOUS SEISMICITY:

Seismicity that would not normally occur when performing hydraulic fracture completions (such as seismicity from fault movement).

INDUCED SEISMICITY:

Seismic events that can be attributed to human activity. Seismicity can be induced by geothermal energy extraction, mining, dam building and hydraulic fracturing.

SEISMICITY:

The frequency and magnitude of earthquake activity in a given area.

SHALE GAS, TIGHT GAS AND TIGHT OIL:

For the purposes of this practice, shale gas, tight gas and tight oil refer to unconventional resources from low permeability reservoirs being developed using horizontal wells with multi-stage hydraulic fracturing.

