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February 18, 2022

British Columbia Utilities Commission
Suite 410, 900 Howe Street
Vancouver, B.C.
V6Z 2N3

Attention: Mr. Patrick Wruck, Commission Secretary

Dear Mr. Wruck:

Re: FortisBC Energy Inc. (FEI)

Project No. 1599185

Application for a Certificate of Public Convenience and Necessity (CPCN) for Approval of the Coastal Transmission System Transmission Integrity Management Capabilities Project (Application)

Response to the British Columbia Utilities Commission (BCUC) Panel Information Request (IR) No. 1

On February 11, 2021, FEI filed the Application referenced above. On February 4, 2022, BCUC staff responded by email with BCUC Panel IR No. 1. FEI respectfully submits the attached response to BCUC Panel IR No. 1. FEI would be pleased to respond to any further questions from the Panel.

If further information is required, please contact the undersigned.

Sincerely,

FORTISBC ENERGY INC.

Original signed:

Diane Roy

Attachments

cc (email only): Registered Parties

1.0 Reference: DESCRIPTION AND EVALUATION OF ALTERNATIVES

Exhibit B-1 (Application), pp. 65, 76; Exhibit B-5, BCUC IR 2.9.1; FEI Comprehensive Review and Application for a Revised Renewable Gas Program, Exhibit B-11,

pp. 76–78, 81–82

Hydrogen Blending

On page 65 of the CTS TIMC Application, FEI states:

> This pipeline replacement (PLR) alternative involves replacing the existing pipeline in its entirety with a new pipeline coated with a high integrity coating that is not conducive to the formation of SCC.

On page 76 of the CTS TIMC Application, FEI provides the following high level financial analysis of the electro-magnetic acoustic transducer in-line inspection (EMAT ILI), PLR and pipeline exposure and recoat (PLE) alternatives:

Table 4-4: NPV Cost Comparison of Three Remaining Alternatives (2020$)

	Alternative 4: EMAT ILI ($ millions)	Alternative 5: PLR ($ millions)	Alternative 6: PLE ($ millions)
NPV of Capital Cost	$225	$1,818	$1,909
NPV of O&M Costs (Savings)	$82	$(7)	$(7)
NPV of Total Capital and O&M Costs	$307	$1,811	$1,902

In response to BCUC Information Request (IR) 2.9.1, FEI stated:

> FEI is still evaluating the impact of an increasing concentration of hydrogen in FEI's natural gas system on the risks posed by stress corrosion cracking, including SCC crack growth behaviour, and is unable to provide discussion at this time.

On pages 76-77 of the Comprehensive Review and Application for a Revised Renewable Gas Program (Renewable Gas Program Review), FEI stated:

> [H]ydrogen presents a significant opportunity to complement RNG in decarbonizing the provincial gas supply. There is strong policy support to develop hydrogen as a low-carbon fuel within the energy mix to meet long-term decarbonization goals. For instance, the BC Hydrogen Strategy states: "Large-scale deployment of renewable and low-carbon hydrogen will play an essential role in reducing B.C.'s emissions."

> FEI is involved with multiple national and international joint initiatives that aim to rapidly develop a hydrogen ecosystem capable of producing and distributing hydrogen affordably as part of a lower carbon energy supply. Through its involvement, FEI intends to learn best practices from pioneering hydrogen projects

> that may be applied in BC. As FEI's understanding of hydrogen production, distribution and end-use applications develops, FEI will pilot projects that will test the use of hydrogen in closed systems. FEI is currently progressing to pre-feasibility planning and technical analyses for introducing hydrogen into the gas distribution network before 2025 and is evaluating large-scale projects for the centralized production and distribution of hydrogen.

On page 81 of the Renewable Gas Program Review, FEI stated:

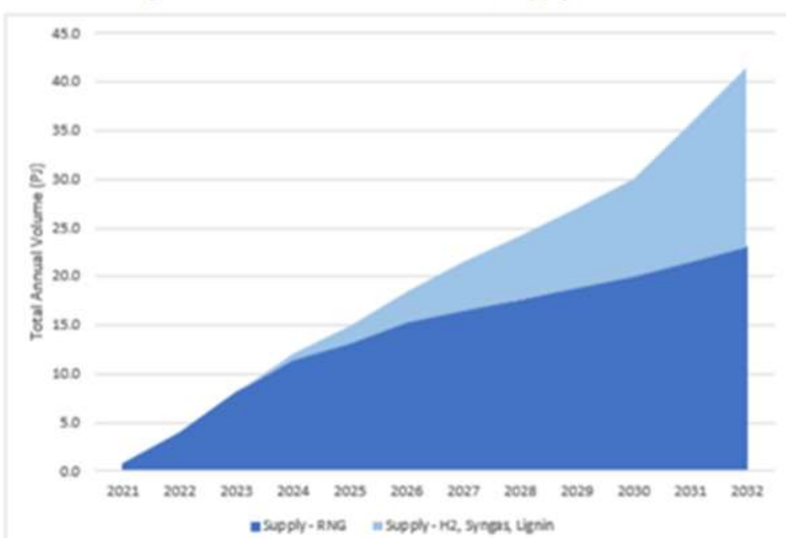
> There are technical and regulatory barriers to integrating alternate forms of Renewable Gas, such as hydrogen, into the gas system. These barriers could delay the use of hydrogen, synthesis and lignin to provide FEI's customers with low carbon energy services. FEI is undertaking steps to ensure that the existing gas pipeline system can accommodate other forms of Renewable Gas and, as applicable, that there are alternative methods to deliver these gases to customers. [Emphasis added]

On page 82 of the Renewable Gas Program Review, FEI stated:

> Assessing the blending of hydrogen into the gas supply, including a technical readiness evaluation. FEI is also in the process of testing how hydrogen interacts with pipeline materials, components and other equipment on its system, enabling hydrogen transport as a blend in the gas system, and the feasibility of hydrogen transport via repurposed high pressure transmission pipelines with a long-term goal of repurposing segments of existing natural gas networks for the delivery of 100 percent hydrogen gas. [Emphasis added]

On page 78 of the Renewable Gas Program Review, FEI provided the following 10-year renewable gas supply forecast:

Figure 6-3: 10-Year Renewable Gas Supply Forecast



1.1 Please provide an update regarding FEI's evaluations into the impacts of blending increasing concentrations of hydrogen into its natural gas transmission and distribution systems.

Response:

FEI continues to advance a range of activities to study, test, and verify that hydrogen is safe to use in the existing gas system and to identify any changes that may be required to ensure the continued safe operation of the gas system. As FEI discusses in the responses to these IRs, regardless of these activities, the data collected by EMAT ILI is necessary to allow FEI to identify and address any cracking threats on the CTS pipelines today. FEI's CTS pipelines will continue to be used and useful as they are capable of safely transporting a blend of hydrogen and large scale replacement of the CTS is neither expected nor cost-effectively feasible. As FEI has an obligation to provide safe service to its customers, FEI cannot defer the CTS TIMC Project due to the potential for hydrogen-related developments on its system.

The following provides background regarding blending hydrogen in pipelines and describes FEI's ongoing activities to investigate doing so.

Hydrogen-ready pipe is well understood

Hydrogen gas has been safely stored and transported in high-pressure steel tanks and pipelines for many decades. As such, the engineering challenges are well understood. Pipelines that are considered fully hydrogen-ready have been specified, designed, and constructed from their outset to transport pure hydrogen. As such, consideration is given to materials, components, and procedures (e.g., pipeline steel, welds, gaskets/seals, valves, etc.) that are known to be able to operate in a pure hydrogen environment.[1] However, even pipe that was not designed and constructed from the outset for hydrogen service can still transport meaningful quantities of hydrogen, in some cases with little to no modifications, as FEI explains below.

Preliminary analysis shows FEI's CTS can transport a blend of hydrogen

FEI has completed preliminary analysis to understand the admissible limits for hydrogen blending for its existing natural gas infrastructure and end-use customer equipment and applications. The analysis was informed by current industry knowledge and indicates that the existing transmission pressure pipelines in the Lower Mainland can transport a blend of hydrogen and natural gas. This is consistent with industry experience from hydrogen blending pilot projects around the world that have consistently demonstrated that steel pipelines can accommodate low hydrogen concentrations (approximately 10 percent or less) with no negative effects.

[1] https://h2tools.org/.

EMAT ILI will be a valuable input to establishing an upper limit for hydrogen blending

While FEI is confident that it can safely transport low concentrations of hydrogen in the CTS, there is no industry-accepted "bright-line" demarcation between hydrogen percentages that are considered acceptable versus unacceptable. This is because every pipeline configuration is different, including the pipe material (e.g., grade and thickness of the steel), operating pressure, gas composition, etc. Even pipe that was not designed from the outset to be hydrogen-ready may still be determined to be capable of transporting hydrogen in higher concentrations. This is done by conducting an engineering assessment which considers a range of factors such as the pipeline design, asset records, and operating history to determine what level of hydrogen blending can be accommodated without negative impacts to the pipeline. One of the inputs to this assessment is data collected from various inline inspection tools including MFL, C-MFL and EMAT. As such, the EMAT ILI data to be collected by the CTS TIMC Project will form a valuable input into determining the allowable concentration of hydrogen in each of the CTS pipelines.

FEI is investigating methods to mitigate risks of higher hydrogen blends

Hydrogen has different chemical properties compared to methane. The most significant concern in the context of steel pipelines is variously known as "hydrogen embrittlement" or "hydrogen-induced cracking". Hydrogen gas is made up of hydrogen molecules which can dissociate into hydrogen atoms on the inside surface of steel pipe and, because hydrogen is the smallest atom, it has some propensity to adsorb into the steel lattice comprising the pipe body and welds. This can degrade the mechanical properties of the steel, and, in simple terms, can cause it to become more brittle and result in the formation or growth of cracks. This is why the data collected by EMAT ILI, which will allow FEI to identify and address any cracking threats on the CTS pipelines, will also help FEI evaluate the safe operation of the CTS pipeline under various hydrogen blending scenarios in the future. FEI is also investigating emerging industry solutions to inhibit hydrogen embrittlement, such as the presence of small quantities of oxygen. Further research and technical assessment is ongoing to analyze if the levels at which the oxygen is present would be sufficient to mitigate the risk of embrittlement if high concentrations of hydrogen were added to the CTS pipelines.

Update on FEI activities

FEI provides an update below on the following ongoing activities:

1. Gas system readiness, system-planning and deployment strategy;
2. Industry collaboration, research and development, feasibility work;
3. Pilot and demonstration project development; and
4. Codes, Standards and Regulations.

1. Gas System Readiness, System Planning and Deployment Strategy

In 2021, FEI completed the scope definition and budget and schedule planning for a project to confirm the admissible limits for hydrogen blending for its existing natural gas infrastructure and end-use customer equipment and applications in British Columbia. This project will start in 2022 and focus on the following key objectives to be completed by 2024:

- Develop a system-wide hydrogen impact assessment to determine the acceptable range of hydrogen content throughout the gas system and confirm hydrogen blend level targets in the gas system that would be suitable for safe long-term operation;
- Determine longer-term increases to the hydrogen blend targets that would be feasible with continuing research, regulatory amendments and codes and standards development, mitigation measures, and network upgrades;
- Identify existing locations throughout FEI's gas service areas with the capability to support initial clusters of hydrogen production and distribution to initiate and grow market demand;
- Develop a hydrogen deployment roadmap to address the technical uncertainties, overlapping project requirements, and any limitations on system capacity to optimize for larger-scale hydrogen production, distribution and use; and
- Develop a deployment strategy to manage change and address safety, training, and education for internal operations and supply chain stakeholders, and the wider societal perceptions and considerations.

2. Industry Collaboration, Research and Development, Feasibility Work, Sector Specific Approaches:

FEI has been a member of various ongoing joint industry partnerships with both private industry and university institutions since 2017 that are in the process of testing how hydrogen interacts with pipeline materials, components, and other gas system equipment using hydrogen blend concentrations in natural gas from 5 percent up to 100 percent by volume. The key objectives of these activities include:

- Advance the adoption of new ways and means to distribute hydrogen and new end-use applications;
- Evaluate the technical and economic feasibility of large-scale projects for the centralized production and distribution of hydrogen;
- Advance involvement with multiple international joint initiatives that aim to share scientific knowledge and technical guidance to rapidly develop the ecosystems that can affordably produce and distribute fuels such as hydrogen as a clean energy supply;
- Engage industry expertise to research the feasibility of hydrogen transport via repurposed natural gas pipelines with a long-term goal of repurposing some segments of existing natural gas networks to 100 percent hydrogen service; and

- Continue to examine and learn best practices from pioneering hydrogen projects that can be applied in BC.

3. Pilot and Demonstration Project Development:

FEI's understanding of hydrogen production, distribution, and end-use applications continues to expand. As such, FEI has also begun developing pilot and pre-commercial demonstration projects to test hydrogen production and the use of these low-carbon fuels in a closed system. The key objectives of this activity are:

- Initiate hydrogen development and deployment through strategic demonstrations with university institutions and other development activities to scale supply and demand in key sectors;
- Demonstrate via hydrogen injection/blending pilot projects the viability and safety of hydrogen as a renewable fuel by addressing the technical uncertainties of introducing hydrogen into the existing gas network, and the potential impacts on end-users;
- Demonstrate a hydrogen micro-grid using hydrogen specific infrastructure to capture, clean, deliver and use byproduct hydrogen to decarbonize industry; and
- Pilot hydrogen separation to remove hydrogen from natural gas steam at locations where this may be necessary.

4. Codes, Standards and Regulations

FEI continues to engage with the various standards working groups to modify and develop safety and technical standards and set longer-term objectives to transition the regional natural gas network to adopt hydrogen. This includes hydrogen-ready infrastructure initiatives, including the certification of new appliances and equipment and the design of hydrogen-compatible natural gas infrastructure. The key objectives of this activity are:

- Harmonize codes and standards across jurisdictions (provincial and international) to ensure that best practices are applied across the domestic and international hydrogen economy.
- Work with the CSA Z662 *Oil and Gas Pipeline Systems* standard task force to review and update the requirements for gas pipelines. This will ensure that pipelines containing pure hydrogen, hydrogen blends, or biomethane blended with natural gas are fully aligned with or incorporated into the CSA Z662 and CSA Z245 *Steel Pipe* standards.
- Develop an FEI corporate hydrogen standard that will guide all aspects of hydrogen blending in the natural gas supply and that will allow FEI, or third-party suppliers, to blend hydrogen into the gas network.

1.2 Based on the 10-year renewable gas supply forecast reproduced above, what percentage (by energy) of the gas in the CTS will be hydrogen in: i) 2030; ii) 2040; and iii) 2050.

Response:

By 2030, FEI expects that there will be minimal hydrogen in the gas flowing in the CTS pipelines. FEI cannot know at this time what the precise percentage of hydrogen in the gas in each CTS pipeline will be in 2040 or 2050, but FEI expects that methane (whether from conventional or renewable sources) will continue to exceed 80 percent by volume of the gas transported by the CTS pipelines for at least 20 years. Additional amounts of hydrogen to support FEI's low-carbon diversified pathway may also be transported by other new or repurposed infrastructure.

1.3 Please explain whether there will be a need to replace existing pipeline segments of the CTS to accommodate the distribution of hydrogen. If so, please indicate the anticipated timing of such replacement.

1.4 Please explain whether there will be a need to repurpose existing pipeline segments of the CTS for the delivery of 100 percent hydrogen. If so, please indicate the anticipated timing of such replacement.

1.4.1 Please explain whether repurposing existing pipeline segments of the CTS would involve replacing the entire length of or portions of the selected pipeline segments with new hydrogen-tolerant piping.

1.5 Please explain whether any of the pipelines modified in the CTS TIMC Project will no longer be used or useful following the blending of increasing concentrations of hydrogen into the CTS. Please explain why or why not.

1.6 Please confirm that, had FEI proposed the PLR as its preferred alternative, the pipeline materials and/or the pipeline coatings would have been selected to ensure the CTS is hydrogen-tolerant. If confirmed, please provide any additional cost related to that selection and its impact on the net present value (NPV) of the PLR alternative.

Response:

While there is some uncertainty around the future pace of hydrogen adoption and distribution for FEI, this uncertainty has no impact on the need for the CTS TIMC Project. FEI expects that the CTS pipelines will continue to be used and useful.

In summary:

- The CTS pipelines will continue to be used and useful. They can accommodate a blend of hydrogen today and EMAT ILI will be a valuable input to establishing an upper limit for hydrogen blending.
- If 100 percent hydrogen distribution is pursued by FEI in the future, this may be done through retrofitting existing infrastructure, by new infrastructure, or by production of hydrogen closer to the point of use.
- EMAT ILI is a significantly more cost-effective solution as compared to PLR and will allow long-term operation of the CTS pipelines, even in a future where hydrogen blending is contemplated.
- The data collected by EMAT ILI is necessary to allow FEI to identify and address any cracking threats on the CTS pipelines today.

FEI expands upon each of these concepts below.

The CTS pipelines will continue to be used and useful

FEI's CTS pipelines will continue to be used and useful. As discussed in the response to BCUC Panel IR 1.1, FEI has completed preliminary analysis which indicates that the existing transmission pressure pipelines in the Lower Mainland can transport a blend of hydrogen and natural gas. This is consistent with industry experience from hydrogen blending pilot projects around the world which have consistently demonstrated that steel pipelines can accommodate low concentrations (approximately 10 percent or less) with no negative effects. While there is no industry-accepted "bright-line" demarcation between hydrogen percentages that are considered acceptable versus unacceptable, EMAT ILI information will be a valuable tool to help determine what level of hydrogen blending can be accommodate without negative impacts to the pipeline.

If 100 percent hydrogen distribution is pursued by FEI in the future, this may be done through retrofitting existing infrastructure, by new infrastructure, or by production of hydrogen closer to the point of use.

At this time, FEI does not know which, if any, of the segments of the CTS might need to be replaced or repurposed, nor the timing of this work. However, FEI does not envision that the CTS pipelines would be removed and replaced with new hydrogen-ready pipelines, as this would not be a cost-effective method to potentially support 100 percent hydrogen distribution. Instead, by 2030, FEI envisions that blending of hydrogen would expand across the low-pressure gas distribution system, with the potential for segments of the system around hydrogen hubs to be converted to 100 percent hydrogen. Between 2030 and 2050, as demand for hydrogen grows, FEI envisions that the existing gas system pipeline corridors would be retrofitted, upgraded, and expanded to transport an increasing share of hydrogen and (bio)methane in a progressively decarbonized gas system. Additional amounts of hydrogen to support FEI's low-carbon diversified pathway may also be transported by other new or repurposed infrastructure.

In all these potential scenarios, EMAT ILI will continue to be needed to address the risk of cracking threats on the CTS pipelines.

All of the pipeline segments modified by the CTS TIMC Project will be used and useful following the blending of increasing concentrations of hydrogen into the CTS

As explained in Section 5.4.2 of the Application, replacement of some pipeline segments is included within the scope of the CTS TIMC Project. During their design and construction, FEI will consider the potential for future use of these pipeline segments to transport increasing percentages of hydrogen. For clarity, these limited replacements may not make the overall pipeline capable of transporting high concentrations of hydrogen, but they may eliminate possible future bottlenecks and allow FEI to increase hydrogen blending concentrations in certain pipelines for little to no cost.

Including future pipeline replacement costs in the NPV analysis for the PLR alternative is not necessary

FEI confirms that had it proposed the PLR as its preferred alternative, the pipeline materials and/or the pipeline coatings would have been selected to ensure the CTS would be hydrogen-tolerant. However, the NPV financial analysis of the PLR alterative need not account for future costs to replace segments of the CTS with hydrogen-tolerant piping. As discussed in the Application and FEI's arguments filed in this proceeding, the PLR alternative is not financially feasible and EMAT ILI is the only feasible alternative to address the threat of cracking on the CTS. As shown in Table 3-9 of the Application, the CTS consists of approximately 254 km of pipeline and replacing all these pipelines would be highly impactful to customers and the public. Further, as shown in Table 4-4, the cost would be at least an order of magnitude higher than the CTS TIMC Project cost. The potential for hydrogen developments on the CTS does not change FEI's conclusion that PLR is not feasible.

CTS TIMC Project is needed now

The only prudent course of action at this time is to modify the existing CTS pipelines to allow them to be inspected using EMAT ILI. This will allow any existing cracking issues to be identified and addressed. Given that the CTS pipelines can carry a blend of hydrogen today, and replacement of the CTS to accommodate hydrogen is not reasonably contemplated, FEI's CTS pipelines will continue to be used and useful. As FEI has an obligation to provide safe service to its customers, FEI cannot defer the CTS TIMC Project due to the potential for hydrogen-related developments on its system.

The information gathered by EMAT ILI will also directly factor into FEI's analysis of determining what concentration of hydrogen each pipeline can safely accommodate in the future. In turn, this will allow FEI to determine a safe and cost-effective plan for transitioning to increased hydrogen distribution in the future. For example, EMAT ILI may identify that FEI could greatly increase the allowable concentration of hydrogen blending in a given pipeline by simply replacing short pipeline segments in limited areas. This would be cost effective for customers as it would allow for targeted upgrades to achieve higher levels of hydrogen concentration. The information provided by EMAT ILI is a necessary input to this determination.