345 Carlingview Drive
Toronto, Ontario M9W 6N9
Tel.: 416.734.3300
Fax: 416.231.1626
Toll Free: 1.877.682.8772

www.tssa.org

July 08, 2020

Re: Enbridge Low Carbon Energy - TSSA file SR# 2581426 - OEB file number: EB-2019-0294

The applicable regulation that applies to Enbridge Low Carbon Energy project is Ontario Regulation 210/01: Oil and Gas Pipeline Systems. The applicable standard for this project is CSA Z662-15 which TSSA adopted under FS-238-18 - Oil and Gas Pipelines CAD Amendment (February 15, 2018). The mentioned Code Adoption Documents (CAD) specifies the standards that are adopted by TSSA and any changes or addition to the requirements of CSA Z662-15.

TSSA audits all utility companies that are licensed to distribute "gas" in the province of Ontario. Last audit of Enbridge Gas Inc. (EGI) was in September 2017. The interval of the mentioned audits were every five years. TSSA is in process of drastically changing the interval and process of the audits by end of 2020. Th new audit format will be risk-based approach and rates the performance of the utility companies. TSSA also reviews and audits all new pipeline projects that are submitted to OEB for leave to construct. The review of the new pipeline projects submitted to OEB consist of reviewing the technical aspect of the project and focused on compliance to the adopted standards and O.Reg.210/01. TSSA has authority to issue order to operator for any non-compliances to the regulation and\or adopted standards.

Reference to Consumers Council of Canada interrogatory #7 and OEB staff #16, EGI is licensed by TSSA as "gas" distributor in the province of Ontario under license # 000163537. "gas" is defined in O.Reg. 210/01 as below:
"gas" means any gas or mixture of gases suitable for domestic or industrial fuel that is conveyed to the user through a pipeline;
According to this definition, EGI does not need any extra approval from TSSA for blending the hydrogen to the distribution network. However according to same definition, EGI requires to prove to TSSA that that mixture of gases is suitable for domestic or industrial fuel for the end users.

Even if TSSA did not do its own investigation on hydrogen blending, however because of attending in different committees including CGA and CSA technical committees, is familiar with this project. It is now known that the CSA testing has begun with many standard HVAC appliances being tested with up to 15% by volume hydrogen, however the report of these test is not published yet. TSSA had several meetings with EGI since November 2018 regarding Low Carbon Energy project and Hydrogen blending. At that time TSSA got familiar with the effort of

European countries on Hydrogen blending. The focus was HYREADY guidelines on the readiness of natural gas system for H2 blending. DNV GL is an international accredited registrar and classification society headquartered in Hovik, Norway. DNV GL has initiated a global joint industry project (JIP) to help prepare the natural gas distribution infrastructure for the injection of hydrogen produced from renewable sources. HYREADY involves stakeholders from the natural gas value chain, including natural gas transmission and distribution system operators and technology providers. The result of this report discussed in a meeting with EGI dated June 26, 2020. Original project road map also referred to CGA (Canadian Gas Association)/AGA (American Gas Association) Hydrogen blending group. This report submitted to TSSA dated July 07, 2020. This report reviewed in detail and following items mainly from this report and information provided by EGI on Exhibit B, Tab 1, Schedule 1, Attachment 1 from the OEB filing and responses to TSSA initial review of the project.

A review of the key issues:

a) The most important item in TSSA point of view was the impact of hydrogen blending on end-user appliances and certification of these appliances. On the above-mentioned reports, it was explained that several studies have discussed the issue of maximum hydrogen blend levels at which no or minor modifications would be needed for end-user systems, including appliances such as household boilers or stoves and industrial or power generation. The conditions determining a maximum hydrogen blend level that does not adversely influence appliance operation or safety vary significantly and include the composition of the natural gas, the type of appliance (or engine), and the age of the appliance. The impact of hydrogen blends on industrial facilities must be addressed on a case-by-case basis, and stationary gas engines likely will require changes to control systems. Also, according to the response from EGI, there is no specific definition of natural gas, there were no anticipated impacts to certification of appliances. CSA/ANSI Z21.1-2018 Table 13 specifies the characteristics of test gases for household cooking appliances. It is also used for furnaces and water heater standards. Gas B is for manufactured gas (which has higher hydrogen content) that the proposed blended gas but it is not longer being used. There was also discussion to test appliances with a hydrogen mix, but it has not been added to the standards.
b) Material interchangeability including existing piping system in the selected network: According to the above-mentioned reports and engineering assessment done by EGI, no adverse affect is anticipated on this hydrogen blending rate.
c) The differences between properties of hydrogen (H2) and methane (CH4). More specifically the differences on Lower Explosive Limit (LEL), auto-ignition and flame speed. Hydrogen has lower LEL and higher flame speed and almost similar auto-ignition temperature. However, at this blending rate no adverse affect was suggested by any of the reports and pilot tests that are done around the world.

TSSA requested more documents for review of this project by an email dated April 14, 2020. In this email several items requested for review including risk assessment done on this project. CFD modelling on indoor leaks, Dispersion modelling on outdoor leaks, fault tree analysis on end-user equipment (with the addition of hydrogen), all items that are incorporated in the EGI risk assessment to quantify the “global” risk. This document is not received yet for review.

This project so far has been reviewed on the technical aspects of the project including design, material specification, wall thickness calculation, end-user equipment assessment. In general, TSSA is in support of this project for the following reasons:

a) Operator did sufficient work on end-user equipment assessments. According to EGI assessment, at the studied levels of hydrogen blending in the selected area, no direct safety issues (flashback, burner overheating, etc.) related to end use equipment is anticipated. Also, responses to original review of the project provided by EGI dated June 29, 2020 shows that the operator did due diligent to even test the hydrogen blended gas on some appliances in Markham facility. In this investigation, a fireplace, barbeque, gas range, indoor grill and furnace were used. The results were satisfactory.
b) Many works are done by different organizations including CGA\AGA and HYREADY on hydrogen blending and addressing the safety concerns. 2% and even higher hydrogen blending rate considered suitable according to the engineering assessment done by EGI and all the work that are done around the world.
c) The pilot projects mentioned on Exhibit B, Tab 1, Schedule 1, attachment 1, table 1 clearly shows successful blending of hydrogen even on higher percentages.
d) According to the CGA\AGA report the auto-ignition temperatures of hydrogen and methane are very similar. Also, Wobbe number at 2% hydrogen blend is very close to natural gas (0.4% difference). The definition of the Wobbe Number is based on the Higher Heating Value (HHV) and specific gravity of a gas and it is related to the thermal input to a burner (BTU per hour). The usefulness of the Wobbe Number is that for any given orifice, all gas mixtures that have the same Wobbe Number will deliver the same amount of heat.
e) Many safety concerns mentioned in CGA\AGA report including following and all results show that blending 0-5% hydrogen do not adversely affect on these items:
    i) Fire and Explosion Risks
    ii) Hydrogen Embrittlement and Durability of Metal Pipes
    iii) Permeability of Hydrogen Through Metal and Plastic Pipes
    iv) Leakage
    v) Stationary Reciprocating Gas Engines: Up to 2% suggested for this item
    vi) Leak Detection: up to 5%, however further investigation suggested by report.

TSSA suggest following documents to be the condition of the approval by OEB:

a) TSSA acceptance of the risk assessment of this project done by EGI. It is worth to note that EGI expressed his concern for proprietary of this document. According to section 24(1) of the Technical Standards and Safety Act, this document when submitted to TSSA is not a public document and TSSA can only share the result of the review.

TSSA will audit and inspect the EGI to ensure compliance with applicable technical and safety standards for construction and operation of this project.

Should you have any questions, please contact me at 416.734.3539 or by e-mail at kmanouchehri@tssa.org. When contacting TSSA regarding this file, please refer to the Service

Request number provided above.

Yours truly,

Kourosh Manouchehri, P.Eng.,
Fuels Safety Engineer
Tel.: (416) 734-3539
Fax: (416) 231-7525

c. Mr. Ritchie Murray
Project Advisor | Supply & Infrastructure | Applications
Ontario Energy Board