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

www.tssa.org

August 14, 2020

VIA EMAIL

Ms. Christine Long
Board Secretary
Ontario Energy Board
2300 Yonge Street, 27th Floor
Toronto, ON M4P 1E4

Dear Ms. Long:

Re: Enbridge Gas Inc. (Enbridge Gas)
Ontario Energy Board (OEB) File: EB-2019-0294
Low Carbon Energy Project (Project)
TSSA responses to Federation of Rental-housing Providers of Ontario (FRPO)

In response to FRPO's questions related to the above-mentioned project, please find the Technical Standards and Safety Authority's (TSSA's), responses enclosed.

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

REF: Exhibit I.SEC.1 and OEB Staff Interrogatory 1

Preamble: To be of assistance to the TSSA, we are providing the specific reference to which we believe, Staff IR 1 refers
http://www.rds.oeb.ca/HPECMWebDrawer/Record/680231/File/document
The table on pdf page 124 of that document states:

"NPS 12 pipe and fittings are not approved for general use by EGD and will require a variance from TSSA to install. Potential operational concerns because of limited experience with NPS 12 PE IP.

In addition to Staff's IR 1, we would like to understand better the technical aspects of the approach that TSSA would undertake to provide a variance.

1) Has the TSSA, CSA or other recognized safety agency undertaken a testing of NPS 12 IP PE pipe exposed to hydrogen for the long term?
   a) If not, please provide a brief description of the process that the TSSA would undertake to test the pipe while simulating long term exposure to hydrogen.

2) Has the TSSA, CSA or other recognized safety agency undertaken a testing of steel High Pressure exposed to hydrogen for the long term?
   a) If not, please provide a brief description of the process that the TSSA would undertake to test the steel pipe under high pressure conditions while simulating long term exposure to hydrogen.

TSSA Response

TSSA cannot comment on Enbridge's statement regarding the requirement for a variance. According to the current regulations and adopted standards, no variance was required for this project.

1) TSSA is not a testing or a certification agency. TSSA relies on accredited certification agencies accepted by Standard Council of Canada. CSA is an accredited certification agency and responsible for such a test. With the current hydrogen blending rate of up to 2%, according to the documents submitted by EGI and other literatures including the CGA\AGA report, this project complies with the Code and regulations.
2) TSSA is not aware of any accredited certification agency testing the effects of steel piping exposed to hydrogen. However, TSSA is aware of CSA testing blends of hydrogen up to 15% for appliances. The report is expected to be ready by October 2020.

REF: TSSA EGI LCEP Review Report 20200708, page 2

Preamble: The TSSA review report states: "*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."

We would like to understand more about the TSSA reliance on DNV GL's work in this area to inform its support for the EGI project.

3) Please provide the TSSA's understanding of the JIP project as it pertains to the EGI project.
   a) To the TSSA's knowledge, has DNV GL done long term simulation testing of components in a natural gas system?
   b) How might that work be applicable to the EGI project?
   c) What other aspects of the JIP project provide TSSA comfort for its support of the EGI project?
4) Please provide the presentation materials form the June 26, 2020 meeting.
   a) Please provide any minutes taken in the meeting.
   b) Please provide all correspondence in regard to any follow-up items generated in the meeting.
   c) Has TSSA initiated any communication directly with DNV GL to work toward standards and codes that may advance the blending of hydrogen with natural gas in a risk sensitive fashion?
      i) If so, please provide a summary of the progress in this area.

TSSA Response

3) TSSA's knowledge of DNV GL is limited to what is explained in the original report.
4) No presentation document was provided to TSSA.

a) TSSA does not believe that disclosing the minutes of this meeting will clarify evidence previously filed by TSSA or promote the full and satisfactory understanding of the matters to be considered in the hearing (which are criteria for interrogatories set out in s. 26.01 of the Rules of Practice and Procedure ["Rules"]). Furthermore, the interrogatory question does not "contain specific requests for clarification of a party's evidence, documents or other information in the possession of the party and relevant to the proceeding", as required by s. 26.02(d) of the Rules. TSSA can provide a summary of the minutes of the meeting.

The topic of the mentioned meeting was "Enbridge presentation on Low Carbon Energy Project (LCEP) and HYREADY \ CGA, AGA reports". The agenda of the meeting was as follows: Introductions; Overview of Engineering Work/Program and Findings; Overview of Risk Assessment Process and Findings; TSSA Questions from April 2020; Roundtable and Action items; and Conclusions.

The following items were discussed in detail with representatives from Enbridge and TSSA and reviewed during this meeting:
- Overview of existing international blending projects
- The engineering assessment methodology
- Major R&D initiatives and the key findings
- HYREADY guidelines with details and summary

- Overview of the initial closed loops
- Material breakdown of the distribution system
- Overview of the key properties of hydrogen
- Interchangeability analysis of the impact of hydrogen addition
- Emissions of the end-user equipment assessment
- Computer modeling of the outdoor and indoor dispersion
- 2% by volume hydrogen has nearly the same characteristics as natural gas
- Risk Assessment Overview
  - CSA Z767 - Process Safety Management

b) No email requests for follow-up items were sent to the operator. Email requests were mainly requested through the virtual meetings on June 26, 2020, which TSSA and EGI key subject matter experts attended. In the mentioned meeting, it was emphasized that the complete risk assessment needs to be reviewed by TSSA subject matter experts. Subsequently, TSSA received all the requested documents for the review of this project from the operator.

c) No.

REF: Exhibit B, Tab 1, Schedule 1, Page 18

Preamble: The TSSA review report states: "*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.*"

We would like to understand better the scope of the material interchangeability that the TSSA is relying upon.

5) Please describe material interchangeability as used in the above reference.
   a) What conclusions does the TSSA draw from EGI's information on material interchangeability?
   b) Do these conclusions apply to each of the following systems in this project:
      i) The natural gas delivery system
      ii) The customer piping and its components
      iii) The hydrogen creating and holding station that delivers hydrogen to the natural gas system.

6) Did these reports include documented assessments of the long-term effects of hydrogen embrittlement?
   a) If so, please provide those aspects of the reports with included references as appropriate.

TSSA Response

5)

a) With the blending rate of less than 2% hydrogen, there is no need for any change on the selected network, according to the engineering assessment provided by EGI and other reports reviewed by subject mater experts within TSSA.
b) Yes, for all the mentioned items. TSSA began reviewing and inspecting the last item as a field development project in 2016; the review and inspection are still in progress.

6)

a) The reports did not refer to the long-term effects of blending up to 2% of hydrogen on the materials. However, the operators have the responsibility to assess their asset and perform maintenance, as required by the standard, and TSSA audits the operators, as explained in the initial report.

REF: TSSA EGI LCEP Review Report 20200708, page 2

Preamble: The TSSA review report states: "*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.* "

We would like to understand better the TSSA's views on the impact of a lower LEL from blending hydrogen into the natural gas stream as it pertains to risk.

7) Please define Lower Explosion Limit and Upper Explosion Limit (UEL)?
   a) What is the LEL and UEL of hydrogen?
   b) What is the LEL and UEL of natural gas?
   c) What is the resulting LEL and UEL of 2% hydrogen blended with 98% natural gas?
   d) What would the effect of the broader range between LEL and UEL for the blended stream on unanticipated leakage inside a customer's premises which prevented atmospheric release of the gas?
      i) What are TSSA views on the additional risk associated with the blended stream vs. the non-blended natural gas stream?

TSSA Response

7) LEL is defined in CSA Z662-15. Please refer to this standard to get more information on the definition of the LEL. UEL is not defined in this standard.

For items "a" to "d", please see the report issued by CGA\AGA in the attachment of the following file: EGI_IRR_Updated_20200709.

(d)(i) TSSA subject mater experts reviewed the submitted engineering assessment, CGA\AGA report, and risk assessment done by Enbridge and other institutes; TSSA did not find any code non-compliances with the suggested hydrogen blending rate of up to 2% for the selected network. The operator's risk assessment was reviewed by TSSA's

risk department, and the risk was within the acceptable criteria for the public receptors according to the standards.

REF: TSSA EGI LCEP Review Report 20200708, page 2

Preamble: The TSSA review report states: "*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.*"

We would like to understand better the nature of the requested items and the potential impact on contingent approvals.

8) Please provide the email request.
   a) Please provide all follow-up correspondence to or from EGI relative to these requests.

TSSA Response

8) The request to review the risk assessment was made during the virtual meeting, dated June 26, 2020.
   a) The complete risk assessment has been submitted to TSSA and reviewed by TSSA risk engineers and pipeline engineers. The reviewed document was comprehensive and addressed the "global risk" mentioned in this question. As mentioned in the original report, this document is considered confidential by operator.

REF: TSSA EGI LCEP Review Report 20200708, page 3

Preamble: The TSSA review report states: "*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:….*

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."

We would like to understand better the TSSA basis for its support of this project as it pertains to the issue of Hydrogen Embrittlement.

9) Please provide an explanation of the concept of hydrogen embrittlement of steel pipe.
   a) How did the TSSA evaluate the impact of the addition of hydrogen on the steel components in the existing system that will be exposed to the hydrogen.
   b) In the view of the TSSA, what is the maximum % content of hydrogen in a natural gas stream below which steel components can carry the gas safely at high pressures over an extended period of time?
      i) Please add any clarifications in terms of Specified Minimum Yield Strength, Maximum Operating Pressure, etc.

10) For the projects referenced in the referenced Table 1,
   a) did the TSSA review these projects for applicability to the proposed EGI project?
      i) If so, did the TSSA review these projects to determine if the components of these systems were comparable to the those proposed by EGI?
         (1) If yes, please provide a summary of conclusions drawn from the review.
      ii) If not, what aspects of Table 1 provide the TSSA the necessary evidence to provide support for the project?

TSSA Response

9)

a) Based on TSSA's review of the documents provided by EGI and other literatures mentioned above, a blend of hydrogen of up to 5% was found to be acceptable with the engineering assessment. TSSA reviewed the submitted engineering and risk assessment and found the risk associated with blending 2% of hydrogen to be in tolerable range to public receptors.

b) Based on TSSA reviews, up to 5% of hydrogen blending is acceptable with engineering assessment. The maximum operating pressure on the selected network in this project is not considered to be "high pressure". Steel embrittlement can be an issue on much higher pressures than the normal operating pressure of the distribution networks. Based on TSSA's review of the submitted risk assessment, the effect of 2% hydrogen on the selected network is within the acceptable criteria.

i) Specified Minimum Yield Strength only applies to steel pipe and does not apply to polyethene pipes. The distribution network has a combination of these materials. The maximum operating pressure for the selected network was found to be suitable for both materials with the selected hydrogen blending rate, based on the engineering assessment submitted by EGI. The normal operating pressure is 55 psig for the selected network.

10)

a) No. The table displayed successful hydrogen blending on higher rates in other parts of the world. However, as TSSA did not review these projects in details (they are outside of TSSA's jurisdiction), TSSA cannot comment further.

REF: Exhibit B, Tab 1, Schedule 1, Attachment 1, Page 15-16

Preamble: EGI evidence states: "Enbridge Gas consulted with the Technical Standards and Safety Authority (TSSA) to introduce and provide information on the Project. The TSSA indicated that they will act as a technical reviewer on behalf of the Ontario Energy Board for the LTC application if requested."

We would like to understand better how the TSSA intends to perform the role of technical reviewer.

11) Please provide a reference to the standards that the TSSA has applied to technical reviews of other hydrogen-natural gas blend projects?
   a) Would these standards be applied to the review of this project?
   b) If not, what standards will be applied?

TSSA Response

11) TSSA's jurisdiction is only Ontario, and TSSA has not reviewed any other hydrogen blending projects within Ontario. TSSA can comment on what is relevant to this project. Depending on the use of the hydrogen, different regulations will apply to any pipeline project. If the hydrogen is used as a fuel, the applicable regulations are either Ontario Regulation 212/01: Gaseous Fuels (upstream production) or Ontario Regulation 210/01: Oil and Gas Pipeline Systems (downstream production). If the hydrogen is not considered as fuel, the applicable regulation for pressure boundary is Ontario Regulation 220/01: Boilers and Pressure Vessel Regulation. Also, for the production facility, Ontario Regulation 219/01: Operating Engineers Regulation will apply. Each of these regulations have Code Adoption Documents (CADs) which adopt specific standard(s). For distribution network (downstream of the production facility), the applicable regulation is O.Reg.210/01, which CSA Z662-15 has adopted through FS-238-18 - Oil and Gas Pipelines CAD Amendment (February 15, 2018). All the above-mentioned regulations and CADs and adopted standards were used for review of this project by TSSA.

REF: TSSA EGI LCEP Review Interrogatory Responses

Preamble: Throughout the letter of 20200708, we noticed a strong reliance on external agencies including EGI for statements made by TSSA in support of the project. We believe the Board ought to be informed of the source of TSSA's understanding as a basis for response to Interrogatory Responses provided to the Board

12) For each of the responses provided to our interrogatories above and the Board staff's interrogatories, please specify which of the responses relies on:
   a) Codes published in Ontario or Canada – please provide the Code and reference
   b) Safety regulators from other jurisdictions – please specify the regulator
   c) Enbridge Gas Inc.
   d) Enbridge Inc.
   e) External Associations – please specify the association
   f) Other utilities – please specify the utility
   g) Literature Review – please provide a specific literature reference

Response

12)
   a) All of the responses relied on what is explained in response in 11 above.
   b) TSSA responses are based on what is applicable in Ontario. Regulations in other jurisdictions do not apply to this project. Other research around the world is only viewed as supplementary documents to support the project review.
   c) All the responses relied on information provided by Enbridge Gas Inc.
   d) All the correspondence was to Enbridge Gas Inc.
   e) No external association was directly consulted by TSSA for this project. However, the responses relied on the CGA\AGA report. TSSA has members on different CSA technical committees, including the Gas Distribution Technical Committee and

Technical Committee on Installation Code for Natural Gas and Propane Appliances. This topic was discussed in different CSA technical committees.

f) No other utility was directly consulted by TSSA for providing the responses. However, other utility companies have members in the CSA Gas Distribution Technical Committee, and this topic is discussed with the committee and is on the agenda for future meetings.

g) All the responses relied on the review of CGA\AGA report. Please see: EGI_IRR_Updated_20200709.

Also following literatures reviewed:

- https://www.nrel.gov/docs/fy13osti/51995.pdf.
- https://www.osti.gov/servlets/purl/1366892
- https://www.hydrogen.energy.gov/pdfs/progress14/viii_4_san_marchi_2014.pdf
- https://prod-ng.sandia.gov/techlib-noauth/access-control.cgi/2013/138904.pdf
- https://www.dgc.dk/sites/default/files/filer/publikationer/C1703_IGRC2017_iskov.pdf