ENBRIDGE GAS INC.
Answer to Interrogatory from
Board Staff (STAFF)

Reference: Exhibit C1/ Tab 2/ Schedule 1/ pg. 93 – Probability of Failure and Asset Health Indices

Question:

With respect to asset analytics, Enbridge Gas Distribution has noted that for some asset classes, historic failure data can be combined with structured tacit knowledge and statistical methods to establish a probability of failure based on age and other statistically significant factors. The probability of failure is used to establish an Asset Health Index – a measure of the current health of the asset population and its expected deterioration.

a) Please provide a list of the asset classes for which health indices are available?
b) Please provide an outline of a process describing how the health indices were arrived at and how the health data is combined with maintenance data to determine asset replacement rates?

Response

a) The 2017 Asset Health Review has asset health indices for the following assets and components.

Asset Class	Asset Category	Asset Sub-Class
Pipes	Distribution Mains	Steel Mains
		Pre-1977 PE Mains
		1977 to 1985 PE Mains
		Post 1985 PE Mains
	Services	Steel Services
		Pre-1977 PE Services
		1977 to 1985 PE Services
		Post 1985 PE Services
	Risers	Steel Risers
		Copper Risers (AMP Fittings)
		PE Risers
		Anodeless Risers
	Mainline Valves (>= NPS 4)	Ball Valves
		Gate Valves
		Plug Valves
		Unknown Type Valves
Stations	District Stations	Station Valve Systems
		Station Regulators
	Header Stations	Station Valve Systems
		Station Regulators
	Sales Stations	Station Valve Systems
		Station Regulators
Storage	Compressor Stations	Compressors
		Crank Assemblies
		Engines
		Foundations
		Aftercoolers
		Heating & Cooling System
		Valve System
	Valves	Station Valves
		Pool Valves
		Pipeline Valves

b) Asset Health Indices are used to score or rate the condition of an asset by incorporating a method to measure the progress of degradation leading to failures (for example those that result from corrosion). Structured tacit knowledge is combined with maintenance and failure data and asset management system to establish a probability (or intensity) of failure curve for each asset or component in the population. An example of relevant tacit knowledge is the significance of good annual cathodic protection readings on a steel pipeline system.

Statistical tools such as SAS and ReliaSoft are used to support this work.

A reliability curve can be developed for each asset or component in the gas distribution system using failure and asset data for the population as a whole. If the tacit knowledge referenced above is available for particular assets, it can be used to adjust the reliability curve to reflect that knowledge.

Reliability engineering applies statistical techniques to calculate the probability of failure for individual assets. An Asset Health Index ("AHI") is the quantification of a calculated condition assessment using reliability engineering to determine the condition of an asset relative to its end of life for non-repairable assets, or its next expected failure for repairable assets.

The AHI methodology provides a high level 10-year overview of the failure probability of asset types. The AHI takes the 10-year average of an asset's probability of failure and classifies the asset into a grouping which showcases the expected time span of its failure. The AHI incorporates an asset's current day probability of failure and the degradation of that asset averaged over a 10-year period.

The table below describes the AHI categories for Pipe, and Station gas carrying assets based on years.

Health Index Category	Time to First or Next Failure
HI1	Greater than 40 years
HI2	Within 40 years
HI3	Within 25 years
HI4	Within 10 years
HI5	Within 5 years

The Storage Health Index ("SHI") method shown in the table below also incorporates probability of failure, however instead of using the age parameter, it uses run time. The five categories were established to closely represent a typical year based on 2,000 run hours per year.

HEALTH INDEX CATEGORY	TIME TO NEXT FAILURE
SHI1	Greater than 10,000 run hours
SHI2	Within 10,000 run hours
SHI3	Within 5,000 run hours
SHI4	Within 3,000 run hours
SHI5	Within 2,200 run hours

As shown in Exhibit C1, Tab 2, Schedule 1, page 70, lifecycle strategies and replacement rates are derived from a number of factors such as the AHI, observed condition, risk, operability, maintainability, obsolescence, and historical failure rates.