STATE OF VERMONT
PUBLIC UTILITY COMMISSION

Investigation pursuant to 30 V.S.A. §§ 30 and 209 regarding the alleged failure of Vermont Gas Systems, Inc. to comply with the certificate of public good in Docket 7970 by burying the pipeline at less than required depth in New Haven, Vermont	)	Case No. 17-3550-INV
Notice of Probable Violations of Vermont Gas Systems, Inc. for certain aspects of the construction of the Addison natural gas pipeline	)	Case No. 18-0395-PET

PREFILED DIRECT TESTIMONY OF KEVIN BODENHAMER ON BEHALF OF VERMONT ELECTRIC POWER COMPANY, INC. AND VERMONT TRANSCO LLC

July 23, 2021

Summary of Testimony

In response to the Commission's order of April 30, 2021, Mr. Bodenhamer of TRC was retained by VELCO to perform a technical review of relevant information concerning whether the HS-20+15% loading standard has been met, considering among other things the May 25, 2016 engineering study prepared for VGS by Mott MacDonald ("MM") and (the "2016 MM Study"). In addition, VELCO asked TRC to consider three assumptions in the 2016 MM Study: (1) the diameter of the pipeline (12 inches versus 15 inches); (2) the method of burial (trenching versus horizontal directional drilling); and (3) the density of the soil surrounding the pipeline. Mr. Bodenhamer's testimony addresses those issues.

Q1. Please state your name and occupation.

A1. My name is Kevin Charles Bodenhamer. I am employed by TRC Pipeline Services, LLC ("TRC") as Vice President and Chief Engineer. I am also a Registered Professional Engineer in all 50 states and the District of Columbia.

Q2. Please describe your educational and business background.

A2. I have a Bachelor of Science degree in Civil Engineering from Missouri University of Science and Technology (formerly University of Missouri – Rolla). I have over 40 years of experience in the construction, engineering, design, operation, maintenance, and regulatory compliance of natural gas and hazardous liquids pipelines and related facilities. Throughout my career I have been involved in all phases of a pipeline's "life cycle" including, but not limited to, initial feasibility, routing, co-location assessments, engineering, detailed design, permitting, construction, testing, commissioning, operations, maintenance, regulatory compliance, conversion of service, decommissioning, abandonment, and removal. My resume is provided as *Exhibit VELCO-KB-1*.

Q3. Have you previously testified before the Public Utility Commission or other regulatory bodies?

A3. No, I have not testified before the Vermont Public Utility Commission, but I have testified before similar state agencies such as the Oklahoma Corporation Commission and the Texas Railroad Commission. I have also testified before federal agencies such as the Pipeline and Hazardous Materials Safety Administration (PHMSA) and the National Transportation Safety Board (NTSB).

Q4. What is the purpose of your testimony?

A4. In the Commission's Order of April 30, 2021 in this proceeding, it stated the following:

> A key finding in the Liability Order is that the burial depth that Vermont Gas achieved in the VELCO right-of-way in New Haven has the potential to limit VELCO's future use of its right-of-way for additional transmission lines. VELCO only recently sought party status in this case and therefore did not participate in the evidentiary hearing. However, in its recent filing VELCO has now opined that the hearing officer's proposed findings on the burial-depth issue, and thus whether the applicable loading standard has been met, are incorrect. We believe that there would be value in hearing testimony from VELCO in this proceeding on why it believes the loading standard has been met.
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> We believe it will be judicially efficient for VELCO to provide testimony as to whether the pipeline as buried in the swamp would, or would not, limit its future use of its right-of-way for additional transmission lines. If VELCO relies on the previously filed study to support its conclusions, then it must account for the flawed assumptions in the study identified by the hearing officer.

In response to the Commission's order, VELCO retained TRC to perform a technical review of relevant information concerning whether the loading standard has been met, considering, among other things, the May 25, 2016 engineering study prepared for VGS by Mott MacDonald ("MM") (the "2016 MM Study"). In addition, VELCO asked TRC to consider three assumptions in the 2016 MM Study that the Commission focused on in its order: (1) the diameter of the pipeline (12 inches versus 15 inches); (2) the method of burial (trenching versus horizontal directional drilling); and (3) the density of the soil surrounding the pipeline. My testimony addresses the above issues.

Q5. What is TRC's role as a consultant to VELCO with respect to this Commission proceeding concerning VGS's pipeline in the VELCO ROW near New Haven, Vermont?

A5. I have been retained by VELCO to review the installed depth of cover and allowable vehicular loading for the VGS pipeline near New Haven, Vermont, as it pertains to the Commission's Order of April 30, 2021.

Q6. What work have you performed and what engineering, technical, and other materials have you considered in preparation of your testimony?

A6. I have reviewed the following information:

- Technical Memorandum between VELCO and VGS, dated October 1, 2012
- Memorandum of Agreement between VELCO and VGS, dated June 13, 2013
- VELCO/VGS Construction, Operations, and Maintenance Agreement, dated July 24, 2015
- Mott MacDonald report to VGS concerning pipe stress calculations, dated May 25, 2016
- CHA Consulting, Inc.'s report to VGS concerning pipe loadings, dated November 7, 2014
- RCP report to the Vermont Public Utility Commission, dated December 11, 2019
- Mott MacDonald report to VGS concerning pipe loading, dated June 15, 2021
- Reviewed the route of the installed pipeline via Google Earth Pro.

Q7. Paragraph 5 of the MOU that you cite above states, "VGS will design the Project in VELCO's ROW and access roads into VELCO's ROW to meet an HS-20+15% standard which VGS plans to meet by using Class 3 pipe interred at a depth of 4 feet." In the Commission's Order of April 30, 2021, it found that "the burial depth in the VELCO right-of way in the Clay Plains swamp in New Haven was less than four feet, and in some places less than three feet." Please explain your understanding of the loading standard and whether it has been met in the VELCO ROW, including in the Clay Plains swamp.

A7. The detailed design of pipelines takes into account many factors, one of which is external loads. The most common external load for a pipeline is from vehicles or equipment passing over the top of a pipeline while it is in service. This can come from cars or trucks passing over the pipeline at a highway crossing or from off-road equipment traveling along the right-of-way. The American Association of State Highway and Transportation Officials (AASHTO) is a standards-setting body which publishes specifications, test protocols, and guidelines that are used in highway design and construction throughout the United States. These specifications are utilized by pipeline engineers to determine external loads to the pipeline from vehicles or equipment to ensure that such loads can be safely tolerated by the pipeline. HS-20 is an AASHTO designation representing a fully loaded tractor trailer with a gross weight of 80,000 pounds, which is the maximum weight allowed in Vermont. The +15% indicates that the weight is increased by 15% for a margin of safety. The HS-20 +15% load classification is a very common and conservative approach to calculate external loads.

To actually translate the AASHTO load into design of the pipeline, engineers utilize American Petroleum Institute's Recommended Practice 1102, Steel Pipelines Crossing Railroads and Highways (API RP 1102). API RP 1102 is the formula used by pipeline engineers and referenced by PHMSA for the design of natural gas pipelines. The Vermont Public Utility Commission defaults to PHMSA regulations for intrastate gas transmission pipelines.

Review of the calculations and documentation for this pipeline indicate that the pipe has been designed and installed to safely accept the HS-20+15% loading at all locations and at 2' to 4' of ground cover above the pipe. These calculations were performed by Mott MacDonald, then reviewed by Brendan Kearns of CHA Consulting, Williams Byrd of RCP Inc, and now TRC. All of the consulting engineers concur that the pipeline as installed has sufficient cover and strength to support HS-20+15% loading.

Q8. Please explain how the APIRP 1102 calculations are performed, including the use of inputs and variables, as well as the use of the output for purposes of designing a pipeline that meets the HS-20+15% loading standard

A8. API RP 1102 calculations are performed utilizing the formulas provided in the recommended practice. These formulas were developed in the 1950s and can be done by hand, but decades ago they were placed into computer programs or software applications for efficiency and accuracy. An engineer will then input all of the variables concerning the pipe (diameter, wall thickness, grade, etc.), construction (burial depth, soil type, casing, etc.), operating conditions (pressure, temperature, etc.), and surface load (type of crossing, maximum surface load, etc.). The output of the calculations is the maximum stress applied to the pipe under the input conditions and then a comparison to the maximum allowable for

the pipe with a pass/fail determination. Pass indicates that the stress to be applied to the pipe by the surface load is within allowable limits and fail indicates that the stress to be applied by the surface load exceeds the allowable limits. All of the various cases that were run for this pipeline passed.

Q9. In your opinion, is a minimum depth of 4 feet necessary to reach the HS-20+15% standard in this section of the VELCO ROW? Why or why not?

A9. A depth of soil cover of 4' is not necessary for the pipe to support a HS-20+15% loading, as confirmed in the above-referenced documents utilizing API RP 1102 calculations for this pipeline as installed. As discussed previously, a soil cover anywhere in the range of 2' to 4' is sufficient for this pipeline as installed. In addition, the depth of cover required for this pipeline by PHMSA and Vermont Public Utility Commission regulations is 36 inches.

Q10. The 2016 MM Study concluded that a three-foot burial depth was sufficient to meet the loading standard. In the 2021 MM Memo that you mention above, MM concludes that as little as a two-feet burial depth meets the loading standard. Please explain: (i) your understanding of these studies; (ii) whether they were conducted according to appropriate industry standards and techniques; and, (iii) whether their conclusions were accurate.

A10. The MM studies and calculations were all performed utilizing standard industry and regulatory API RP 1102 calculations. In all cases the pipe as installed has sufficient strength to safely operate within the design conditions with as little as 2' of cover. The API RP 1102 calculations are the industry and regulatory standard for the design and safe operation of pipelines under normal vehicle loadings. Based upon my review of the above-referenced

documents, Mott McDonald performed all calculations correctly using the as-installed soil conditions and depth of cover.

Q11. The Commission requested that VELCO address three assumptions that were utilized in the 2016 MM Study. First, the Commission stated that the 2016 MM Study included a diameter of the ANGP (12.75 inches) which did not consider the cement coating of the pipeline which increased the total diameter to approximately 15 inches. In your opinion, does the fact that MM did not account for the cement coating on the pipe's overall diameter for purposes of its loading analysis affect the accuracy of MM's conclusion that the ANGP met the HS-20+15% loading standard? Please explain.

A11. No. MM's assumption to not include the cement coating in the diameter did not affect the accuracy of its conclusion. The purpose of concrete coating is to add weight to the pipe to counteract the buoyancy effect of the pipe to maintain the proper burial depth during construction or normal operation. The concrete coating does not add any strength to the steel pipe and thus is not considered in any pipe loading calculation. The API RP 1102 calculations do not take concrete coatings into account and rely solely on the diameter and strength of the steel pipe. Based upon my review of the above-referenced documents, Mott McDonald correctly performed the calculations by not considering the concrete coating.

Q12. The second assumption in the 2016 MM Study that was called out by the Commission was the method of installation – open trench vs. horizontal direction drill. In your opinion, did MM's assumption concerning the installation method for purposes of its loading analysis affect the accuracy of MM's conclusion that the ANGP met the HS-20+15% loading standard? Please explain.

A12. No. The method of installation did not affect the accuracy of MM's conclusion. Open trench construction is a common method of pipe installation in marsh or wetland locations. For marsh or swamp locations, concrete coating is used for buoyancy control, to ensure that the pipeline remains at the proper burial depth. The API RP 1102 calculations are not based upon the method of installation, but are based upon the physical conditions present after installation. Depth of cover and type of soil are two of the post construction conditions considered by API RP 1102. Based upon my review of the above-referenced documents, Mott McDonald correctly applied the API RP 1102 calculations for this pipeline.

Q13. The third assumption in the 2016 MM Study that was called out by the Commission was that the density of the soil surrounding the pipeline was a mix of "swamp water and mud," rather than compacted soil. In your opinion, did MM's soil density assumption affect the accuracy of MM's conclusion that the ANGP met the HS-20+15% loading standard? Please explain.

A13. No. The soil density during construction did not affect the accuracy of MM's conclusion. The API RP 1102 calculations take into account the type of soil above the pipe after construction when any surface load might occur. Soil conditions in wetland areas may vary throughout the year but the type of soil remains unchanged. The pipeline as installed has sufficient strength to support HS-20+15% loading in this area based upon the type of soil.

Upon my review of the above-referenced documents, Mott McDonald correctly applied all of the required variables, including soil type and soil conditions in the calculations.

Q14. Does that conclude your testimony at this time?

A14. Yes, it does.