Exhibit VGS-AG-119

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...	Case No.17-3550-INV

PREFILED TESTIMONY OF GREGORY R. LIEBERT, PE RE: MOTT MACDONALD LOAD-BEARING CALCULATIONS AND PROPOSED REMEDIES FOR CPG VIOLATIONS

September 10, 2021

Summary: Mr. Liebert testifies that all of the 2-foot depth of cover load-bearing calculations used by Mott MacDonald in Exhibit BC-4, when corrected to comply with the requirement imposed by the Commission in Docket No. 7970 that the ANGP satisfy Class 3 location standards (which impose a Design Factor of 0.5), result in failure. This is true of both CEPA and GPTC calculations, and remains true regardless of whether Mott MacDonald's axle-weight and bedding angle are inputted or whether corrected axle-weight and bedding angle are inputted.

Mr. Liebert testifies that Mott MacDonald's GPTC calculations, even when applying Class 1 standards, result in failure if the weight of a single axle is calculated. Mott MacDonald inputted only the weight of one-half of an axle. In fact, when inputting full axle-weight at 2-foot depth of cover, the calculated load-exceeds Specified Minimum Yield Strength.

Mr. Liebert testifies that even when inputting a half of an axle and using Class 1 standards, the calculations just barely pass by the Class 1 Design Factor.

Mr. Liebert also testifies that if bedding angle is inputted at zero, because of the muck conditions testified to by Mr. Bubolz, rather than the 30 degrees that is standard for trench burial, when inputting a single axle and using Class 1 standards, the result is load-bearing failure.

Mr. Liebert also found that the API RP 1102 calculations VGS relied upon for the other wetlands in the ANGP inputted 4-foot depth and a 180-degree bedding angle—and barely satisfy Class 3 standards even with those inaccurate assumptions.

Mr. Liebert also testifies that reduced depth of cover affects AC Mitigation. The unsigned ARK AC Mitigation Plan explicitly assumed a minimum of 3-foot depth of cover and also assumed that only the existing 115 kV line is present.

Mr. Liebert also addresses remedies that the Commission may wish to order, including: 1) an order that VGS cease operation of the ANGP in New Haven unless VGS demonstrates that Mr. Liebert's load-bearing calculations are incorrect; and 2) an order that, by a date set by the Commission, VGS submit, and the Commission approves, an AC Mitigation and Cathodic Protection Plan for the as-built ANGP that has been signed and sealed by a Vermont-licensed PE with experience in these areas.

Exhibits: *A.* Calculations; *B.* 49 C.F.R. 192.111; *C.* US BOR Method for Prediction of Flexible Pipe Deflection (2019); *D.* CEPA Final Report (2009)

Q.1. Mr. Liebert, have you previously filed testimony and your CV in these proceedings?

A. Yes, I have.

Q.2. Have you read the prefiled testimony and exhibits of Mr. Bodenhamer and Mr. Connaughton, and the deposition transcripts of Mr. Chaves, Mr. Bodenhamer and Mr. Connaughton?

A. Yes.

Q.3. What else have you done to prepare this testimony?

A. I calculated load-bearing capacity using the same software programs that Mr. Bodenhamer and Mr. Connaughton refer to, and that Mr. Chaves (the author of Exhibit BC-4) utilized. These software calculations are <u>Exhibit GL 9-10-21 Exhibit A</u>. I also referred to the Commission's December 23, 2013 Order, 49 C.F.R. 192.111 and the U.S. Department of the Interior, Bureau of Reclamation, methodology for determining deflection of flexible steel pipe (*Reclamation--Managing Water in the West, Method for Prediction of Flexible Pipe Deflection*, M-25 (3rd ed. 2019)[1]. Section 1902.111 is <u>Exhibit GL 9-10-21 B</u>. The BOR publication is <u>Exhibit GL 9-10-21 C</u>.

Q. 4. Please describe the calculations you performed, and what you discovered.

A. Federal regulation 49 C.F.R. 192.111 states that the Design Factor for Class 3 is 0.5, which is more protective than the Class 1 Design Factor of 0.72. A Design Factor of 0.5 means that the pipeline must be constructed so that the load on the pipeline is no greater than 50% of the Specified Minimum Yield Strength (SMYS). A Design Factor of

[1] The steel pipe used in the Addison Natural Gas Project (ANGP) is a flexible pipe.

0.72 means that means that the pipeline must be constructed so that it has no more than 72% of the SMYS.

When using the CEPA and GPTC models that Mott MacDonald used, I discovered that the load-bearing calculations used by Mott MacDonald in Exhibit BC-4 and discussed in Mr. Chaves' deposition used the Design Factor for Class 1 pipelines rather than the Design Factor for Class 3 pipelines. When corrected to comply with the requirement imposed by the Commission in Docket No. 7970 that the ANGP satisfy Class 3 standards, all of Mott MacDonald's calculations result in failure. This is true of both CEPA and GPTC calculations. (The API RP 1102 method is inapplicable because, as Mr. Chaves agrees, it cannot be used for depths of burial less than three feet, and also for other reasons I discuss below.)

This means that the ANGP in wetlands in New Haven fails the load-bearing standards in the CPG—regardless of whether the load-bearing capacity is acceptable to VELCO. Failure to satisfy the load-bearing standards in the CPG is related to, but distinct from, failure to satisfy the depth of burial standard in the CPG.

There is one apparent exception that is not an exception. The final page of the attachments to Exhibit BC-4 consists of a printout of GPTC calculation of load-bearing. It states that Mott MacDonald used a Design Factor of 0.5—but the results fail the 0.5 standard. The SMYS of the pipeline is 65,000 psi. The calculated combined stress shown on that page s 45,865 psi. This is a ratio of 0.71. This barely satisfies the Class 1 Design Factor requirement of 0.72 but does not satisfy the Class 3 Design Factor of 0.5. One must read the numbers. The numbers show failure. As noted next, however, this calculation also erroneously inputted only the weight of half of an axle.

I found that Mott MacDonald inputted only the weight of one-half of an axle; that is, the weight of only one wheel or set of wheels, when using the GPTC software. This is 18,400 pounds. When a truck crosses perpendicular to the pipeline, the pipeline must be able to bear the weight of the entire axle—<u>both</u> sets of wheels will pass over the pipeline at the same time, a weight of 36,800 pounds. Mott MacDonald's GPTC calculations, even when applying Class 1 standards, result in load-bearing failure if the full weight of one axle (36,800 pounds) is inputted. It does not appear from the testimony and depositions that VELCO is aware that the weight of only one-half an axle was modelled using the GPTC software, or that if the full axle is modelled the result is failure of the pipeline within the VELCO ROW when using Class 1 standards. In fact, when inputting full axle-weight at 2-foot depth of cover, the calculated load-exceeds Specified Minimum Yield Strength.

Mott MacDonald used the correct weight when entering inputs into the CEPA model. However, as noted above, that model showed failure to meet the Class 3 Design Factor of 0.5. In sum, the CEPA calculations show failure to meet Class 3 standards when inputting both wheels, while the GPTC calculations show failure of both Class 1 and Class 3 standards when inputting the weight of both wheels.

I also found that even when inputting only half of an axle and using Class 1 standards, the calculations result in an unacceptably small margin of safety at 2-foot depth of burial. I calculated the depth at which the weight of half an axle would violate the Class 1 standard. This occurs at 1.7 feet. I used the GPTC model, rather than the CEPA model, to determine this because the GPTC model is ratio-constrained for width. Mott MacDonald has submitted calculations that the pipeline meets loading standards at 2 feet (albeit Class 1 standards). Mr. Byrd found the pipeline to lie 2'5" or 2'6" below the surface in several locations. Mott MacDonald's engineer, Donald Hartman, stated in an attachment to Exhibit BC-4 that adherence to a 4-foot depth of burial standard provided a margin of safety of one foot above the Class 3 requirement of 3-foot depth of cover, which was important, he wrote, because the soils over the pipe may settle over time. For the same reason, a margin of safety of three-tenths of a foot is not acceptable.

I also found that an improper bedding angle was inputted. Bedding angle refers to the degrees (out of 360) of the circumference of the pipeline that is supported by the bedding beneath the pipeline. The standard, default input for CEPA and GPTC calculations is 30 degrees for trench burials. Because of the muck conditions testified to by Mr. Bubolz, use of the standard figure of 30 degrees is inappropriate. The actual degrees of support are unknown but will be significantly less than those of the usual trench. Input of the default value of 30 degrees does not constitute the conservative analysis needed for a natural gas pipeline in a high-voltage line right-of-way. I inputted zero as a worst-case scenario, since the actual value is unknown and the conditions described by Mr. Bubolz were close to liquid. The result was load-bearing failure using both the CEPA method and the GPTC method. However, as noted above, even when the standard 30-degree bedding angle is inputted all of the calculations fail to meet Class 3 standards for full axle-weight.

Discovery that Mott MacDonald had relied upon Class 1 standards and had inputted only half an axle into the GPTC calculations led me to ask what had been inputted into the API RP 1102 modelling done for wetland soils outside this one location. I looked at CHA's November 7, 2014 letter and attachments (Intervenors' Trial Exhibit 43). I found that CHA had inputted the weight of a full axle, 180-degree bedding and 4-foot depth of cover. With those inputs, the Class 3 Design Factor of .5 was satisfied by 5 percent (the load was .45 of SMYS). However, one-hundred-and-eighty-degree bedding is not achievable using open trench installation, especially in wetlands (because no compaction was allowed). Also, several locations in New Haven, and one in St. George, had less than four feet of cover according to Exhibit JSH-2 (pdf pp. 101, 107-107).

Q. 5. Please explain why you applied the Class 3 Design Factor.

A. Finding 26 in the Commission's Order stated:

26. The DPS recommended, and VGS has agreed, to build the Transmission Mainline to meet Class 3 standards, even in those areas where only Class 1 or Class 2 standards

apply. Howe pf. reb. at 7; David Berger, DPS ("Berger") pf. reb. at 2; Teixeira pf. reb. at 6; Heintz pf. reb. at 14.

Finding 262 stated:

262. Vermont Gas has agreed to adopt the additional safety measures recommended by the Department. The design of the Project will exceed safety standards established by the Pipeline Safety Code in several important respects, including the following:

●The pipeline will be constructed to meet Class 3 design requirements in all areas along the pipeline;

As noted above, federal regulations state that the Design Factor for Class 3 location is .5.

Q. 6. Please explain how you discovered that Mott MacDonald used the Class 1 Design Factor.

A. I was not involved in this matter in 2012 or 2013. I do not have detailed recall of the Commission's order in Docket No. 7970. When I was inputting the Design Factor in my modelling runs, I relied upon my training and experience as an engineer, and therefore I used the conservative Design Factor that I ordinarily use, which is 0.5. My results showed failure in every scenario. I realized that Mott MacDonald had not applied a Design Factor of .5. They did not determine whether the pipeline's SMYS would be at least 200% of the predicted load. I notified counsel of this result. He referred me to the Commission's order, which requires adherence to Class 3 standards. I had already read 49 C.F.R. 192.111, which requires a Design Factor of 0.5 for Class 3 pipelines and a Design Factor of 0.72 for Class 1 pipelines.

Q. 7. Please explain why you used the CEPA and GPTC models.

A. I used these models for several reasons. One is that Mott MacDonald used the CEPA and GPTC models and I wanted to try to replicate and verify Mott MacDonald's calculations and conclusions. I wanted to be able to compare the results of two different models to ensure the appropriateness of the calculations and validate the results. Another reason is that API RP 1102 cannot be used for depths of cover less than three feet. The model does not allow the user to enter depth of cover less than three feet. Mr. Chaves, in his deposition, agrees that API RP 1102 cannot be used with depth of cover of less than three feet. Another reason is that the engineering literature I have read, including the Manual for the CEPA model, explains that API RP 1102 was developed based on data derived from bored installations rather than trench installation. The CEPA and GPTC models were developed for use with regard to trench installation and therefore are more reliable.

Q. 8. Did you use any other models?

A. Yes I did. I used a software module that included the GPTC calculation method and another method, the Wheel Load Analysis model. Wheel Loading Analysis produced the same results of the GPTC calculations I conducted.

Q. 9. What is the role of soil classifications in determining load-bearing capacity?

A. Soils have been classified specifically for the purpose of calculating their contribution to the load-bearing capacity of a pipeline. Their suitability, or "modulus," is captured by the E' factor in load-bearing calculations. Both the Bureau of Reclamation and the CEPA Manual discuss the importance of utilizing correct soil classifications. They state that certain soils, those labelled CH, MH, OH and OL, have such poor load-bearing qualities that E' values should be entered as zero unless a competent soils engineer is consulted.

Q. 10. What E' value did Mott MacDonald input?

A. I am not a soil scientist. I have consulted the United Soil Classification System. Mr. Bubolz' description of the soils encountered in the wetlands suggests that they have the qualities of soils CH, MH, OH and/or OL.

Mr. Chaves performed a sensitivity analysis to validate his calculations. He inputted different soil conditions. This analysis was produced after his deposition had been completed. I have reviewed it. The worst-case scenario E' value he inputted was 50 psi. In his deposition, and in VELCO's discovery answers, I read that no soil scientist was consulted. Input of an E' value of zero would reduce further below Class 1 and Class 3 standards the results that Mott MacDonald produced.

Q. 11. What is the relevance of less than 3-foot depth cover to AC mitigation?

A. The ARK Mitigation plan stated that its modelling had assumed a minimum depth of cover of 3 feet. Depth of cover is a factor in determining the potential effect of stray current from a high-voltage line, but I am not an electrical engineer and would not attempt to perform those calculations. The ARK report explicitly stated that it assumed a minimum depth of cover of 3 feet. The ANGP in this wetland in New Haven has a depth of cover of less than 3 feet. The potential effects of stray current on a steel natural gas pipeline can be devastating. In my opinion the reduced depth of cover must be evaluated by a competent Vermont-licensed engineer versed in AC mitigation design, to recalculate AC mitigation needed for depths less than 3 feet.

Q. 11. What is the relevance of less than 3-foot depth cover to future construction of a 345 kV line in the VELCO ROW?

A. Mr. Connaughton has testified that the as-built condition of the ANGP in New Haven will not affect future construction plans. I don't believe that the Commission can reach that conclusion. The ARK report addressed only the effects of a 115 kV line on a pipeline buried at least 3 feet below grade. A higher voltage line will present greater risk to the pipeline. This risk has not been modelled for a gas pipeline that is less than 3 feet below grade, for either a 115 kV line or the combination of a 115 kV and a 345 kV line.

Q. 12. What remedies do you believe the Commission should consider with regard to depth of burial and load-bearing capacity?

A. The analysis submitted by Mott MacDonald fails to satisfy the safety standards agreed to by VGS in 2013 and then ordered by the Commission. The ANGP in this wetland in New Haven does not meet Class 3 standards for load-bearing or for depth of cover.

Regardless of VGS's commitments to meet Class 3 standards and the Commission's order imposing Class 3 standards, the as-built ANGP in New Haven violates federally mandated safety standards—if the full weight of one axle (36,800 pounds) is inputted into the GPTC model, the result is failure to satisfy minimum federal safety standards, those for Class 1 locations. If a conservative bedding angle is inputted, the result also is failure to meet minimum federal safety standards, when using either the CEPA or the GPTC model.

I believe that public safety demands that VGS promptly cease using the ANGP in this wetland unless VGS demonstrates that my load-bearing calculations are incorrect. If VGS submits evidence demonstrating that my calculations are incorrect, the Commission may wish to hold a hearing on the adequacy of that evidence. If the evidence fails to convince the Commission that the ANGP is safe, the ANGP should cease operation unless and until these failings are remedied.

As noted above, I have also found that load-bearing calculations for wetlands in other areas were predicated upon 4-foot depth of burial and 180-degree bedding. With these inputs, the pipeline load is .45 of SMYS. With more realistic inputs, the ANGP may fail to meet Class 3 standards, The Commission may wish to impose a condition that VGS submit load-bearing calculations that utilize actual depth of cover and bedding degree for all other wetland areas.

Q. 13. What remedies do you believe the Commission should consider with regard to the AC Mitigation and Cathodic Protection Plan?

A. VGS has been on notice of the public safety consequences and unlawfulness of failure to have a Vermont licensed professional engineer sign and seal the AC Mitigation and Cathodic Protection Plan since the National Transportation Safety Board issued its report on the Lowell explosion in the fall of 2018 and then I raised these issues in the reports filed with the Commission in the fall of 2019.

I previously have testified that AC Mitigation and Cathodic Protection is absolutely essential for public safety, and that co-location with a high voltage line increases the risk of corrosion due to induced electrical current. I testified that I find it astounding that a 41-mile natural gas transmission line, more than half of which has been co-located next to a high-voltage electric line, has been built, and is being operated on the basis of an AC Mitigation and Cathodic Protection design that was never signed and sealed by a licensed Vermont engineer with appropriate knowledge and experience. One cannot say "except for AC Mitigation and Cathodic Protection ," a natural gas pipeline project is safe.

At this juncture, I believe that the Commission should issue an order that VGS cease operation of the ANGP unless, within a specified number of days after the order, VGS submits an AC Mitigation Plan and Cathodic Protection Plan for the as-built ANGP that is signed and sealed by a Vermont-licensed professional engineer with appropriate knowledge and experience, and the Commission finds the submission to be reliable.

Q. 14. What remedies do you believe the Commission should consider with regard to the future construction of a 345 kV line?

A. Vermont may need, or benefit from, construction of a new high-voltage line within the existing right-of-way in New Haven, according to VELCO's testimony in Docket 7970. A 345 kV line will increase the risk of stray current damaging the ANGP.

So far, no licensed professional engineer has placed her or his name on the AC mitigation and cathodic protection plans. If, as I believe to be prudent, the Commission is to require that a licensed professional engineer sign and seal a report addressing the safety of the AC mitigation and cathodic protection of the as-built ANGP, the Commission may wish to require that the engineer also address these issues with regard to the 345 kV line. Remedial action that might be cost-effective with regard to the effects of the 115 kV may not be cost-effective once the impacts of the second line are evaluated.

This concludes my testimony.