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April 28, 2005 053-3044

Georgia Transmission Corporation
2100 East Exchange Place
Tucker, Georgia 30084

Attention: Mr. Stephan Tremblay

RE: FINAL REPORT FOR TESTING ON CI AGENT OIL STOP VALVE FOR GEORGIA TRANSMISSION

Dear Mr. Tremblay:

Golder Associates Inc. (Golder) is pleased to submit this final report to the Georgia Transmission Corporation (GTC). Mr. Michael Gudger of Tracy Hall & Associates, a representative for the CI Agent Oil Stop Valve, supplied the oil stop valves for the testing program. The transformer fluid (mineral oil) was supplied by GTC. Golder was requested to determine the flow rate of three different oil stop valves (valves) using two different permeants: water and mineral oil; as well as determining the "breakthrough time" the mineral oil would begin to penetrate through the valves.

The flow rate of the water through the valves was performed by Golder on April 20th and 21st. Mr. Gudger of Tracy Hall & Associates and Ms. Christy Johnson of GTC observed the flow rate of water through the CIA1814 valve, as well as the introduction of mineral oil to all three valves on April 21st. Ms. Johnson observed the dissection of all 3 valves on April 22nd. Below are descriptions, test results, and observations of each test. Table 1 is attached with the test results, and attached are sketches of two of the valves, as well as photographs of the valves.

Description of the CI Agent Oil Stop Valves

The valves are identified and described as follows:

- **CIA1814** was a Grey "Geotextile Top Hat with Flange" which had outside measurements of approximately 14 inches in diameter and 18 inches in length and inside measurements of approximately 12 inches in diameter and 16 inches in length. Between the inner geotextile and outer geotextile was a white powdery substance called CI Agent. The CI Agent allows water to pass through the valve freely (hydrophobic) but absorbs and impedes the flow of oil.

- **CIAPVC624SL** was a slotted 5.5 inch inner diameter and 24 inch length PVC pipe with a mounting flange (the slotted portion of the pipe was 20.5 inches in length). This slotted/flanged PVC pipe included a geotextile "sock" which had been slipped over the pipe (by the manufacturer) and attached with metal bands attached near the flange. This sock was also grey and had a white powdery substance called CI Agent between the inner geotextile and outer geotextile.

- **CIAPVC624AgentX** was also a slotted 5.5 inch inner diameter and 24 inch length PVC pipe with a mounting flange (the slotted portion of the pipe was 20.5 inches in length). This slotted/flanged PVC pipe included a geotextile "sock" which had been slipped over the pipe

(by the manufacturer) and attached with metal bands attached at the flange. The sock was a composite of a grey geotextile and material the manufacturer calls Agent X. This composite material appeared to be adhered together.

Flow Rate of Water through the Valves

Test 1A: **CIA1814** Flow Rate via Water

The flow rate was performed using two 150-gallon interconnecting water tanks with a piping system which flowed into the test specimen. The valve was affixed to an observation tank in order to collect the water from the valve. After the water exited the valve, the water was re-circulated back into the water tanks. The water filled the valve and the flow rate was adjusted to maintain a level within 1 inch of the top of the valve (to the sewn perimeter seam). An approximate 15-inch level of water was maintained within the valve. The flow rate was determined for the valve by measuring the quantity of water versus the time that it passes through the valve, in gallons per minute (gal/min). The average flow rate of this valve was approximately 43 gal/min.

Test 2A: **CIAPVC624SL** Flow Rate via Water

The flow rate was performed in a similar manner as mentioned above. The water filled the valve and the flow rate was adjusted to maintain a level within 0.5 inch of the top slot of the PVC valve (to the inner flange). An approximate 24-inch level of water was maintained within the valve. The flow rate was determined for the valve by measuring the quantity of water versus the time that it passes through the valve. The average flow rate of this valve was approximately 34 gal/min.

Test 3A: **CIAPVC624AgentX** Flow Rate via Water

The flow rate was performed in a similar manner as mentioned above. An approximate 13-inch level of water was maintained within the 24-inch length valve. Due to the maximum flow capacity of the test set-up, we were unable to completely fill the valve with water. The flow rate was determined for the valve by measuring the quantity of water versus the time that it passes through the valve. The average flow rate of this valve was approximately 34 gal/min with a 13-inch level of water. If the flow was able to maintain a 24 inch level of water within the valve, we estimate that the flow rate would be between 65 to 80 gal/min.

Flow Rate of Mineral Oil through the Valves

Test 1B: **CIA1814** Flow Rate via Transformer Fluid

After the flow rate using water was completed, mineral oil was poured into the valve (valve remained damp from the water) to a level within 1 inch of the top of the valve (to the sewn perimeter seam). Small droplets of oil effluent were first noted after approximately 60 seconds of adding the mineral oil to the valve ("breakthrough"). Once the oil level was topped off at the upper seam (approximately 1 inch below top of valve) the level of oil was periodically measured over a 24 hour period. The oil level decreased 0.6 inch (15 mm) over the 24 hour period.

Measurements of the effluent were obtained periodically over the 24 hour test period to determine the flow rate using a volumetric beaker and a volumetric pipette. The effluent was initially measured for a 75 minute time period and yielded a total of 54 ml; of this, approximately 42 ml was water and 12 ml was oil (could visibly see oil above (separated from) the water)). This initial flow rate of the oil has been calculated to be 4.2E-05 gal/min (0.16 ml/min). Several other measurements were taken over the 24 hour period. The last measurement was taken between the 18 to 24 hour periods. During this six hour period,

the effluent showed only oil and was measured to be 35 ml which converts to 2.6 E-05 gal/min (0.097 ml/min).

Test 2B: **CIAPVC624SL** Flow Rate via Transformer Fluid

The mineral oil was poured into the valve (valve remained damp from the water) up to the lower portion of the inside flange (above the top slot). Oil effluent was first noted after approximately 30 seconds of adding the mineral oil to the valve ("breakthrough"). Once the oil level was topped off, the level of oil was periodically measured over a 24 hour period. The oil level decreased 1.3 inch (33 mm) over the 24 hour period.

The effluent was initially measured for a 180 minute time period and yielded a total of 20 ml; of this, approximately 15 ml was water and 5 ml was oil. This initial flow rate of the oil has been calculated to be 7.3E-06 gal/min (0.028 ml/min). Several other measurements were taken over the 24 hour period. The last measurement was taken between the 18 to 24 hour periods. During this six hour period, the effluent showed only oil and was measured to be 5 ml which converts to 3.7E-06 gal/min (0.014 ml/min).

Test 3B: **CIAPVC624AgentX** Flow Rate via Transformer Fluid

The mineral oil was poured into the valve (valve remained damp from the water) and "breakthrough" of oil was noted almost immediately (3 seconds). Only one flow rate was measured which was approximately 4.4 gal/min (16,000 ml/min); however, this could be the rate the oil was being poured into the valve such that the oil flow rate could be greater. The test was terminated after a few minutes.

Observations

Test 1C: **CIA1814** Post Test Observations

After the 24 hour test period the oil was pumped from the valve to the original containers. We cut through the geotextile to expose the CI Agent Starting at the upper portion of the valve and then to the bottom, using a razor knife (utility knife) and scissors. The uppermost 1 to 2 inches of CI Agent appeared to be fully saturated with oil and had a thickness of approximately ¼-in to ½-in. Along the side cut of the valve the CI Agent was approximately 1 inch in thickness and appeared to be partially saturated; the inner portion was saturated (approximately ½ inch) while the outer portion was still powdery. The bottom portion of the valve had approximately 2 to 3 inches of CI Agent in which only the inner portion was saturated (½ to 3/4 inch) and the outer portion was still powdery.

Test 2C: **CIAPVC624SL** Post Test Observations

After the 24 hour test period the oil was pumped from the valve to the original container. Starting at the upper portion of the valve and then to the bottom, a razor knife and scissors were used to cut through the geotextile to expose the CI Agent. Along the side cut of the valve the CI Agent was approximately ½ to 1 inch in thickness and appeared to be partially saturated (approximately ½ inch); the inner portion was saturated while the outer portion was still powdery. The bottom portion of the valve had approximately 2 to 3 inches of CI Agent in which only the inner portion was saturated (½ to 3/4 inch) and the outer portion was still powdery.

Test 2C: **CIAPVC624AgentX** Post Test Observations

Starting at the upper portion of the valve and then to the bottom, a razor knife and scissors were used to cut through the geotextile to expose the Agent X material which appeared to be adhered to the geotextile. The geotextile/Agent X composite appeared to be saturated with oil and/or water.

Summary

All three valves appear to transmit water based on their manufacture. The flow rate of the mineral oil through valves CIA1814 and CIAPVC624SL is over a million times slower than the water flow rate (they both had CI Agent). However, the flow rate of oil through the CIAPVC624AgentX valve was only 14 times slower than the water flow rate. Breakthrough time may appear to be a function of the water that is remaining in the valve as it gets pushed out and replaced with the oil before the CI Agent can begin to react with the oil.

Golder Associates Inc. appreciates the opportunity to assist the Georgia Transmission Corporation with your laboratory testing requirements. If you have any questions, please do not hesitate to contact us 770-492-8281.

Very truly yours,
GOLDER ASSOCIATES INC.

Barry E. Sigmon, P.G.
Assistant Laboratory Manager

BES/HM:bes

Attachments: Photographs

Sketch

Table 1

Laboratory Test Results

	Water Flow Rate (gal/min)	Initial Oil Flow Rate (gal/min)	Final Six Hour Oil Flow Rate (gal/min)	Breakthrough (secs)	Absorption[3] (%)
CIA1814	43	4.2E-05	2.6E-05	60	4
CIAPVC624SL	34	7.3E-06	3.7E-06	30	6
CIAPVC624AgentX	65 to 80[1]	4.4[2]	4.4[2]	3	0

Notes:

1. Estimated flow rate if the flow was able to maintain a 24 inch level of water within the valve.

2. This could be the rate that the oil was being poured into the valve such that the oil flow rate could be greater.

3. Percent absorption is the amount of oil within the valve.