SUMMARY REPORT OF THE SCIENTIFIC PEER REVIEW OF THE

TEST PROCEDURE FOR DETERMINING ANNUAL FLASH EMISSION RATE OF METHANE FROM CRUDE OIL, CONDENSATE AND PRODUCED WATER

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Introduction

As part of an initiative by the State of California Air Resources Board (ARB) to reduce greenhouse gas emissions, regulations have been proposed. The Proposed Regulation for Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities (Oil and Gas Regulation) is given in Appendix A of the Initial Statement of Reasons (ISOR) document of May 31, 2016. Part of the regulations involve standardizing test procedures for determining annual flash emissions from vessels or tanks that store crude oil, hydrocarbon condensate and water. The summary and rationale for each section of the Test Procedure for Determining Annual Flash Emission Rate of Methane from Crude Oil, Condensate and Produced Water Tank and Separator Systems (Test procedure) is described in the ISOR on pages 78-83. The Test Procedure itself is given in Appendix C of the Oil and Gas Regulation. The ARB has requested that the Test Procedure be subject to scientific peer review.

As per Attachment 2 of the memo to Dr. Gerald Bowes, Manager, Cal/EPA Scientific Peer Review Program from the Office of Research, Planning and Performance of the State Water Resources Control Board on August 10, 2016, the Test Procedure scientific peer review has been divided into four conclusions.

The purpose of this report is to summarize a scientific peer review of conclusion 1:

1. The Test Procedure provides a sound approach for taking samples of oil, condensate and produced water upstream from oil and gas production separator and tank systems. The approach is described in Sections 1-9 of the Test Procedure, Appendix C of the Oil & Gas Regulation. A summary and rationale for these sections can be found on pages 78-81 of the ISOR.

The scientific peer review was initiated and this report are in response to the letter of October 26, 2016 from Dr. Gerald Bowes to the author.

Scientific Peer Review Results

Section 1 of the Test Procedure briefly discusses the Purpose and Applicability while Section 2 is the Principle and Summary of the Test Procedure and mentions that there are two methods, one involving a double cylinder and the other involving a piston cylinder. Section 3 is Definitions while Section 4 summarizes Biases and Interferences that can affect results. Sections 5 and 6 discuss Sampling Equipment Specifications and Sampling Equipment, respectively, and Section 7 lists Data Requirements required prior to sampling. Section 8 details the Double Valve Cylinder Sampling Method while Section 9 details the Piston Cylinder Sampling Method.

These sections were reviewed for common sense, accuracy and consistency and the procedures of Sections 8 and 9 were compared to GPA 2174-93. The results of the review are presented below as comments and suggested modifications pertaining to the procedure number.

Test Procedure Review Comments for Sections 1-9

4.3 State when samples are to be taken. For example: Samples shall not be collected from a pressure separator or portable pressurized separator while it periodically drains liquids but should be collected during periods liquids are not being drained.

4.6 State how often gauges should be calibrated. For example: All pressure and temperature measurements shall be conducted with calibrated gauges as specified in this procedure and these gauges should be calibrated twice per year.

4.8 The collection and testing of duplicate samples is recommended in order to verify the reported results. At least two samples are required but three samples are preferred.

5.1 Since even a small inaccuracy can change the results, more accurate pressure gauges are recommended. For example: A pressure gauge capable of measuring liquid pressures of less than 50 pound per square inch gauge pressure within +/-5% accuracy.

5.2 Since even a small inaccuracy can change the results, more accurate pressure gauges are recommended. For example: A pressure gauge capable of measuring liquid pressures greater than 50 pounds per square inch gauge pressure within +/- 3% accuracy.

6.4 High-pressure rated metal components and control valves that can withstand the temperature and pressure of the pressure vessel or portable pressurized separator

being sampled and should at least match the design pressure and temperature of the system being sampled.

7.2 (b) The separator temperature and pressure must be known (not optional), either from instruments on the vessel being sampled or the sample train.

8.1 Add why condensate the piston cylinder method is preferred for condensate samples. For example: The double valve cylinder sampling method is used for collecting crude oil or produced water samples and is not applicable for collecting samples of condensate due to potential sample flashing.

8.6 Make the boundary clear between the existing sample port fittings on the vessel of interest and the sample train. This can be done by stating that valve A is the sample source valve as follows: Connect the sampling train as illustrated in Figure 1 to the sampling port on the pressure separator or portable pressurized separator at the outlet of the sample source valve A while minimizing tubing between the purge valve and cylinder as shown. Bushings or reducers may be required.

8.7 Note that depending on the pressure drop across the sampling train purge valve, there will likely be some bubbles in the liquid stream. This can be added to the wording as follows: Purge the sampling train: Place the outlet of valve B into the waste container. With valves B, C and D closed, slowly open valve A completely, and then slowly open valve B to purge the sample train until a steady stream of liquid without gas pockets is observed, and then close valve B. Note that there may be some bubbles in the liquid stream due to some flashing across purge valve B.

8.10 Slightly modify the valve closure wording. Continue until 80 to 95 percent of the displacement liquid is measured in the graduated cylinder, then close valves D and then C.

8.13 The sample source valve needs to be closed before the sample cylinder can be removed so modify wording as follows: Close sample source valve A then disconnect the sample cylinder from the sampling train and verify that both valves are sealed.

8.14 Since valve A needed to be closed in 8.13, modify this procedure as follows: Remove sampling train: With valves A, D and C closed, purge any remaining liquid in the sampling train through valve B and then close valve B. Disconnect the sampling train from the pressure separator or portable pressurized separator at the outlet of sample source valve A.

Note that if these procedures do not consider valve A as the sample source valve, then they need to be modified to include a sample source valve located on the outlet of the existing sample port of the vessel of interest.

The double valve cylinder valves should be periodically leak tested (once per year) with an inert gas and a statement should either be added to the beginning of this section or added to Section 6.

9.1 The pressure of the inert gas needs to be added to the procedure, perhaps as follows: Locate a pressure separator immediately upstream of the separator or tank required for testing and verify it is pressurized to at least 15 psig. Install a portable pressurized separator if no pressure separator is available immediately upstream of the separator or tank that can be used to collect condensate and produced water samples. Ensure the inert gas in the piston cylinder is at least at the sampled vessel pressure or preferably a 3-5 psi above it.

9.4 As in the previous procedures, make the boundary clear between the existing sample port fittings on the vessel of interest and the sample train. This can be done by stating that valve A is the sample source valve as follows: Connect the sampling train as illustrated in Figure 3 to the pressure separator or pressurized portable separator at the outlet of the sample source valve A while minimizing tubing between the purge valve and cylinder as shown. Bushings or reducers may be required.

9.5 As in previous procedures, note that depending on the pressure drop across the sampling train purge valve, there will likely be some bubbles in the liquid stream. This can be added to the wording as follows: Purge the sampling train: Place the outlet of valve B into the waste container. With valves B, C and D closed, slowly open valve A completely, and then slowly open valve B to purge the sample train until a steady stream of liquid without gas pockets is observed, and then close valve B. Note that there may be some bubbles in the liquid stream due to some flashing across purge valve B.

9.7 State how the sampler is to judge how the filling rate of the cylinder and the volume collected. Is this done by an indicator rod? Or, perhaps the sampler just needs to follow manufacturer's instructions. Add a statement as follows: Collect liquid sample: With valve A opened and B closed, slowly open Valve D to allow liquid to enter the piston cylinder at a rate of 150 to 200 milliliters per minute until 80 to 95 percent of the cylinder is filled with liquid, as per manufacturer's instructions for cylinder indication. Do not allow pressure M to drop below the sampling pressure. Then close valves C and D.

9.10 Valve A must be closed before the sampling train can be removed so modify the procedure as follows: Close sample source valve A then disconnect the sample cylinder from the sampling train and verify that both valves C and D are sealed.

9.11 Remove sampling train: Place the outlet of valve B into the waste container and slowly open valve B to purge all liquid from the sampling train and then close valve B. Disconnect the sampling train from the pressure separator or portable pressurized separator at the outlet of sample source valve A.

Note that if these procedures do not consider valve A as the sample source valve, then they need to be modified to include a sample source valve located on the outlet of the existing sample port of the vessel of interest.

The piston cylinder should be leak tested across the piston periodically (once per year) with an inert gas so this should be added to either at the beginning of this section or added to Section 6.

Conclusion

The test procedure needs some modifications as outlined in this peer review report and with these modifications would provide a sound approach for taking samples of oil, condensate and produced water upstream from oil and gas separator and tank systems.