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Noble Energy Consent Decree (90-5-2-1-10811) – 1:15-cv-00841 RBJ

Third-Party Verification Final Audit Report
First Audit

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First Audit

Prepared for:

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This document has been prepared by SLR International Corporation. The material and data in this report were prepared under the supervision and direction of the undersigned.

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DEFINITIONS

For purposes of this report, every term expressly defined in this section shall have the meaning given that term herein. Where noted, the terms have the meaning expressly defined in the Consent Decree ("CD")[1].

As defined in Section III of the CD, "condensate" means hydrocarbon liquids that remain liquid at standard conditions (68 degrees Fahrenheit and 29.92 inches mercury) and are formed by condensation from, or produced with, natural gas, and which have an American Petroleum Institute gravity ("API gravity") of 40 degrees or greater.

As defined in Section III of the CD, "Engineering Design Standard" means an engineering standard developed by Noble pursuant to Paragraph 9 of the CD.

"Engineering Evaluation" means application of the Modeling Guideline and Engineering Design Standard to determine if the Vapor Control System at each Tank System is adequately designed and sized to handle the Potential Peak Instantaneous Vapor Flow Rate pursuant to Paragraph 10 and 11 of the CD.

As defined in Section III of the CD, "EPA" means the United States Environmental Protection Agency and any of its successor departments or agencies.

As defined in Noble's Modeling Guideline, "Flash," "Flashing," "Flash Losses" or "Flash Vapor" means the released hydrocarbons and other entrained gases from liquid that are emitted to surroundings when the liquid changes temperature and/or pressure.

"Flash Factor" means the volume of gas at standard conditions (60 °F and 29.92 inches mercury), standard cubic feet (scf), flashing from each U.S. Petroleum barrel (bbl) at stock tank conditions (scf/bbl).

As defined in Section III of the CD, "IR Camera Inspection" means an inspection of a Vapor Control System using an optical gas imaging infrared (IR) camera designed for and capable of detecting hydrocarbon and volatile organic compound (VOC) emissions, conducted by trained personnel who maintain proficiency through regular use of the optical gas imaging infrared camera.

As defined in Section III of the CD, "Modeling Guideline" means the modeling guideline developed by Noble pursuant to Paragraph 8 of the CD.

As defined in Section III of the CD, "Normal Operations" means all periods of operation, excluding Malfunctions. For storage tanks at well production facilities, normal operations includes, but is not limited to, liquid dumps from the Separator.

As defined in Section III of the CD, "Parties" means the United States, the State of Colorado, and Noble.

[1] CD between the United States, the State of Colorado, and Noble, Civil Action No. 1:15-cv-00841-RBJ, entered by the U.S. District Court of Colorado as final judgment on June 2, 2015.

As defined in Section III of the CD, “Potential Peak Instantaneous Vapor Flow Rate (PPIVFR)” means the maximum instantaneous amount of vapors routed to a Vapor Control System during Normal Operations, including flashing, working, breathing, and standing losses, as determined using the Modeling Guideline.

As defined in Section III of the CD, “Tank System” means one or more tanks that store Condensate and share a common Vapor Control System.

As defined in Section III of the CD, “Tank System Group” means one of the groupings of Tank Systems as set forth in Paragraph 10.a of the CD.

As defined in Section III of the CD, “Three Line Pressure Groupings” means the distribution of Tank Systems that are associated with Well Production Operations which produce gas into sales lines that, as of August 17, 2014, had line pressures within the following three ranges: (1) 233 psi or greater (“Group I”); (2) less than 233 psi and greater than or equal to 186 psi (“Group II”); and (3) less than 186 psi (“Group III”). If Noble later determines that another grouping of the Tank Systems is more appropriate, in consultation with EPA and CDPHE and subject to both agencies’ prior written approval, the Tank Systems can be redistributed among Group I, Group II, and Group III.

As defined in Section III of the CD, “Vapor Control System (VCS)” means the system used to contain, convey, and control vapors from Condensate (including flashing, working, breathing, and standing losses, as well as any natural gas carry-through to Condensate tanks) at a Tank System. A Vapor Control System includes a Tank System, piping to convey vapors from a Tank System to a combustion device and/or vapor recovery unit, fittings, connectors, liquid knockout vessels or vapor control piping, openings on Condensate tanks (such as pressure relief valves (“PRVs”) and thief hatches), and emission control devices.

ACRONYMS

API	American Petroleum Institute
bbl	U.S. Petroleum barrel (42 gallons)
CDPHE	Colorado Department of Public Health and Environment
COCR	Certification of Completion Reports
CPF	Central Production Facility
EPA	United States Environmental Protection Agency
ESD	Emergency Shut Down
HPCV	High Pressure Control Valve
IR	Infrared
oz/in^2	ounces per square inch
PCCM	Post-Certification of Completion Modifications
PPIVFR	Potential Peak Instantaneous Vapor Flow Rate
psi	pounds per square inch
psia	pounds per square inch, absolute
psig	pounds per square inch, gage
PRV	Pressure Relief Valve
scf	standard cubic feet
scfh/bbl	standard cubic feet per hour per U.S. Petroleum barrel (42 gallons)
STEM	Storage Tank Emission Monitoring
TLO	Tank Truck Loadout
tpy	tons per year
TVP	True Vapor Pressure
VCS	Vapor Control System
VOC	Volatile Organic Compound
VRT	Vapor Recovery Tower

EXECUTIVE SUMMARY

Noble Energy, Inc. (Noble) entered into a Consent Decree (Civil Action No. 15-cv-00841-RBJ) with the United States, the Department of Justice, and the State of Colorado entered by the US District Court of Colorado as final judgment on June 2, 2015. The Consent Decree (CD) required Noble to develop a Modeling Guideline to determine Potential Peak Instantaneous Vapor Flow Rate (PPIVFR) "for purposes of designing and adequately sizing Vapor Control Systems." The CD also required that Noble complete Engineering Design Standards "to provide sufficient guidance to design adequately sized and properly functioning Vapor Control Systems at the Tank Systems." Noble completed its Vapor Control System (VCS) Engineering Evaluations, necessary modifications and verifications, and submitted its Certification of Completion Report ("Report") to the United States Environmental Protection Agency (EPA) and the Colorado Department of Public Health and Environment (CDPHE) in accordance with prescribed timelines.

SLR International Corporation (SLR) was retained by Noble to conduct a third-party verification audit ("Audit") in calendar year 2016 in accordance with Paragraph 20 of the CD. The Audit pertained to Engineering Evaluations and any necessary modifications of Tank Systems completed as of December 31, 2015 and submitted in Noble's Report. The Draft Audit Report was submitted electronically simultaneously to all Parties, as stipulated in Paragraphs 20.f. and 105 of the CD, on March 30, 2017.

The audit was conducted in two parts. In the first part SLR conducted a document review for each Tank System included in Noble's Report to: 1) Verify that Noble has applied the Modeling Guideline; 2) Verify that Noble has applied the applicable Engineering Design Standard; and 3) Verify that the VCS are adequately designed and sized to handle the PPIVFR. The Audit did not include field verification of modifications or of inputs to the Modeling Guideline or Engineering Design Standards. SLR completed the document review on or about December 30, 2016.

The adequacy of the design and sizing of the VCS for each Tank System was evaluated as part of the document review based on SLR's application of Noble's Modeling Guideline to determine PPIVFR and SLR's determination of VCS capacity using Noble's Engineering Design Standard in keeping with the mandate of the CD in Paragraph 20. The VCS was considered adequately designed and sized if SLR's calculated VCS capacity (burner capacity plus headspace surge capacity) was greater than SLR's calculated PPIVFR.

In the second part of the audit, GreenPath Energy Ltd. (GreenPath) conducted Infrared (IR) Camera Inspections of a subset of Tank Systems included in Noble's Report as stipulated in Paragraph 20.d. of the CD. The field IR inspections were completed on or before September 12, 2016.

In the Draft Audit Report, SLR reported a "systemic error in the Valko-McCain Correlation equations used to estimate condensate tank flash vapor losses (Flash Factor), as prescribed by the Modeling Guideline." As a consequence of the error, PPIVFR was underestimated for all 139 Tank Systems evaluated." Noble corrected the Valko-McCain error, addressed other inconsequential errors and revised all 139 Tank System Engineering Evaluations. Noble submitted documentation of its rework on January 18, 2017. SLR reviewed Noble's revised Engineering Evaluations and issued its Addendum to the Draft Audit Report simultaneously to parties via electronic mail on July 6, 2017.

Noble conducted a review of both the Draft Audit Report and Addendum and met with the United States and State of Colorado to discuss the content of SLR's reports. On February 15, 2018, Noble submitted comments to the Draft Audit Report and Addendum to the United States and the State of Colorado.[2] By way of its correspondence, Noble memorialized its comments to the Draft Report and Addendum and provided additional requested revisions, comments, and clarifying information for the United States' and State of Colorado's consideration for inclusion in an updated Draft Report ("Revised Draft Report"). Noble suggested that if the United States and State of Colorado agree, that SLR revise the Draft Report to incorporate the information provided in the Addendum submitted on July 6, 2017 and that once the revisions are incorporated that the Draft Report be retitled to "Revised Draft Report" and recirculated for review prior to finalization. To the extent that the Addendum proactively addressed any comments or suggested revisions outlined in its letter, Noble recommended – based upon concurrence with the United States and State of Colorado – that SLR review the comments and suggested revisions to determine whether any additional updates are appropriate for inclusion into the Revised Draft Audit Report. SLR received a copy of Noble's letter on May 10, 2018 via electronic mail. This Final Audit Report incorporates information reported in the Addendum and comments and suggested revisions set out in the Noble Letter, subject to confirmation and agreement by SLR.

In the Addendum, SLR reported that of the 139 Tank System VCSs audited, 135 (97%) were adequately designed and sized to accommodate the PPIVFR based on the revised Engineering Evaluations. Four systems were reported by SLR to be inadequately designed. In addition, SLR reported that it could not determine whether or not one of the Tank Systems was adequately designed and sized to accommodate the PPIVFR due to inability to confirm installed equipment. Noble reviewed records associated with the five (5) Tank Systems identified by SLR to be inadequately designed to accommodate the PPIVFR. For three (3) Tank Systems, Noble confirmed the accuracy of the existing Engineering Evaluation and provided documentation to confirm. For two (2) Tank Systems, Noble agreed with SLR and progressed a Post-Certification of Completion Modifications (PCCM) to ensure the Tank System meets the Performance Standards. SLR reviewed Noble's response and finds, based on documentation provided by Noble, that all of the 139 Tank System VCSs audited are adequately designed and sized to accommodate the PPIVFR. Results of the document review for each Tank System are summarized in Table 1 and detailed in Appendix B.

SLR reported that of the 81 Tank Systems inspected using an IR camera, 44 (54%) were found to have VOC emissions from their respective VCS. In each case where VOC emissions were observed, the component was repaired and re-surveyed using an IR camera, either at the time of the survey of the subject Tank System, or at a later date. IR Camera inspection and repair confirmation re-inspection results are summarized in Table 2 and detailed in Appendix C.

[2] Letter, Gomez, Susan (Noble Energy), to Sorrell, Virginia et al.,(United States) and Roan, Tom et al., (State of Colorado), February 15, 2018

1. INTRODUCTION

1.1 THIRD-PARTY AUDITOR AND WORK PLAN APPROVAL

On October 28, 2015, Noble notified Parties in writing that SLR and GreenPath were its recommended consultants for the Audit. SLR's and GreenPath's qualifications, as well as an Audit Work Plan developed by Noble, were provided to Parties as required by Paragraph 20.b. The third-party auditors (SLR and GreenPath) and the Audit Work Plan were approved by EPA and CDPHE.

1.2 AUDIT REPORT

On March 30, 2017, SLR submitted a Draft Audit Report in accordance with Paragraph 20 of the CD. The Audit pertained to Engineering Evaluations and any necessary modifications of Tank Systems completed as of December 31, 2015 and submitted in Noble's Report.

In the Draft Audit Report SLR reported a "systemic error in the Valko-McCain Correlation equations used to estimate condensate tank flash vapor losses (Flash Factor), as prescribed by the Modeling Guideline." As a consequence of the error, PPIVFR was underestimated for all 139 Tank Systems evaluated. Noble discovered a typographical error in its Valko-McCain Correlation equations ("$C1_3$ constant") used to estimate flash gas-to-oil ratio in while undertaking a review of its model in response to technical questions posed by SLR during the audit. After making the discovery, Noble disclosed the error to SLR on March 8, 2017. Noble subsequently corrected the Valko-McCain equation in its model and revised all 139 Tank System Engineering Evaluations. In addition to the Valko-McCain error, Noble corrected some other smaller errors related to valve and trim sizes and tank sizes and configurations in the revised Engineering Evaluations. Noble also provided some additional information for combustions devices and truck loadout control systems. Noble then requested SLR re-audit each site based on the revised Engineering Evaluations.

SLR conducted a document review of the revised Tank System Engineering Evaluations and submitted an Addendum to the Draft Audit Report simultaneously to parties via electronic mail on July 6, 2017. Noble conducted a review of both the Draft Audit Report and Addendum and met with the United States and State of Colorado to discuss the content of SLR's reports. On February 15, 2018, Noble submitted its comments to SLR's Draft Audit Report and Addendum to the United States and the State of Colorado. On May 10, 2018, SLR received Noble's comments and supplemental information related to SLR's findings pertaining to application of the Modeling Guideline, Engineering Evaluations and adequacy of design reported for certain Tank Systems. This Final Audit Report discusses SLR's findings related to its document review pertaining to revised Engineering Evaluations provided by Noble and incorporates updated findings previously reported by SLR in the Addendum Report.

1.3 AUDIT TEAM

Key auditors comprising SLR's Audit Team are listed below.

AUDITOR	TITLE	AFFILIATION	QUALIFICATIONS	ROLE
James Van Horne, P.E.	Associate Engineer	SLR Fort Collins, CO	B.S. Mechanical Engineering 9+ Years	Lead Auditor
Angela Oberlander, P.E.[3]	Senior Engineer	SLR Fort Collins, CO	B.S. Chemical Engineering, MBA. 20+ Years	Lead Auditor
Kenneth Malmquist	Principal Engineer	SLR Fort Collins, CO	B.S. Petroleum Engineering 30+ Years	Project Manager and Senior Review
Tim Quarles	Manager, US Air Program	SLR Portland, OR	B.S. Chemical Engineering 30+ Years	Senior Review
Joshua Anhault	President	GreenPath Energy Ltd. Calgary, Alberta, Canada	Journeyman Instrumentation Tradesman	IR Camera Inspections
Justin Frahm	Project Engineer	SLR Fort Collins, CO	B.S. Engineering Physics 6+ Years	Auditors
Tom Kussard	Staff Engineer	SLR Fort Collins, CO	B.S. Environmental Engineering 5 Years	
Erin Ehrmantraut	Staff Engineer	SLR Fort Collins, CO	B.S. Environmental Engineering 4+ Years	

1.4 AUDIT OBJECTIVES

The objective of the Audit required by paragraph 20 of the CD is to independently verify that Noble:

1. Applied its Modeling Guideline to determine the PPIVFR into each Tank System VCS;

2. Applied an appropriate Engineering Design Standard to determine if the existing VCS at each Tank System is adequately designed and sized to handle the PPIVFR ("Engineering Evaluation");

3. Made all necessary modifications to reduce the PPIVFR and/or increase the capacity of the VCS for those Vapor Control Systems found to be inadequately designed and sized based on the Engineering Evaluation; and

[3] SLR discloses that Angela Oberlander worked on the 2016 Third-Party Verification Audit ("First Audit") pursuant to paragraph 20 of the CD from January 2016 until December 2016. In January 2017 she began working under contract with Noble at its Greeley Colorado field office in a seconded part time position supporting Process Hazard Analysis, Process Safety Management, Stormwater Pollution Prevention and Spill Prevention, Control and Countermeasure program compliance, and other non-air quality-related duties for Noble. The seconded position ended on October 6, 2017. Ms. Oberlander began work on the 2018 Third-Party Verification Audit ("Second Audit") pursuant to paragraph 20 of the CD in November 2017.

4. Conducted an IR Camera Inspection of each Tank System to confirm the VCS is adequately designed and sized and not emitting VOCs.

1.5 AUDIT SCOPE

SLR audited in calendar year 2016 those Tank Systems that were included in the Reports submitted by Noble as of December 31, 2015 as stipulated by Paragraph 20.a. of the CD.

Consistent with Paragraph 20 of the CD, the Audit Work Plan stipulates the Auditor will:

1. Conduct a document review of each Tank System to verify that Noble has applied the Modeling Guideline and the applicable Engineering Design Standard to ensure that the Vapor Control Systems are adequately designed and sized to handle the PPIVFR; and

2. Conduct an IR Camera Inspection of the subset of Tank Systems subject to this First Audit.

1.5.1 DOCUMENT REVIEW

SLR audited Noble's Engineering Evaluations of 139 Tank Systems. A detailed list of the Tank Systems audited is provided in Table 1.

Noble's Reports submitted on May 27, 2015 and July 30, 2015 consisted of Engineering Evaluations for 148 Tank Systems. Twelve of the Tank Systems listed as "Shut-In" did not undergo Engineering Evaluations, nor were such Tank Systems audited by SLR. SLR only audited Tank Systems with condensate storage tanks. Engineering Evaluations for produced water tank VCS that are separate from the condensate tanks were not included in the audit.

SLR also audited three Tank Systems for which ownership has been transferred to Bayswater Exploration & Production, LLC. Noble is responsible for compliance with Paragraph 20 (Third-Party Verification) for those three Tanks Systems.

1.5.2 IR CAMERA INSPECTIONS

SLR selected a subset of Tank Systems for IR Camera Inspections by GreenPath, including 92 Tank Systems selected from the following groups in accordance with Paragraph 20.d. of the CD:

1. One hundred percent (100%) of the Tank Systems with actual uncontrolled annual VOC emissions, as of September 2014, of 50 tpy or more – 79 Tank Systems;
2. Twenty percent (20%) of the Tank Systems with actual uncontrolled annual VOC emissions, as of September 2014, less than 50 tpy but greater than or equal to 12 tpy – 12 Tank Systems; and
3. Five percent (5%) of the Tank Systems with actual uncontrolled annual VOC emissions, as of September 2014, less than 12 tpy – one Tank System.

IR Camera inspections were completed by GreenPath at 81 of the 92 selected Tank Systems. Four of the selected Tank Systems could not be inspected because the wells were shut-in and the facility was not operating. Six of the Tank Systems were converted to emergency storage only and are no longer connected to a VCS. All liquids previously sent to those Tank Systems flow directly to the Wells Ranch Central Production Facility (CPF). The Tank System at the SHELTON T4N-R65W-S25 L01 has been removed from service and the production equipment was relocated to another nearby facility. All of the Tank Systems that could not be inspected were listed in the CD as having uncontrolled actual VOC emissions greater than 50 tpy and selection of alternative Tank Systems for inspection was not required.

1.6 NOBLE ENGINEERING EVALUATION APPROACH

Noble used a spreadsheet that calculates storage tank pressure over time using various inputs. The spreadsheet, titled “STEM Engineering Evaluation”, calculates both PPIVFR and the VCS capacity. This section describes the methodology used by Noble to apply the Modeling Guideline and Engineering Design Standard at each Tank System.

1.6.1 MODELING GUIDELINE

The methods and approaches used by Noble to determine PPIVFR as specified in its Modeling Guideline is detailed in the sections below. All general assumptions and inputs are summarized in Appendix A.

1.6.1.1 Flash Losses

Flash losses were determined based on the maximum design flowrate of Condensate and Produced Water from each separator to the Tank System and a Flash Factor.

Condensate and Produced Water maximum design flow rates were calculated using Equations 1 through 3 in Modeling Guideline. The sources of the inputs to the equations are as follows:

- **Valve Flow Coefficient and Pressure Recovery Factor.** Noble used coefficients and factors from the valve manufacturer (Kimray). Noble primarily uses High Pressure Control Valves (HPCV) of various sizes and with various trim sizes. Noble also used Kimray 2-inch treater valves for produced water on a few separators. A list of the flow coefficients and pressure recovery factors for each valve size and trim combination can be found in Appendix A.
- **The API Gravity of the Pressurized Liquid.** Noble used an American Petroleum Institute (API) Gravity of 80 degrees for pressurized condensate in all Engineering Evaluations. Noble used a process simulator, Aspen HYSYS®, to determine the API Gravity of 127 pressurized condensate samples. The average pressurized liquid API gravity of the samples was 76.4 degrees. The flow rate calculated is proportional to liquid API Gravity; the calculated flow rate increases as API Gravity increases. API gravity of 10 degrees was used to calculate produced water flow rates for those Tank Systems that captured flash/working losses from produced water tanks.

- **Separator Pressure.** The maximum operating pressure of the vessel was used. The control methods used by Noble to limit the separator operating pressure included: pipeline emergency shut down (ESD) pressure, vessel PRV set pressure, and automated systems to shut in wells controlled by separator pressure. The method used varies site by site. Noble considered Vapor Recovery Towers (VRTs) as pass through vessels and used the maximum operating pressure of the vessel upstream of the VRT to calculate the maximum design flow. The flow rate calculated is proportional to separator pressure; the calculated flow rate increases as separator pressure increases.
- **Absolute Vapor Pressure.** Condensate vapor pressure was calculated using the lesser of either the separator pressure or a vapor pressure calculated using a linear regression of the known sample pressure and the True Vapor Pressure (TVP) predicted by the Aspen HYSYS® Model. The regression was based on 127 pressurized condensate samples. This approach results in the vapor pressure being equal to separator pressure when the separator pressure is below approximately 330 pounds per square inch, gage (psig). The flow rate calculated is inversely proportional to vapor pressure; the calculated flow rate increases as vapor pressure decreases. A pressurized water vapor pressure of 0.947 pounds per square inch, absolute (psia), the vapor pressure of pure water at 100 °F, was used for all Engineering Evaluations.
- **Critical Pressure.** Condensate critical pressure was calculated using a linear regression of the known sample pressure and critical pressure predicted by the Aspen HYSYS® Model. The regression was based on 127 pressurized condensate samples. The flow rate calculated is inversely proportional to critical pressure; the calculated flow rate increases as critical pressure decreases. A pressurized water critical pressure of 3,200 psia, the critical pressure of pure water, was used for all Engineering Evaluations.

Noble calculated the Flash Factor for condensate using the Valko-McCain (Valkó & McCain Jr., 2003) flash gas correlation. The sources of the inputs to the equations were as follows:

- **Separator Pressure.** Noble used a separator pressure equal to the maximum operating pressure of the vessel. The control methods used by Noble to limit the separator pressure included: pipeline ESD pressure, vessel PSV set pressure, and automated control systems used to shut in wells when the separator pressure reached a specified pressure. The method used varies site by site. For example, Noble used a 12 psig operating pressure for any condensate that is directed through a VRT. The flow rate calculated is proportional to separator pressure; the calculated flow rate increases as separator pressure increases.
- **Separator Temperature.** Noble used a separator temperature of 65 °F for all Engineering Evaluations. The value is within the published journal article limits. The Flash Factor calculated by the Valko-McCain correlation is inversely proportional to separator temperature; the calculated Flash Factor increases as temperature decrease.
- **Stock Tank API Gravity.** Noble used a stock tank API gravity of 60 degrees for all Engineering Evaluations. The value is above the published journal article limits. The Flash Factor calculated by the Valko-McCain correlation is directly proportional to stock tank API gravity; the calculated Flash Factor increases as stock tank API gravity increases.

The Flash Factor for produced water used by Noble for all Engineering Evaluations was 4 scf/bbl. The value is based on multiple flash liberation studies of produced water from Noble's facilities.

1.6.1.2 Working and Breathing Losses

Noble used methods in API Standard 2000 (American Petroleum Institute, 2014) to calculate working and breathing losses from both oil and water tanks as specified in Sections 6.2 and 6.3 of the Modeling Guideline. Noble used the working loss factor of 12 scf of air per barrel of liquid flow and a breathing factor of one scf of air per bbl of tank capacity[4]. These are the highest of the factors presented in API Standard 2000 and apply to liquids with a flash point under 100 °F or a normal boiling point under 300 °F. Volume of air (scf) was converted to hydrocarbon vapor volume (scf) using a hydrocarbon vapor specific gravity of 1.59.

1.6.1.3 Other Losses

Noble did not identify or include any other losses in its calculation of PPIVFR. Other vapor sources listed in the Modeling Guideline to be considered in PPIVFR calculations if they exist include vortex gas entrainment, separator vapor, VRT vapor, and truck loading vapor. Vortex gas entrainment was not included because Noble maintains liquid level height to a height greater than the "critical liquid height" as provided by the equipment vendor to prevent vortex gas entrainment. Separator and VRT vapors were not included because Noble stated that those vapors are directed to pipeline or to a VCS separate from the condensate tanks at every site audited. SLR found some Tank Systems where truck loading vapors are or may be directed to the same VCS as the condensate storage tanks. This is discussed further in Section 4.1.

Vapor losses from the loading of condensate into trucks were included by Noble in the calculation of PPIVFR at Tanks Systems with Tank Truck Loading Control Systems in revised Engineering Evaluations submitted with this comment letter and discussed in Section 4.0 below. The vapor flow rate Noble used to calculate truck loading losses 2,527 scf per hour[5].

1.6.2 ENGINEERING DESIGN STANDARD

Noble applied its site-specific design standard to each site using the STEM Engineering Evaluation spreadsheet. Noble did not complete Engineering Design Standards for Pressure Line Groupings pursuant to Paragraph 9 of the CD, as noted in the approved Work Plan and Certification of Completion Reports. Each Tank System has its own individual Engineering Design Standard determined by the STEM Engineering Evaluation spreadsheet. The spreadsheet calculates the Tank System pressure in one-second intervals over a 10- to 60-minute period based on the amount of vapor entering via flashing, working and breathing losses, and leaving the Tank System via the VCS.

[4] The factor is less than 1 scfh/bbl capacity for tanks over 20,000 bbl. None of the Tank Systems included in the audit included tanks with a capacity greater than 20,000 bbl.

[5] Based on an April 25, 2017 phone call with Noble's engineer this value was calculated based on the maximum loadout rate of 450 bbl per hour in Noble's standard operating procedure for truck loading. Noble assumed as liquid enters the truck, the same amount of vapor is displaced and sent to the VCS and the vapor in the truck is at standard conditions.

Flashing and working losses only occur during a dump event. The frequency and duration of dump events from each separator is calculated based on the production rate, production cycles and average time per cycle. Breathing losses are assumed to occur constantly. All separators that produce to the Tank System are assumed to simultaneously dump at the beginning of the modeling period (i.e., at 0 seconds) unless automation is installed to prevent simultaneous dump events. After time zero, the separators dump based on their individually calculated frequency for the remainder of the modeling period.

The amount of vapor leaving the tank via the VCS is determined based on burner curves and pressure drop through the VCS piping. Burner curves relating burner inlet pressure to flow rate were obtained from the combustion control device manufacture or based on testing at Noble facilities. A list of the burners used by Noble and the manufacturer published maximum capacity are tabulated in Appendix A. Noble also accounted for a burner management system typically used with Cimarron, Leed, and Tornado control devices. The burner management system prevents vapor from entering the control device until a certain pressure at the inlet to the device or in the tanks is reached, referred to as the “Turn On” point by Noble. Vapor is allowed to flow into the device once the “Turn On” point is reached and continues flow until the “Turn Off” point is reached. The most common “Turn On” point used by Noble was 5 ounces per square inch (oz/in^2) and the most common “Turn Off” point used by Noble was 2 oz/in^2. Pressure drop through VCS piping was calculated based on the Spitzglass Formula. The diameter and number of vapor collection lines were specified by the user. The spreadsheet calculated the equivalent length of piping based on the number of tanks entered. The correlation of equivalent piping length based on the number of tanks was created based on actual measured pipe lengths and number fittings from a number of Noble’s Tank System VCS.

Other critical inputs into the spreadsheet include the volume of liquid in the tanks (liquid level), the tank PRV set pressure, and tank design pressure. The liquid level in the tanks is used to determine the vapor volume in the tanks, which in turn is used to calculate tank pressure. Noble assumed the tanks were filled to the liquid overflow line height. Typically the overflow lines were located at a level 90% of the tank height. Noble, at some Tank Systems, disconnected one or more tanks from the liquid fill header to prevent them from receiving liquids and removed all liquids from the tank(s). The tank(s) remained connected to the VCS to act as a vapor surge vessel. The Tank System average liquid level used in the spreadsheet in these cases would reflect that some of the tanks had no liquid in them. Typical tank PRV set point and tank design pressures used by Noble were 16 oz/in^2 and 10 oz/in^2, respectively. Noble ensured that in each Engineering Evaluation the calculated peak tank pressure did not exceed the tank design pressure.

2. DOCUMENT REVIEW

Noble provided the following documents for each Tank System for SLR review in accordance with the approved Work Plan:

- Signed Facility STEM Plan – Tank System specific STEM Plan used to comply with Colorado Air Quality Control Commission Regulation 7, Section XVII.C.2.b;
- Signed Vapor Control System Engineering Evaluation – Signed Engineering Evaluation of the Tank System VCS and PPIVFR after any necessary modifications were completed;
- Work Request – Formal request to modify facility equipment and or operating parameters based on the Engineering Evaluation;
- Walkdown Checklist – Documentation of a final inspection of the Tank System verifying the modifications directed in the work request were completed;
- IR Camera Verification Documentation Field Data Sheet – Documentation of IR Camera Inspection after modifications were complete;
- IR Camera Video Files – Videos of each IR Camera Inspection during normal operations, during a dump event, and immediately after a dump event; and
- Final Packet – A consolidated facility information document that included the documentation mentioned above and possibly pre-evaluation documents, Tank System configuration drawings, construction job sheets, and confirmation of completion for requested automation modifications.

2.1 DOCUMENT REVIEW APPROACH

SLR utilized the following approach to audit each Tank System Engineering Evaluation and confirm whether Noble applied the Modeling Guideline and applicable Engineering Design Standard to verify each VCS was adequately designed and sized to handle PPIVFR:

1. Review pre-evaluation documentation to determine the facility pre-modification sources of vapor into the VCS, VCS configuration, and control equipment.
2. Review issued work requests to determine the impact of requested changes to facility equipment and any subsequent changes to PPIVFR or VCS.
3. Review walkdown and final packet information to substantiate the requested changes were completed.
4. Calculate PPIVFR based on methods and equations in the Modeling Guideline (Noble Energy, Inc., 2015) and the final confirmed Tank System configuration.
5. Assess the capacity of the final verified control device configuration using published manufacturer specifications. SLR used the capacity as published and did not correct for site specific factors such as atmospheric pressure, gas density or pressure drop through VCS piping.

6. Calculate the final verified Tank System headspace surge capacity using Noble's STEM Engineering Evaluation model.
7. Determine if the PPIVFR exceeds the combined control device and headspace capacity at the pressure relief valve set pressure.
8. Review the IR Camera Verification Documentation Field Data Sheet and IR Camera Videos to verify any detection of VOC emissions.

Each verification audit review was performed by an SLR Auditor and subsequently verified by a SLR Lead Auditor. All audit verified data, comparison calculation results, and any explanatory audit notes are captured in an Engineering Evaluation Verification Audit package for each Tank System included in Appendix B, Detailed Document Review Findings.

2.2 EVALUATION CRITERIA

SLR developed evaluation criteria to determine if Noble applied its Modeling Guideline and applicable Engineering Design Standard correctly and if each VCS was adequately designed and sized to accommodate PPIVFR.

2.2.1 APPLICATION OF THE MODELING GUIDELINE

SLR reviewed inputs, assumptions, and methods related to calculation of PPIFVR to assess the correct application of the Modeling Guideline. SLR calculated PPIVFR using Noble's selected approach, as specified in its Modeling Guideline, and compared the results with Noble's calculated PPIVFR at each Tank System. Alignment of PPIVFR determined by Noble versus that determined by SLR indicated correct application of the Modeling Guideline. Possible causes of discrepancies between PPIVFR results reported by Noble versus results independently determined by SLR using the same methods and equations include but are not limited to:

1. Incorrect equations or conversion factors were used in determining maximum instantaneous condensate liquid flow rate;
2. Incorrect application of the Valko-McCain Correlation in the determination of Flash Factors;
3. Site-specific values, such as valve size, valve trim size, or maximum operating pressure used in Noble's Engineering Evaluation differed from what could be verified based on the documentation provided;
4. All sources of vapor were not included in Noble's calculation of PPIVFR; or
5. Assumptions or correlations used as inputs into the equations for determining PPIVFR were not representative of Noble's Operations

2.2.2 APPLICATION OF THE ENGINEERING STANDARD

SLR reviewed inputs and assumptions related to Noble's calculation of the VCS capacity to determine whether or not the Engineering Design Standard was applied correctly. The VCS capacity is determined by the sum of the control device capacity and the Tank System VCS headspace surge capacity. SLR used manufacturer's published maximum control device capacities and independently determined VCS surge capacity using Noble's STEM Engineering Evaluation spreadsheet. SLR considered the Engineering Design Standard to be properly applied by Noble if the inputs and assumptions that affect the VCS capacity were correct or otherwise conservative. Examples where the VCS capacity determined using Noble's Engineering Design Standard may represent an overestimation of actual capacity include but are not limited to:

1. The calculated control device capacity in Noble's Engineering Evaluation is greater than the manufacturer published maximum capacity;
2. The number of control devices used in Noble's Engineering Evaluation is greater than the number installed;
3. The control device used in Noble's Engineering Evaluation has a higher capacity than the control device installed;
4. The number of vapor lines or the diameter of the vapor line(s) used in Noble's Engineering Evaluation is greater than the number of lines or the diameter of the line(s) installed;
5. The number of storage tanks or the capacity of the storage tanks used in Noble's Engineering Evaluation is greater than the number of storage tanks or the capacity of the storage tanks installed; and
6. The storage tank liquid level used in Noble's Engineering Evaluation is lower than the maximum liquid level, resulting in overestimation of headspace surge capacity.

2.2.3 VCS ADEQUATE DESIGN AND SIZING

The VCS was considered adequately designed and sized if SLR's calculated VCS capacity (burner capacity plus headspace surge capacity) was greater than SLR's calculated PPIVFR.

2.3 MISSING OR CONFLICTING DATA

SLR encountered missing or conflicting data used to verify inputs into some Engineering Evaluations. In cases where conflicting information was presented and additional information was not available, a hierarchy of documentation was used to determine inputs SLR would use in its calculations. The hierarchy is as follows:

1. Final facility walkdown checklist
2. Job Sheets and confirmation emails
3. Initial facility walkdown field data sheets

If the information could not be verified with the first document in the hierarchy, SLR would use information from the next one. SLR used conservative inputs in its calculations when information was missing.

3. IR CAMERA INSPECTIONS

Noble was notified of the Tank Systems chosen for IR Camera Inspections via electronic mail on July 19, 2016. The IR Camera Inspections were conducted by GreenPath August 1, 2016 through August 9, 2016, and September 6, 2016 through September 12, 2016.

3.1 SELECTION CRITERIA

The selection of Tank Systems for IR Camera Inspections was based on the results of an initial review of Noble's Engineering Evaluation for each Tank System. Tank Systems found to be inadequately designed and sized or having emissions visible in the IR camera videos provided by Noble were selected for an IR Camera Inspection as part of the audit. If an insufficient number of sites were identified in each category using the aforementioned criteria, then sites with the smallest difference between SLR's calculated VCS capacity and PPIVFR were selected for IR Camera Inspection. A detailed list of the sites selected for IR Camera Inspection can be found in Table 2.

SLR made a best effort to ensure the IR Camera Inspections were divided proportionately among the Three Line Pressure Groupings[6] defined in the CD as prescribed by the approved Work Plan. The selected sites for IR camera inspections consisted of 36 Tank Systems from Group I, 29 Tank Systems from Group II, and 27 Tanks Systems from Group III.

[6] "'Three Line Pressure Groupings' shall mean the distribution of Tank Systems that are associated with Well Production Operations which produce gas into sales lines that, as of August 17, 2014, had line pressures within the following three ranges: (1) 233 psi or greater ("Group I"); (2) less than 233 psi and greater than or equal to 186 psi ("Group II"); and (3) less than 186 psi ("Group III"). If Noble later determines that another grouping of the Tank Systems is more appropriate, in consultation with EPA and CDPHE and subject to both agencies' prior written approval, the Tank Systems can be redistributed among Group I, Group II, and Group III." Consent Decree, Section III, Paragraph 6, kk.

4. FINDINGS

The results of SLR's document review and IR Camera Inspections are summarized below.

4.1 APPLICATION OF THE MODELING GUIDELINE

SLR reports the following general findings related to the determination of PPIVFR as prescribed by the Modeling Guideline. The impact or potential impact of underestimating PPIVFR on the adequate design evaluation of each VCS, if any, is discussed below. Some VCS parameters impact both PPIVFR and VCS surge capacity, as noted.

1. After SLR had completed its document review, Noble disclosed to SLR its discovery of a systemic error in the Valko-McCain Correlation equations used to estimate condensate tank flash vapor losses (Flash Factor), as prescribed by the Modeling Guideline. As a consequence of the error, PPIVFR was initially underestimated for all 139 Tank Systems evaluated.[7] SLR initially reported that the underestimation of the Flash Factor was as much as 50 percent for a separator operating at 500 psig or as low as 20 percent for a VRT operating at 12 psig. The Valko-McCain error was the primary reason the VCS was considered not adequately designed and sized to handle the PPIVFR at the KODAK T6N-R67W-S35 L01, but the systemic error did not impact adequate design for the other sites.

   Noble corrected the Valko-McCain error, addressed other inconsequential errors and revised all 139 Tank System Engineering Evaluations. Specifically, for the KODAK T6N-R67W-S35 L01, Noble reset the inlet HP separator HI/LO controller no higher than 235 psi from 275 psi, and the system was programmed to shut-in all wells connected to the Tank System if separator pressures exceed this pressure. Noble submitted the documentation for this rework to SLR on January 18, 2017. SLR completed its Document Review of the revised Tank System Engineering Evaluation for the KODAK T6N-R67W-S35 L01 and concluded that the Tank System VCS was adequately designed.

2. SLR initially reported that Noble did not include sources of vapor captured by the VCS other than tank flashing, working and breathing losses in the determination of PPIVFR. The installation of Tank Truck Loadout ("TLO") Control Systems (Vapor Balance) is a requirement for 160 Tank Systems per the Environmental Mitigation Projects described in Appendix C of the CD. TLO vapor was not included in the PPIVFR calculations for any of the 139 VCS initially audited.

   SLR reported its finding that five Tank System evaluations indicated that TLO Control Systems had been installed, but the TLO vapors were not included in the calculation of PPIVFR, including:

[7] Noble discovered the typographical error of the Cl_3 constant while undertaking a review of the model to respond to a question posed by SLR. Noble disclosed the error of the Cl_3 constant to SLR after making the discovery on March 8th, 2017. This information was initially provided to the United States and State of Colorado in Noble's Semi-Annual Report (3rd) dated July 28, 2017, as it related to Post-Certification of Completion Modifications ("PCCM").

1) DECHANT T2N-R65W-S1 L01 (TS# 2357);

2) FURROW ST USX T7N-R64W-S22 L01 (TS# 2018);

3) SCOOTER T3N-R64W-S18 L01 (TS# 2367);

4) SHELTON T4N-R65W-S25 L01/PLUSS SHELTON T4N-R65W-S25 L02 (TS#661); and

5) KUMMER T8N-R61W-S23 L02 (TS# 569).

Omission of TLO vapor results in an underestimation of PPIVFR. SLR did not quantify any contribution to PPIVFR from TLO vapor and SLR could not determine if the VCS is adequately designed and sized to handle PPIVFR for Tank Systems where TLO Control Systems have been installed.

Noble revised its PPIVFR determinations to include TLO vapors for each of the five Tank Systems identified above. Noble completed Engineering Evaluations and submitted a revised COCR with its Semi-Annual Reports (5th) (July 28, 2017) and (6th) (January 29, 2018) for each of the five Tank Systems.

In addition, Noble identified 74 additional Tank Systems covered during this first audit period that have a TLO system installed. Noble updated Engineering Evaluations for all 74 of these additional locations and submitted updates with the 5th semi-annual report (July 28, 2017).

Noble provided revised Engineering Evaluations for the following five Tank Systems and requested that SLR review those evaluations and incorporate the conclusions of the evaluations into this Final Audit Report.

1) DECHANT T2N-R65W-S1 L01 (TS# 2357);

2) FURROW ST USX T7N-R64W-S22 L01 (TS# 2018);

3) SCOOTER T3N-R64W-S18 L01 (TS# 2367);

4) SHELTON T4N-R65W-S25 L01/PLUSS SHELTON T4N-R65W-S25 L02 (TS#661); and

5) KUMMER T8N-R61W-S23 L02 (TS# 569).

SLR found that the TLO systems were appropriately included in the determination of PPIVFR in accordance with the Modeling Guideline and that each Tank System is adequately designed to accommodate PPIVFR.

3. For 27 of 139 Tank Systems evaluated SLR noted Tank System configurations where tanks are grouped (“banked”) in a manner where one bank of tanks directly receives flashing liquids while the other tank bank(s) is simply storing produced liquids. Noble’s Engineering Evaluation was completed such that the tank information (count, size, etc.) for a single bank was input into the spreadsheet. By including only one bank in the evaluation, potential evaporative breathing losses from the non-producing, storage-only bank are not accounted for in the calculation of PPIVFR. This results in an

underestimation of PPIVFR. The underestimation may be as much as 10%[8] for Tank Systems with a VRT and a large number of storage tanks. This error did not impact the adequate design or sizing of the VCS for any Tank System included in the Audit. The 27 Tank Systems included:

1) CECIL FARMS T6N-R66W-S6 L02
2) DECHANT T2N-R65W-S1 L01
3) EAGLE RELIANCE SENECA TAHOMA ECONODE T6N-R65W-S14 L01
4) FEUERSTEIN T6N-R66W-S28 L01
5) FIVE RIVERS T4N-R66W-S8 L01
6) FRANKIE T4N-R65W-S4 L01
7) FRICO T3N-R65W-S15 L02
8) GITTLEIN MARIE T3N-R64W-S4 L01
9) GUTTERSEN T3N-R63W-S5 L01
10) HOLMAN COCKROFT T5N-R64W-S15 L01
11) JOHNSON ROBERTSON REIS UPRR PAN AM T2N-R64W-S19 L01
12) KUMMER T8N-R61W-S23 L02
13) LOEFFLER K01 ECONODE T4N-R66W-S1 L01
14) LUNDVALL T5N-R66W-S18 L03
15) NAKAGAWA T5N-R64W-S13 L01
16) NO WORRIES T4N-R65W-S14 L01
17) SCOOTER T3N-R64W-S18 L01
18) SEYLER B10, B15 ECONODE T5N-R64W-S10 L01
19) TREBOR JENKINS LEEROY T5N-R64W-S11 L01
20) UPRC BRANDON SEBASTYEN T4N-R67W-S23 L01
21) WELLS RANCH AA12, AE07, AA12 ECONODE T6N-R63W-S12 L01
22) WELLS RANCH AA14, AA16 ECONODE T6N-R63W-S14 L01
23) WELLS RANCH AA24, AA23, BOB AA24 ECONODE T6N-R63W-S24 L01
24) WELLS RANCH AA25 & 26 ECONODE T6N-R63W-S25 L01
25) WELLS RANCH CPF
26) WELLS RANCH USX AE18, AA13 ECONODE T6N-R62W-S18 L0
27) WOLFPACK/LONEWOLF B02 ECONODE T5N-R64W-S2 L01

Noble acknowledged that breathing losses were not incorporated for the non-producing, storage-only bank. However, Noble also chose not to incorporate the headspace surge capacity associated with those tanks. Noble asserts that modeling the single bank generates a more conservative analysis to ensure design adequacy during all operating modes. Noble acknowledges that the Modeling Guideline did not provide details for incorporation of the headspace surge capacity. Noble updated its Modeling Guideline with these details and submitted with Noble's Semi-Annual Report (6th) on January 29,

[8] Based on the underestimation of PPIVFR from the Wells Ranch USX AE18,AA13 Econode

2018. SLR acknowledged that the error did not impact adequate design and agrees that omitting headspace surge capacity adds conservativism in the Engineering Design Analyses.

4. SLR initially reported that Noble used a lower vessel pressure or smaller valve and/or trim than was confirmed in the field for 14 of 139 Tank Systems evaluated. The vessel pressure, valve size and valve trim size impact working and flashing loss components of PPIVFR. Noble's use of a valve size and trim smaller than that confirmed to be installed on the separator at the WOLF USX T4N-R63W-S7 L01 was the primary reason that VCS was considered not adequately designed and sized to handle the PPIVFR.

   Noble reviewed records associated with the 14 Tank Systems identified by SLR. For eight (8) Tank Systems, Noble confirmed the accuracy of the existing Engineering Evaluation and provided documentation to confirm. For five (5) Tank Systems, Noble agrees with SLR and has updated documentation to accurately reflect the Tank System operation. For one (1) Tank System, Noble agrees with SLR and progressed a PCCM to ensure the Tank System meets the Performance Standards. The Tank Systems include:

   1) BERNHARDT HULL T4N-R67W-S1 L01 (TS# 47): Confirmed accuracy of existing Engineering Evaluation. Automation standard practice sets shut-in pressure no higher than 70 psig.

   2) DECHANT T3N-R64W-S31 L01 (TS# 424): Confirmed accuracy of existing Engineering Evaluation. Automation standard practice sets shut-in pressure no higher than 70 psig.

   3) BERNHARDT SCHNEIDER ST T5N-R67W-S36 L01 (TS# 46): Confirmed accuracy of existing Engineering Evaluation. Automation standard practice sets shut-in pressure no higher than 70 psig. Completed Rework Request documents confirmation that shut-in pressure is 70 psig.

   4) GOLDBERG T5N-R67W-S14 L01 (TS# 24): Confirmed accuracy of existing Engineering Evaluation. Completed Rework Request documents confirmation that shut-in pressure is 65 psig.

   5) GUTTERSEN T3N-R63W-S5 L01 (TS# 546): Confirmed accuracy of existing Engineering Evaluation. Rework Request and Generwell project completion report (Attachment H) documents confirmation that shut-in pressure was changed to 70 psig.

   6) LOWER LATHAM T5N-R65W-S35 L02 (TS# 231): Confirmed accuracy of existing Engineering Evaluation. SLR misread Page 21 of the Final Packet. The specified pressure of 80 psig is referring to PCV-103, which is supposed to be set 10 psig higher than the shut-in pressure. Work request and walkdown checklist documents the identified misinterpretation by SLR.

   7) MOSER THORSON T3N-R65W-S27 L01 (TS# 2096): Confirmed accuracy of existing Engineering Evaluation. Although initial work request specifies 70 psig shut-in pressure, subsequent rework documents confirmation that shut-in pressure was set to 60 psig. Completed Rework Request documents confirmation that shut-in pressure is 60 psig.

8) WELLS RANCH AA25 & 26 ECONODE T6N-R63W-S25 L01 (TS# 346): Confirmed accuracy of existing Engineering Evaluation. Although the dump valve is 3" body with 2" trim, there is an orifice plate downstream of the valve to further restrict flow. Facility P&ID (Attachment K) documents the restriction orifice location and size.

9) JOHNSON T7N-R65W-S33 L01 (TS# 1914): Noble agrees that Engineering Evaluation was incorrect. An updated Engineering Evaluation was completed and a revised COCR submitted with Noble's Semi-Annual Report (5th) (July 28, 2017).

10) OSCAR Y10 ECONODE T2N-R64W-S10 L01 (TS# 2335): Noble agrees that Engineering Evaluation was incorrect. An updated Engineering Evaluation was completed and a revised COCR submitted with Noble's Semi-Annual Report (5th) (July 28, 2017).

11) SPIKE GUTTERSEN ST T3N-R64W-S16 L01 (TS# 527): Noble agrees that Engineering Evaluation was incorrect. An updated Engineering Evaluation was completed and a revised COCR submitted with Noble's Semi-Annual Report (5th) (July 28, 2017).

12) ST T8N-R60W-S16 L01 (TS# 2034): Noble agrees that Engineering Evaluation was incorrect. An updated Engineering Evaluation was completed and a revised COCR submitted with Noble's Semi-Annual Report (5th) (July 28, 2017).

13) ST T8N-R60W-S16 L02 (TS# 2035): Noble agrees that Engineering Evaluation was incorrect. An updated Engineering Evaluation was completed and a revised COCR submitted with Noble's Semi-Annual Report (5th) (July 28, 2017).

14) WOLFE USX T4N-R63W-S7 L01 (TS# 1416): Noble agrees that the Engineering Evaluation was incorrect and the site did not meet the Performance Standards. A PCCM was completed on July 14, 2017. Updated Engineering Evaluation design parameters submitted with Noble's Semi-Annual Report (5th) (July 28, 2017).

5. SLR reported that Noble did not include the correct quantity and/or dimensions of tanks within the Tank System in its evaluation for 3 of 139 Tank Systems evaluated. The quantity and size of tanks within a Tank System impacts breathing loss components of PPIVFR, as well as VCS surge capacity – see SLR's findings described in the Engineering Design Standards discussion in Section 4.2.

   Noble reached out to SLR to get the list of Tank Systems related to this finding per the Draft Report. The records provided by SLR included four (4) Tank Systems. Noble reviewed records associated with the four (4) Tank Systems identified by SLR. For one (1) Tank System, Noble confirmed the accuracy of the existing Engineering Evaluation and provided documentation to confirm. For three (3) Tank Systems, Noble agrees with SLR and has updated documentation to accurately reflect the Tank System operation. The four subject Tank Systems included:

   1) BERNHARDT HULL T4N-R67W-S1 L01 (TS# 47): Noble agrees that Engineering Evaluation was incorrect due to data entry error (315 bbl tanks misrepresented as 300 bbl in evaluation). An updated Engineering Evaluation

was generated and a revised COCR submitted with Noble's Semi-Annual Report (6th) (January 29, 2018).

2) BORESEN DETIENNE T5N-R67W-S12 L01 (TS# 2264): Noble agrees that Engineering Evaluation was incorrect due to data entry error (315 bbl tanks misrepresented as 300 bbl in evaluation). An updated Engineering Evaluation was generated and a revised COCR submitted with Noble's Semi-Annual Report (6th) (January 29, 2018).

3) DECHANT T2N-R64W-S19 L01 (TS# 438): Noble agrees that Engineering Evaluation was incorrect due to data entry error ((2) 400 bbl + (6) 300 bbl tanks misrepresented as (8) 300 bbl in evaluation). An updated Engineering Evaluation was generated and a revised COCR submitted with Noble's Semi-Annual Report (6th) (January 29, 2018).

4) MOSER CHAMP T4N-R65W-S34 L01 (TS# 432): Confirmed accuracy of existing Engineering Evaluation. TLO walkdown picture (Attachment L) confirms that one of the tanks is a Maintenance Tank and is not part of the Vapor Control System.

Based on a document review of information provided by Noble, as discussed above, SLR finds that the Modeling Guideline was applied correctly to all 139 Tank Systems included in the audit. Table 1 provides a summary of revised findings.

4.2 APPLICATION OF THE ENGINEERING DESIGN STANDARD

SLR initially reported that the Engineering Design Standards were not applied correctly for 25 of 139 Tank Systems evaluated and correct application could not be verified for 1 of 139 Tank Systems based on a comparison of field-verified information and information input into the site-specific Engineering Design Standard. SLR reported the impact of any discrepancies between information actually used in the Engineering Design Standards versus field-verified information on the adequate design evaluation of each VCS, if any, as discussed below. Some VCS parameters impact both PPIVFR and VCS surge capacity, as noted.

Noble's response to each finding or observation reported by SLR in its Draft Audit Report and Addendum is provided below, including clarifying comments and, where appropriate, corrective action and results. Based on updated Engineering Evaluations or other information, as discussed below, SLR finds that Noble applied its Engineering Design Standards correctly for all of the 139 Tank Systems.

1. For 12 of 139 Tank Systems evaluated, SLR reported that Noble used a tank capacity that was larger in quantity and/or size (physical dimensions and capacity) of storage tanks evaluated versus the actual quantity or size(s) of the tanks installed at the facility. This typically occurred due to Noble evaluating the Tank System with an unbanked configuration when the Tank System was confirmed to have a banked tank configuration. The quantity and size(s) of tanks impact VCS surge capacity and PPIVFR – see Modeling Guideline discussion in Section 4.1. The VCS for the FIVE RIVERS T4N-R66W-S8 L01 and WELLS RANCH AA12, AE07, AA12 ECONODE T6N-R63W-S12 L01 was determined by SLR to be inadequately designed and sized to handle the

PPIVFR because of the discrepancy in the actual quantity and/or dimensions of tanks within the Tank System versus that used in Noble's evaluation.

Noble reviewed records associated with the 12 Tank Systems identified by SLR and listed below. For three (3) Tank Systems, Noble confirmed the accuracy of the existing Engineering Evaluation and provided documentation to confirm. For eight (8) Tank Systems, Noble agrees with SLR and has updated documentation to accurately reflect the Tank System operation. For one (1) Tank System, Noble agrees with SLR and completed a PCCM to ensure the Tank System meets the Performance Standards.

1) FIVE M T6N-R65W-S28 L02 (TS# 2372): Confirmed accuracy of existing Engineering Evaluation. TLO walkdown documentation (Attachment M) confirms that one bank of tanks had been removed from service at the time the facility retrofit was performed.
2) WELLS RANCH AA12, AE07, AA12 ECONODE T6N-R63W-S12 L01 (TS# 1973): Confirmed accuracy of existing Engineering Evaluation that the tanks are banked and is provided in the attached email correspondence (Attachment N).
3) WILMOTH BUROUGH T4N-R64W-S14 L01 (TS# 467): Confirmed accuracy of existing Engineering Evaluation. Noble Verification Form improperly identified the Tank System as being banked. TLO walkdown documentation (Attachment O) confirms that the Tank System is not banked.
4) DECHANT CORBIN RIVA T3N-R64W-S30 L01 (TS# 437): Noble agrees that Engineering Evaluation was incorrect. Updated Engineering Evaluation submitted with Noble's Semi-Annual Report (5th) (July 28, 2017).
5) FIVE RIVERS T4N-R66W-S8 L01 (TS# 2372): Noble agrees that Engineering Evaluation was incorrect in representing the correct quantity of tanks. Updated Engineering Evaluation submitted with Noble's Semi-Annual Report (5th) (July 28, 2017).
6) LUCCI ST T5N-R64W-S1 L01 (TS# 301): Noble agrees that Engineering Evaluation was incorrect. Updated Engineering Evaluation submitted with Noble's Semi-Annual Report (5th) (July 28, 2017).
7) SHELTON T4N-R65W-S25 L01 (TS# 661): Noble agrees that Engineering Evaluation was incorrect. Updated Engineering Evaluation submitted with Noble's Semi-Annual Report (5th) (July 28, 2017).
8) DECHANT T2N-R65W-S1 L01 (TS# 2357): Noble agrees that Engineering Evaluation was incorrect. Updated Engineering Evaluation was generated and submitted with Noble's Semi-Annual Report (6th) (January 29, 2018).
9) ROACH BASS T5N-R67W-S14 L01 (TS# 26): Noble agrees that Engineering Evaluation was incorrect. Updated Engineering Evaluation was generated and submitted with Noble's Semi-Annual Report (6th) (January 29, 2018).
10) ST T8N-R60W-S16 L01 (TS# 2034): Noble agrees that Engineering Evaluation was incorrect. Updated Engineering Evaluation was generated and submitted with Noble's Semi-Annual Report (6th) (January 29, 2018).

11) WELLS RANCH AA14, AA16 ECONODE T6N-R63W-S14 L01 (TS# 1966): Noble agrees that Engineering Evaluation was incorrect. Updated Engineering Evaluation was generated and submitted with Noble's Semi-Annual Report (6th) (January 29, 2018).

12) SPIKE ST T4N-R63W-S30 L01 (TS# 1223): Noble agrees that the Engineering Evaluation was incorrect and the site did not meet the Performance Standards. A PCCM was completed on July 26, 2017. Updated Engineering Evaluation was submitted with Noble's Semi-Annual Report (5th) (July 28, 2017).

2. For 12 of 139 Tank Systems evaluated, SLR reported that Noble used a combustion control device capacity greater than the manufacturer published maximum capacity, potentially resulting in an overestimation of the VCS design capacity. SLR compared the manufacturer's published maximum capacities with the capacities used in Noble's engineering evaluations. Generally, the burner capacities Noble applied to determine overall VCS design capacity were below those published by the manufacturer. The Tornado (Tornado Combustion Technologies Inc., 2013) control device capacities used by Noble were consistently greater than the manufacturer published maximum capacity. The capacity used by Noble for the COMM 200 (Mooney, 2016) control device was greater than the manufacturer published maximum capacity in some limited cases. Noble's use of a higher burner capacity than the manufacturer's published maximum capacity at the SPIKE ST T4N-R63W-S30 L01 was the primary reason that VCS was considered not adequately designed and sized to handle the PPIVFR.

   Noble reviewed records associated with the 12 Tank Systems identified by SLR in the Draft Report. For all 12 Tank Systems, Noble disagreed with SLR that a combustion control device capacity greater than the manufacturer published maximum capacity was considered.

   For nine (9) of these Tank Systems, Noble asserts that SLR did not appropriately assess the manufacturer specified capacity specific to the Tornado combustion control devices. Noble offers that Tornado's burner curves (and published capacity) truncate at 10 oz/in^2 burner inlet pressure, whereas Noble's Engineering Evaluations consider Tank System pressures up to 16 oz/in^2 (where it is designed for 10-11 oz/in^2 but incorporates a contingency capacity up to 16 oz/in^2). After reviewing SLR's Draft Report, Noble contacted Tornado to confirm that its burners can handle capacities beyond the published specification or 10 oz/in^2. Tornado confirmed that the published burner curve can be hydraulically extrapolated beyond 10 oz/in^2. Moreover, Tornado noted the stated capacity is based on heat release (86.4 MSCFD at 2,300 BTU/scf). Noble's typical flash gas is lighter in composition (1,800 BTU/scf) such that the Tornado burner would be capable of handling up to 110.4 MSCFD at the published heat release limit. The Tornado specification sheet notes the maximum flow is dependent on heating value of the gas, consistent with Noble's conversation. The nine (9) Tank Systems pertaining to this response are listed below.

   1) BECCA GUTTERSEN T3N-R64W-S3 L01 (TS# 485)

   2) BORESEN DETIENNE T5N-R67W-S12 L01 (TS# 2264)

3) CARLSON T5N-R65W-S4 L01 (TS# 1437)
4) LDS T3N-R64W-S5 L01 (TS# 693)
5) MOSER CHAMP T4N-R65W-S34 L01 (TS# 432)
6) SPIKE ST T4N-R63W-S30 L01 (TS# 1223)
7) SPIKE ST T4N-R63W-S30 L02 (TS# 1481)
8) SPIKE ST T4N-R63W-S30 L03 (TS# 1217)
9) WOLFE USX T4N-R63W-S7 L01 (TS# 1416)

SLR acknowledges Noble's assertion of the higher burner capacity for the subject Tornado combustors and agrees with the resulting conclusion that Noble did not overestimate the VCS design capacity in its Engineering Evaluation.

For the following two (2) Tank Systems, Noble contends that SLR incorrectly interpreted the audit analysis data.

10) BERNHARDT VETTER T4N-R67W-S1 L01 (TS# 2331): Confirmed accuracy of existing Engineering Evaluation. Per Appendix B of Draft Report, Noble considers a burner capacity of 8,209 scfh, whereas SLR considered a burner capacity of 13,083 scfh.
11) DECHANT ST T3N-R65W-S36 L01 (TS# 2213): Confirmed accuracy of existing Engineering Evaluation. Per Appendix B of Draft Report, Noble considers a burner capacity of 7,860 scfh, whereas SLR considered a burner capacity of 9,106 scfh.

SLR agrees with the burner capacities confirmed by Noble.

For one (1) of these Tank Systems, Noble asserts that SLR incorrectly applied the manufacturer specified capacity as listed in Appendix A of the Draft Report.

12) KODAK T6N-R67W-S35 L01 (TS# 1684): Confirmed accuracy of existing Engineering Evaluation. SLR applied an incorrect VOC capacity to the COMM burner for this location. Appendix B of the Draft Report documents the KODAK was evaluated with 95 MSCFD VOC capacity, however Appendix A of the Draft Report documents a COMM burner capacity of 157 MSCFD.

SLR agrees with the burner capacity confirmed by Noble.

SLR initially found that the Engineering Design Standard was applied correctly to 82 percent of the 139 Tank Systems included in the audit. Based on a document review of information provided by Noble, as discussed above, SLR finds that the Engineering Design Standard was applied correctly to all 139 Tank Systems included in the audit. Table 1 provides a summary of revised findings.

4.3 VCS ADEQUATE DESIGN AND SIZING

SLR reported that of the 139 Tank System VCS audited, 124 (89%) were adequately designed and sized to accommodate the PPIVFR. SLR also reported that it could not determine if the VCS was designed and sized adequately to accommodate PPIVFR at 10 Tank Systems due to inability to quantify vapor losses from other sources or confirm installed equipment.

Noble reviewed records associated with the five (5) Tank Systems identified by SLR to be inadequately designed to accommodate the PPIVFR. For three (3) Tank Systems, Noble confirmed the accuracy of the existing Engineering Evaluation and provided documentation to confirm. For two (2) Tank Systems, Noble agrees with SLR and progressed a PCCM to ensure the Tank System meets the Performance Standards – note that these Tank Systems are the same Tank Systems identified and previously addressed in Sections 4.1.4 and 4.2.1.

1) FIVE RIVERS T4N-R66W-S8 L01 (TS# 2372): Confirmed accuracy of existing Engineering Evaluation. Although there are multiple tank banks on this location, each bank has its own dedicated set of VOC combustors. Adding in breathing losses from parallel tank banks means that additional VOC capacity would be available. Initial site walkdown picture (Attachment P) documents the existing VOC system configuration.
2) KODAK T6N-R67W-S35 L01 (TS# 1684): Confirmed accuracy of existing Engineering Evaluation. SLR applied an incorrect VOC capacity to the COMM burner for this location. Appendix B of the Draft Report (attached) documents the KODAK was evaluated with 95 MSCFD VOC capacity, however Appendix A of the Draft Report (Attachment Q) documents a COMM burner capacity of 157 MSCFD.
3) WELLS RANCH AA12, AE07, AA12 ECONODE T6N-R63W-S12 L01 (TS#1973): Confirmed accuracy of existing Engineering Evaluation. (Attachment N).
4) SPIKE ST T4N-R63W-S30 L01 (TS# 1223): Noble agrees that the Engineering Evaluation was incorrect and the site did not meet the Performance Standards. A PCCM was completed on July 26, 2017. Updated Engineering Evaluation was completed and a revised COCR submitted with Noble's Semi-Annual Report (5th) (July 28, 2017).
5) WOLFE USX T4N-R63W-S7 L01 (TS# 1416): Noble agrees that the Engineering Evaluation was incorrect and the site did not meet the Performance Standards. A PCCM was completed on July 14, 2017. Updated Engineering Evaluation was completed and a revised COCR submitted with Noble's Semi-Annual Report (5th) (July 28, 2017).

In addition to the five (5) Tank Systems identified by SLR to be inadequately designed to accommodate the PPIVFR, Noble also reviewed records associated with the ten (10) Tank Systems for which SLR could not assess design adequacy. For two (2) Tank Systems, Noble confirmed the accuracy of the existing Engineering Evaluation and provided documentation to confirm. For eight (8) Tank Systems, Noble agrees with SLR and has updated documentation to accurately reflect the Tank System operation – note that five (5) of these Tank Systems are the same Tank Systems identified and previously addressed in Section 4.1.2.

1) AVA ST T4N-R64W-S36 L03 (TS# 970): Confirmed accuracy of existing Engineering Evaluation. Evaluation specifies a maximum allowable oil dump trim of ¾”. Field QAQC documents current oil dump trim of ½”, which is less than ¾”. Field QAQC markup (Attachment R) confirms the existing oil dump trim.
2) ST BOOTH T4N-R64W-S36 L01 (TS# 503): Confirmed accuracy of existing Engineering Evaluation. Evaluation specifies a maximum allowable oil dump trim of ¾”. Initial work request (Attachment S) specified a combination of ½” and ¾” valve trims, which do not exceed the maximum specification. This Tank System was recently modified (Attachment T), so that all oil dumps are ¾” for operational reasons. Since the existing Engineering Evaluation already considered all oil dump trims to a maximum of ¾”, the field change does not impact the Engineering Evaluation.
3) DECHANT T2N-R65W-S1 L01 (TS# 2357): An updated Engineering Evaluation was completed and a revised COCR submitted with Noble’s Semi-Annual Report (5th) (July 28, 2017).
4) FURROW ST USX T7N-R64W-S22 L01 (TS# 2018): An updated Engineering Evaluation was completed and a revised COCR submitted with Noble’s Semi-Annual Report (5th) (July 28, 2017).
5) SCOOTER T3N-R64W-S18 L01 (TS# 2367): An updated Engineering Evaluation was completed and a revised COCR submitted with Noble’s Semi-Annual Report (5th) (July 28, 2017).
6) SHELTON T4N-R65W-S25 L01/PLUSS SHELTON T4N-R65W-S25 L02 (TS#661): An updated Engineering Evaluation was completed and a revised COCR submitted with Noble’s Semi-Annual Report (5th) (July 28, 2017).
7) KUMMER T8N-R61W-S23 L02 (TS# 569): Facility undergoing further modification for new well addition. Future Engineering Evaluation is planned to be completed with an updated COCR submitted with Noble’s Semi-Annual Report (6th) (January 29, 2018).
8) CHECKETTS JERKE T4N-R65W-S15 L01 (TS# 2158): An updated Engineering Evaluation was completed and a revised COCR submitted with Noble’s Semi-Annual Report (5th) (July 28, 2017). Tank volumes, dump valve trims, and PSHH installation were field verified. Revised Engineering Evaluation reflects the field verified tank volumes, dump valve trims, and PSHH installations (Attachment U).
9) EHRLICH T4N-R67W-S23 L02 (TS# 170): An updated Engineering Evaluation was completed and a revised COCR submitted with Noble’s Semi-Annual Report (5th) (July 28, 2017). Dump valve trims were verified. Completed Rework Request (Attachment V) documents confirmation that all dump valves are ½” trim.
10) HSR DECHANT PARKMAN SAFRANS BARBOUR PETRIE T3N-R64W-S7 L01 (TS# 388): Updated Engineering Evaluation submitted with the 5th semiannual report (July 28, 2017). Dump valve was verified to be a Kimray 212, which does not have an adjustable trim and seat. The updated Engineering Evaluation considered the specific dump valve characteristics, which are comparable to a

1.5” trim. Additionally, field verification confirmed that a dedicated LP gas system was installed. Satellite imagery of the Tank System (before and after) shows the dedicated system that was installed.

Revised results of the document review for each Tank System are summarized in Table 1 and detailed in Appendix B.

4.4 IR CAMERA INSPECTIONS

GreenPath detected VOC emissions from the VCS at 44 Tank Systems, or 54 percent of the Tank Systems inspected. The most prevalent source of emissions was the thief hatches and PRVs on oil and water tanks. GreenPath found 72 thief hatches or PRVs leaking, or 12 percent of the 582 tanks inspected. Details of the IR inspections can be found in Table 2 and the detailed GreenPath Report found in Appendix C.

For each of the 44 Tank Systems from which VOC emissions were detected, GreenPath notified Noble, Noble completed corrective action, and GreenPath re-surveyed the component to confirm that the VOC emissions had been eliminated. Records documenting GreenPath’s IR Camera Inspections, Noble’s corrective action and GreenPath’s re-survey of those components are provided in Appendix C.

IR camera inspection video files were provided on a flash drive to Parties, as required by the Work Plan. All of the videos associated with two of the Tank Systems inspected and some of the videos associated with a third Tank System, 22 of the videos in all, could not be recovered.

5. REFERENCES

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TABLES

APPENDIX A

ASSUMPTIONS AND REFERENCES

Third-Party Verification Final Audit Report
First Audit

Noble Energy, Inc.
1625 Broadway, Suite 2200
Denver, CO 80202

November 5, 2018

APPENDIX B

DETAILED DOCUMENT REVIEW FINDINGS

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APPENDIX C

GREENPATH IR CAMERA INSPECTION REPORT

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