INDEPENDENT EXPERT REPORT V2: MO367

Module Title	M0367 CO_2 Capture from Acid Gas Removal in Natural Gas Processing Plants
Version	1.0
Sectoral Scope(s)	16, Carbon Capture and Storage
Document Reviewed	M0367 CO_2 Capture from Acid Gas Removal in Natural Gas Processing Plants
Date of Issue	05 November 2025 Revision: 21 November 2025
Expert Assessors	Aster Global Environmental Solutions, Inc. Barbara Toole O'Neil, QEP, and Nancy Wellhausen
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1 INTRODUCTION

Verra is managing the development of VCS module *M0367 CO_2 Capture from Acid Gas Removal in Natural Gas Processing Plants*. Per Section 3.5 of the *VCS Methodology Development and Review Process, v5.0*, module development requires a review by a group of independent experts to ensure the module aligns with current scientific knowledge, research, and best practices, assuring the technical rigor, accuracy, and consistency of the proposed content.

Based on their experience in upstream oil and gas, carbon capture and storage, and project development for the carbon market, Verra hired Aster Global Environmental Solutions to provide an expert assessment of the proposed module. The expert assessor's assessment focused on the following:

1) Scientific rigor: Assessment of whether the proposed module reflects the most recent scientific knowledge of greenhouse gas (GHG) emissions in carbon capture and storage
2) Validity of technical assumptions
3) Appropriateness, relevance, accuracy, and/or conservativeness of:
    a) equations for quantifying project emissions and leakage emissions
    b) assumptions, calculations, and data sources
    c) monitoring approach
4) Scope of module boundary relative to typical gas plant facilities, their capture facilities, and other module boundaries in the VCS methodology *VM0049 Carbon Capture and Storage* framework
5) Key risks or criticisms expected from the market for this activity type

2 ASSESSMENT APPROACH AND FINDINGS

Aster Global's expert assessors reviewed the draft methodology module that was published for public consultation and provided feedback to Verra. Verra prepared responses to the expert assessors' findings. Our expert assessors reviewed the responses with Verra. The planned updates addressed the assessors' findings. See Section 5 for our detailed expert assessment feedback.

The expert assessors submitted their review on 5 November. The comments on the review were discussed on 14 November with Verra. Section 5 has been updated to include the Verra comments and some additional comments from the expert assessors.

3 ASSESSMENT CONCLUSION

Aster Global's expert assessors completed the expert assessment of *M0367 CO_2 Capture from Acid Gas Removal in Natural Gas Processing Plants* and confirms that the draft module adheres to the criteria established with the exceptions as noted in the attached issues/comments log.

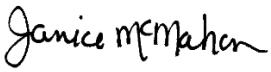
4 EXPERT QUALIFICATIONS

Barbara Toole O'Neil has authored 18 peer-reviewed scientific publications to date. A detailed list of relevant publications, employment, education and qualifications, and experience has been provided under separate cover to Verra.

Nancy Wellhausen has authored 6 peer-reviewed scientific publications to date. A detailed list of relevant publications, employment, education and qualifications, and experience has been provided under separate cover to Verra.

SIGNATURE

Signed for and on behalf of:

Name of entity:	*Aster Global Environmental Solutions, Inc.*
Signature:	
Name of signatory:	JANICE MCMAHON
Date:	*21 November 2025*

5 EXPERT FEEDBACK

Section # – Description of the Section			
#	Paragraph from Draft Methodology	Comment	Verra's Response and/or Update
1.	General	• The Module may be used by project proponents with no expertise in natural gas processing. Within the document there is no overview of natural gas processing from ground to pipeline. The US DOE EIA site provides a short and clear overview https://www.eia.gov/energyexplained/natural-gas/delivery-and-storage.php A DOE paper from 2006, 'Natural Gas Processing: The Crucial Link Between Natural Gas Production and Its Transportation to Market", provides more references on the process, which can be summarized in the module. https://www.eia.gov/naturalgas/archive/feature_articles/2006/ngprocess/ngprocess.pdf ***Additional Comment: The reviewers understand the purpose of the module and that this isn't needed. We discussed adding this as reference material for inexperience project proponents***	The scenario proposed in your comment seems extremely unlikely. No action warranted or taken
		• The Module doesn't discuss or account for other products from processing raw natural gas including helium, carbon dioxide, and hydrogen sulfide. Besides selling carbon dioxide to the food industry, depending on the process, carbon dioxide can be re-injected into the natural gas well or an adjacent well for many reasons including enhanced recovery or aquafer stabilization. How is the sale or re-injection of CO2 accounted for in the module, and would the tCO2 be creditable? https://www.eia.gov/naturalgas/archive/feature_articles/2006/ngprocess/ngprocess.pdf ***Additional Comment: The reviewers understand the purpose of the module and that this isn't needed. We discussed adding this as reference material for inexperience project proponents***	Unclear on what is being communicated here. Again, the purpose of this module is not to inform a layperson or someone with casual interest in CCS. This comment seems like recounting general knowledge and seems to demonstrate a lack of understanding of how the VM0049 methodological framework operates and where M0367 fits into that framework. VM0049 is not applicable to projects that are diverting CO2 from utilization (Applicability Condition 7). This module does not credit any activity, it accounts for the PE and LE associated with the diversion of CO2 captured from the processing of natural gas that would

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			have been released to atmosphere. It is a capture module that can only be used under the VM0049 framework and in conjunction with other modules relevant to the project activities.
		• Units of measure in the module, especially equations 2 and 3, are confusing. An explanation that all calculations should be in units of mass, e.g. kg. would clarify the confusion. ***Additional Comment: The reviewers understand that the project process information may be in different units, e.g. m^3/min . It is important that the module clearly state that all process data be converted to mass to be included in the methodology.***	The need to limit the acceptable units to mass is unclear
		• In gas processing, the units are usually corrected to Standard Temperature and Pressure(STP), which is defined in VM0049 as 'STP must be selected and defined by the project proponent as per industry practice in their geographic location '. Providing clear guidance that the calculations are in units of mass also aligns with VM0049. This is mentioned again below. ***Additional Comment: The reviewers understand that the project process information may be in different units, e.g. m^3/min . It is important that the module clearly state that all process data be converted to mass to be included in the methodology.***	
		• A universal check of subscripts for consistency is suggested. ***Additional Comment: The reviewers understand that this check will be completed during the final editorial review.***	No response is required.
2.	**Definitions** **Acid gas** Hydrogen sulfide (H_2S) and/or carbon dioxide (CO_2) contaminants present in raw natural gas streams that are	Acid gas is a general term that generally includes any gas in the raw natural gas before processing. Acid gases include H_2S, CO_2, COS, and other gases. Further, raw natural gas contains many different components which need to be removed to process the raw gas to pipeline quality. Please clarify the definition.	This definition was taken from the EPA.

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	separated from sour natural gas by an acid gas removal unit	Sour natural gas is also not defined. It may not be needed. Please revise as appropriate ***No Further Comment needed***	
3.	**Definitions** **Pipeline Quality**	Pipeline quality is mentioned in the module but not defined. It is a quality standard for natural gas transported in North America, but a similar standard in other parts of the world may be called something else. This needs to be clarified. https://www.northernnaturalgas.com/infopostings/GasQuality/Pages/Requirements.aspx ***Additional Comment: The reviewers understand the purpose of the module and that the term pipeline quality is a commonly used term in North America. We discussed removing the term from the module.***	This seems like it would be a well understood concept in the sector, even if the terminology was different. Further, this term is not relevant to any of the functions or requirements of this module. Therefore, a change seems unnecessary.
4.	**Summary Description** - **Paragraph 1 -** This module calculates project emissions (PECap,y) and leakage emissions (LECap,y) from project activities eligible under the most recent version of Verified Carbon Standard (VCS) methodology VM0049 Carbon Capture and Storage that result in the diversion of carbon dioxide, separated from raw natural gas flows through acid gas removal and capture processes, towards permanent storage.	The term Summary Description seems confusing – the section is either a summary or a description. It is acknowledged that Verra has used that title in many documents for several years. This is an observation and opportunity for improvement.	1 (a) No response required.
		• A suggested revision to increase clarity is below: - This module calculates project emissions (PECap,y) and leakage emissions (LECap,y) from project activities eligible under the most recent version of Verified Carbon Standard (VCS) methodology VM0049 Carbon Capture and Storage that results in the separation of carbon dioxide from raw natural gas. This is accomplished through acid gas removal using absorption or adsorption of H_2S (and its	b) The suggested text provided does not describe the function of the module. The separation of carbon dioxide from the gas stream happens whether the project is in place or not

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		intermediates) and/or CO_2 from the natural gas stream. The resulting products from the acid gas removal process may be held in permanent storage. ***Additional Comment: The discussion provided needed clarification that may be incorporated into the module by Verra if needed.***	
		Why is 'reductions' in quotes in the last paragraph? ***Additional Comment: The discussion provided needed clarification that was sufficient.***	This is standard formatting convention known as a parenthetical abbreviation. It is a common practice used to introduce an abbreviation to the reader the first time the term is used.
5.	Applicability Conditions	• Confirm that all applicability conditions align with VM0049.	
		• Item 1 a) The installation and operation of equipment or systems that divert captured CO_2 towards permanent storage at an existing natural gas processing plant ***Additional comment: See comment below***	Unclear on what is being communicated with this first comment. Are you describing what you have done or directing Verra to take action. If it is the second, please provide specific examples of cases where the content of this module is misaligned with VM0049
		Is reinjection considered permanent storage? It isn't clear in the narrative ***Additional comment: The discussion provided clarification, reinjection is considered permanent storage. Item 1 and 2 should have been combined into one comment.***	2 Reinjection of what? Are you referring to EGR? Please clarify your concern here.
		• Item 3) The capture process used in the project activities is designed to regenerate the primary capture fluid or media, such that it is not a one-time use, and a concentrated CO_2 stream is recovered from regeneration and available for subsequent transport (where applicable) and storage. ***Additional comment: The discussion provided needed clarification. No further comment needed***	3 The requirements of the capture process apply regardless of the end-use of the CO2.

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		Since CO_2 is also sold, this item should include a note, e.g.; subsequent sales, or transport or storage ***Additional comment: The discussion provided needed clarification. No further comment needed***	
		• Additional end uses of CO_2 or other products should be included as appropriate. ***Additional comment: The discussion provided needed clarification. No further comment needed***	
		• Item4 d) Flue gas capture from oil and gas production and processing, including the capture of native CO_2, acid gas removal, and liquefied natural gas (LNG) production that meet the eligibility conditions in VMD00XX Emission Reductions from CO2 Capture from Oil and Gas Production and Processing. ***No Further Comment needed***	4 We will consider your comment in the next revision of VM0049.
		• The current module is 'M0367 CO_2 Capture from Acid Gas Removal in Natural Gas Processing Plants'. Will there be another module as listed above? ***No Further Comment needed***	5 The naming conventions used in VM0049 are being revised and will address this comment
6.	5.1 Module Boundary	• The discussion does not include sales of CO_2 in the process. Figure 1 also does not include other uses, e.g. sales of CO_2 or other gases. ***Additional Comment: The discussion provided needed clarification.***	1 Gas captured within the project boundary that subsequently leaves the boundary, as in the case of gas that is sold, is accounted for as Non-VCS. The blue arrow that reaches the blue box on the right side of the project boundary illustrates such a scenario.
		• Just to be clear, in VM0049, Figure 1, would this module fit in the Industrial Processes or Oil & Gas Box? There could be a need for another box titled 'Natural Gas Processing'. The box Oil and Gas could be interpreted as oil and gasoline, not natural gas. Likewise, Industrial Processes could be interpreted to include Natural Gas Processing.	

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		***Additional Comment*: The discussion provided needed clarification.**	
		• Table 1 would be much clearer if an example process was provided or a reference for typical operations. ***Additional Comment*: The discussion provided needed clarification. No further comment needed.**	2 The use of Table 1 is a standard procedure. The arrangement of the facilities involved in the natural gas processing process will vary from project to project. Including an "indicative" diagram would likely raise as many questions as it answers for projects with a different arrangement from the one presented.
		• In Table 1, there are processes identified that are not defined elsewhere. For instance, acid gas conditioning is mentioned. It is probably a separate unit operation, but it isn't clear. ***Additional Comment*: The discussion provided needed clarification.**	3 Seems like this would be well understood by the operators of these facilities. We did not receive comments from sectoral stakeholders calling for additional clarification.
		• The comment that "The operation of the capture facility is consistent between the baseline and project scenarios and therefore the emissions are equivalent" needs to be further explained. Comments like that are frequently rejected by Verra reviewers. ***Additional Comment*: The general assertion that the emissions are equivalent should be supported by additional information or reference to a case study in the module. Supporting references would be useful in addition.**	4 Please provide specific advice or suggestions on what this explanation should address. And, please provide the rationale given when statements like this are rejected.
7.	5.2 Baseline scenario CO2 is captured and diverted towards permanent storage, and/or utilization in products or processes, at historical levels from an existing natural gas processing plant.	• This doesn't seem to be consistent with the applicability definition and in alignment with VM0049. ***Additional Comment*: The discussion provided needed clarification between what is required for this module and the methodology. No further comment needed**	1 How is it not aligned? Please explain the specific issue, so that it can be addressed.

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		• Also, historic levels are not defined. It could include the emissions history since the well was drilled or just the 10 years. Please clarify *No Further Comment needed*	2 This baseline is no change to existing capture and storage, i.e. – the expansion of existing capture capacity by installing new facilities. In this case, the gas stream captured by the capacity present in the baseline is treated as Non-VCS gas and continues to be monitored throughout the project. To use this baseline, a project would need to demonstrate that there was gas being released to the atmosphere, and now, through the expansion of capacity, is not being released. We don't expect that this baseline will be used due the poor ROI, but it was included for completeness
8.	5.3 Quantification of Project Emissions	• As stated above, the calculations are confusing. The measurement values need to be converted to STP and then converted to mass. Energy units need to be converted to mass.	Discussed above
		• Please provide unit definitions/conversions to ensure consistency. *No Further Comment needed*	
9.	5.4 Quantification of Leakage	• Leakage emissions from process and equipment are an area of significant uncertainty. We suggest providing an example Process and Instrument Design (P&ID) or other process flow examples as part of the procedure tools to identify and facilitate the boundary accounting process. *<u>Additional comment</u>: Further clarification was provided related to uncertainty and leakage. The two sources for uncertainty were fuel combustion*	1 – Unclear about this comment. Is it that the process for calculating leakage emissions is unclear or that the sources of leakage emissions are unclear? Please clarify.

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		and leakage emissions related to this mode, not the meters. No further information is needed.	
		• Equation 4 has the term GWP_{CH4} in the equation but not listed or defined in the terms below the equation. ***No Further Comment needed***	2 – Thank you for your feedback. We will revise to address.
		• Equation 5 has a term defined that is not in the equation, $LE_{elec,y.}$ ***No Further Comment needed***	3 - Thank you for your feedback. We will revise to address.
10.	5.5 Uncertainty The primary sources of uncertainty identified f or the project activities covered in this module are measurement error related to fuel combustion and the production of capture materials. All other potential sources of uncertainty are either considered de minimis or accounted for in the conservativeness of the default factors.	• Modern or even older processing plants have data acquisition systems and accurate measurement systems. Measurement meter systems for gases are very precise, and all data is gathered electronically. In addition, safety requirements for combustible gases are very stringent and would require special measurement meters. Sub metering may not be as certain, e.g. calibrated less often, but that is not mentioned. This discussion is not clear. ***<u>Additional Comment</u>: The discussion focused on the details of the VM0049 uncertainty requirements. The two sources for uncertainty were fuel combustion and leakage emissions related to this mode, not the meters. As the reviewers understand, the module discussion on uncertainty will be revised.***	1 This seems like general information, I am unclear on how to address. The parameter descriptions provide QA/QC requirements for metering.
		• Measurement related to fuel production and production of captured materials relates to the calibration of the meters used to determine the volume of natural gas combusted or produced. Those meters may have more uncertainty than tolling meters. Some ways to evaluate the uncertainty might be to evaluate calibration records, maintenance records, and fugitive emissions data. Please provide additional information to clarify the issue.	2 Again, this seems like general information. The parameter descriptions provide QA/QC requirements for metering. It seems redundant to remind projects that they have access to that information

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		***Additional Comment*: The discussion focused on the details of the VM0049 uncertainty requirements. As the reviewers understand the module discussion on uncertainty will be revised**	
		• Second, this discussion does not align with VM0049, nor does it provide an overview of the required process in VM0049. ***Additional Comment*: The discussion focused on the details of the VM0049 uncertainty requirements. As the reviewers understand the module discussion on uncertainty will be revised**	3 Simply stating that it does not align is not helpful. Please clarify how this does not align
		• This section should be revised to be consistent with VM0049 ***Additional Comment*: The discussion focused on the details of the VM0049 uncertainty requirements. As the reviewers understand the module discussion on uncertainty will be revised**	4 Again how? Without specific details on the nature of the misalignment, addressing it is not possible.
11.	5.5 second paragraph -Uncertainty of measurement error related to project emissions from fuel combustion for capture activities is considered de minimis where the metering equipment used for determining fuel volumes ($Q_{Fuel,d,y}$) uses a custody transfer meter or fiscal metering for the transaction	• Why would this source be considered de minimis? Although custody transfer meters or fiscal metering provide accurate measurement, that does not mean the emissions would be de minimis. Please clarify or revise. The comments above apply here too. ***Additional Comment*: The discussion provided needed clarification that distinguished between the accuracy of the meter and the leakage from the process.**	1. This section refers to the uncertainty of fuel quantity measurements associated with metering equipment. What emissions are you referring to? 2. What comments are you referring to? Please be specific
12.	6.2 Data Parameters Monitored	• All data monitored should be in units of mass and corrected to Standard Temperature and Pressure. The conversions can be included in the boxes, or in the calculations in Section 5. ***No Further Comment needed***	Your feedback is noted