Mine Methane Capture Methodology Peer Review - Compilation of Comments from Round 1 and 2

Chapter	In regard to	Comment Peer Reviewer R1	Respond from Author	Comment Peer Reviewer R2	Respond from Author
General	General	This methodology is an upgrade on the MMC Protocol, being as rigorous as the MMC protocol, but simpler and easier to read. Most of my comments aim at providing more accuracy and flexibility to the VAM abatement quantification methodology, including the data substitution methodology, based on my experience monitoring a VAM abatement project. This methodology will be useful, generating more projects opportunities to reduce GHG emissions from coal mining activities. However, it would be great to extent project eligibility beyond North America since GHG emissions have the same global impact, regardless where they are generated on the planet. Currently, the sole financial incentive to implement VAM abatement project outside U.S.A. and Canada is to generate heat (for district heating) or electric power.		My main comment refers to the quantification methodology. To my point of view, the modifications made to equations do not fully address the confusion that may result from the use of averages. Some equations still refer to hours.  $PE_{NO_y} = \sum_y (VA_{flow_y} + CA_{flow_y}) \times C_{CH4_{exhaust_y}} \times 0.0423 \times 0.000454$ WHERE May 2019 americancarbonregistry.org 41 METHODOLOGY FOR THE QUANTIFICATION, MONITORING, REPORTING AND VERIFICATION OF GREENHOUSE GAS EMISSIONS REDUCTIONS AND REMOVALS FROM CAPTURING AND DESTROYING METHANE FROM U.S. COAL AND TRONA MINES Version 1.0 y: Hours during which destruction device was operational during reporting period (h) VA_{flow_y}: Volume of ventilation air sent to a device for destruction through use i during the reporting period (scf) CA_{flow_y}: Volume of cooling air sent to a destruction device after the metering point of the ventilation air stream during period y (scf) $C_{CH4_{exhaust_y}}$: Weighted average of measured methane concentration of exhaust gas emitted from the destruction device during the reporting period (scf CH_4/scf) I included at the **<u>end of the document</u>** a proposed structure for the equations based on the summation of time intervals. I believe this approach would be more suitable. The former method that was based on averages was OK, but less accurate and more complex as I explained in my first review.	All reviewer comments on the methodology's quantification section have now been addressed and the equation structure suggested by the reviewer has been adopted. Also note that these changes are reflected in each quantification section in the methodology.
General	General	The underlying science, procedures, and usability of the methodology is sound and valid. It serves as a solid basis for MMC projects for the Cap-and-Trade program, as well as other potential offset protocols (The	Thank you for the affirmation of the approach. It is appreciated.		

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		Canadian markets come to mind, if applicable. The layout/structure is very similar to the CA Compliance Offset Protocol, which makes it easy to compare and follow from the project developer's perspective. I have no issues with the eligibility and additionality requirements outlined in this protocol. The calculation method for quantifying emissions reductions is also sound. Calculation logic fairly and adequately quantifies emission reductions while minimizing risk to the parties involved. The public comments have also asked some of the questions that I had and the response to the public comments properly addresses them.			
General	General	A similar methodology was published by the California Air Resource Board and other methodologies have been in existence for years, so the underlying science and sampling protocols have been well established and tested. The authors have been careful to lay out the quantities that must be measured and recorded and subsequently input into clearly defined equations to provide the resultant emissions reductions. The methodology is well designed and useable. However, I suggest that the methodology is designed for a project engineer and may not be easily understood by a project developer, which may deter the use. The document could be much more accessible if a bit more narrative is added up front and at each point where the project type changes, i.e., Active Underground Mines, Active Surface Mines, etc. An introduction and background for this	Authors added small intro to CMM in Section 1 - Purpose to provide an overview of mine methane activities, methane sources, etc. Additionally, regarding qualifying destruction equipment, the language in these sections (see, for example, Section 2.1 II) has been changed to state that equipment operation at the mine prior to the project start date is eligible if it was part of a past project and was a qualifying device in that project.		

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		document and a few illustrations, such as block-flow diagrams to give the reader/ user a synoptic overview of the flow of data through the equations and the resultant quantities would be useful. Even recognizing that this document is meant to be prescriptive in order to establish and maintain the integrity of the process and lower the cost of validation and verification, a little work on making it more user friendly would be appreciated by all readers. I do not agree with the reasoning related to allowing pipeline sales to be eligible, and there was never a reason for pipeline sales to be disallowed by other methodologies. That concept was driven by CARB on faulty reasoning. The statement that CMM projects are not increasing is true, it is worse in that many have begun to decrease in effectiveness. I agree that we are at the point where any project that captures and uses or destroys methane that would otherwise become fugitive should be encouraged. This should be the guiding principle and publicized. I believe that the credits created by this methodology will have value and be a low risk investment for the buyer My comments generally pertain to minor details except in two places. One is that the wording related to drawing offset project boundaries: figure 2 should show that well drilling and gas well completion is inside the project boundary. If the author has a reason for leaving it out, there should be an explanation. It is included in the surface mine	This acknowledges situations such as one where a destruction device is moved and repurposed for use in a new project.		

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		project boundary, and even if the wells are drilled for other reasons, and since pipeline sales are allowed, the wells, gathering systems and compressors, should be included in all mining cases. The second is related to the rules for qualifying destruction equipment, as an example 2.3 II states: "In order to be considered a qualifying device for the purpose of this methodology, a methane destruction device for an active surface mine methane drainage activity must not have been operational at the mine prior to the project start date." I understand this is meant to ensure that equipment that was commissioned prior to the start date of the project could not be "re-commissioned" and become a part of a new project simply by declaration. However, the way that it is written could disqualify equipment that was in use, moved and/or repurposed through a legitimate process. I do not believe that it is the intent to disqualify equipment simply because it has been used in a methane destruction project. Finally, I found the discussion of the coal mining in Canada and México to be well done and even though I understand the reasoning behind placing these sections in the appendices of the document, I feel that that they should be more visible. They could be used on ACR's website or other published material to promote the widespread use of the methodology.			

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Acronyms	**Mscf** Thousand standard cubic feet, and **Mscf/d** Thousand standard cubic feet per day	M usually refers to Mega or million (1×10^6). The letter k is usually used for Kilo or Thousand (1×10^3).	We could not locate a reference for an abbreviation of Kscf or Kscf/d. In oil and gas engineering, all located references state that the appropriate abbreviation for "thousand standard cubic feet" is Mscf. No change was made in the methodology.		
2.1 I, and 2.2 II	In order to be considered a qualifying device for the purpose of this methodology, **the device must not have been operational at the mine prior to the project start date.**	Recommends that if the destruction device was used in a past project at the mine with the sole objective of reducing GHG, it should still be considered a qualifying device for a new GHG abatement project. For example, at the completion of a VAM abatement project at a first Vent Shaft, the destruction device should still be qualified to be relocated to another Vent shaft in order to implement a new project. Some Vent shafts may remain operational only a few years (typically 3-7 years). It would not make sense to invest millions for the implementation of a VAM abatement plant for only a few years of operation and not be allowed to relocate it while the equipment remains fully functional	Sections 2.1 II, 2.2 II, 2.3 II, and 2.4 II were revised to acknowledge that a device could be considered a qualifying device if it was used in a past project at the mine and was a qualifying device in that past project.		
2.3 element I. D	Converted dewatering wells.	Any borehole, as an example, exploration boreholes that are repurposed for production should be allowed	All abandoned wells are included in I.C.		

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			Well definition includes exploration wells.		
2.3 element II	In order to be considered a qualifying device for the purpose of this methodology, a methane destruction device for an active surface mine methane drainage activity must not have been operational at the mine prior to the project start date.	Maybe this has been meant to disqualify equipment employed for methane destruction in a project that is not registered or is registered as another project. However, there is no reason to disqualify the use of a piece of equipment that was employed in a destruction activity, but is being recommissioned for the new project.	Sections 2.1 II, 2.2 II, 2.3 II, and 2.4 II were revised to acknowledge that a device could be considered a qualifying device if it was used in a past project at the mine and was a qualifying device in that past project.		
2.3, element VI, part A	Account for virgin CBM extracted from wells outside the extents of the mine according to the mine plan or from outside the methane source boundaries as described in Section 3.4;	1. For Account, include production of… 2. Virgin CBM is not a standard term, and if it is necessary to use the term, it should be defined. The sentence would still have the same meaning without "virgin".	1. Edit made to section 2.3.VI.A 2. Virgin CBM defined with coal bed methane.		
2.3, element VI, part C	Occur at mines that employ mountaintop	This seems punitive. It is bad enough that mountain top removal is allowed, but not useful to allow methane to go to the	We have removed the prohibition on projects where mountaintop removal is occurring.		

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	removal mining methods.	atmosphere just because the source is distasteful.			
2.4 Abandoned Underground Mine Methane Recovery Activities	Voluntarily pump water from the mine for the sole purpose of extracting methane.	Are MMC projects at flooded mines permissible as long as they are not pumping water from the abandoned mine?	Yes, MMC projects at flooded mines are permissible. The only requirement is that water cannot be voluntarily pumped from the mine void in order to artificially increase the methane emission rate.		
2.4 element I	Methane drainage systems must consist of only one methane source: In-mine boreholes and post-mining wells drilled into the mine during or after mining operations;	This needs to be clarified. The way that it is written it could mean either two mines or two draw points from the same mine.	A footnote for clarification has been added as follows: Please note that in this methodology, in-mine boreholes and post-mining wells, are considered to be the same "methane source". Projects may include one or more in-mine boreholes and post-mining wells within a project.		
2.4 element II	In order to be considered a qualifying device for the purpose of this methodology, a methane destruction device for an abandoned	This is the equipment use issue mentioned above. This ambiguity could be removed by saying that a project that is operational before the start date of the intended project cannot be qualified and registered, but there should not be a prohibition of dismantling the project and moving the equipment to another site that can be qualified under this methodology	Sections 2.1 II, 2.2 II, 2.3 II, and 2.4 II were revised to acknowledge that a device could be considered a qualifying device if it was used in a past project at the mine and was a qualifying device in that past project.		

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	underground mine methane recovery activity must not have been operational at the mine prior to the project start date unless the mine was previously engaged in active underground methane drainage activities and the methane destruction device was considered a qualifying destruction device for those activities.				
2.4 element II, part A	Account for **virgin CBM** from wells outside the extents of the mine according to the final mine map(s) or from outside the methane source boundaries described in Section 3.4	This implies that a CBM well located within the extents of the mine will qualify as long as it is within the methane source boundaries—is this correct?	Edits made to section 2.4.II.A		

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3.2 Eligibility	Projects located in **the** North America are eligible under this methodology.	Remove word "the"	Correction made.		
3.3.1 element II, part A	If no law, regulation, or legally binding mandate requiring the destruction of methane at the mine at which the project is located **exists**, all emission reductions resulting from the capture and destruction of mine methane are considered to not be legally required, and therefore eligible for crediting under this methodology.	Should be moved to precede the word requiring occurring earlier in the sentence. "…mandate exists requiring…"	Corrected		
3.3.1 element II, part B	If any law, regulation, or legally binding mandate requiring the destruction of methane at the	1. As above. Should be moved to precede the word requiring occurring earlier in the sentence. "…mandate exists requiring…" 2. "which exceeds the mandated requirement"	Both revisions made.		

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	mine at which the project is located **exists**, only emission reductions resulting from the capture and destruction of mine methane **that are in excess of what is required** to comply with those laws, regulations, and/or legally binding mandates are eligible for crediting under this methodology				
3.3.2 element II, part A	Destruction of VAM via any **end-use** management option automatically satisfies the performance standard evaluation because destruction of VAM is not common practice nor considered business-as-usual, and is	Or destruction? End-use management option is not clear---should be defined to encompass end use or destruction.	Deleted “via any end-use management option” for all project types.		

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	therefore eligible for crediting under this methodology				
3.4 Methane Source Boundaries, element III, part B	To ensure that virgin **coal bed** methane is excluded from the mine methane accounted for in this methodology, physical boundaries must be placed on methane drainage systems.	Coalbed should be one word in this context	Changed coal bed to coalbed.		
3.4 Methane Source Boundaries, element III, part D	Abandoned mine methane contained in mine gas extracted from strata up to 150 meters above and 50 meters below a mined seam through existing or newly drilled in-mine boreholes or post-mining wells.	Is it alright to understand that this allows for wells drilled into unmined coal or other strata that is contained within the final mine map boundaries?	Yes, within the stated vertical limits of the mined coal seam.		

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4.2 Active Underground Mine Methane Drainage Activities, Table 2, element 9	Emissions resulting from mine methane combustion resulting from pipeline injection (CO_2 and N_2O)	Asks for clarification to understand this SSR. Does the pipeline injection process may involve any methane combustion? Does it refer to the eventual emissions of CO2 that will result from the combustion of methane by the end-user?	Yes, this is the eventual combustion of the gas that was injected into the natural gas pipeline.		
4.2 Active Underground Mine Methane Drainage Activities, Table 2, element 9 Pipeline injection	Emissions resulting from the incomplete mine methane combustion resulting from pipeline injection (CH_4)	Same comment: Does it refer to the methane emissions resulting from the incomplete combustion by the end-user? If so, how these emissions will be calculated considering that the percentage of incomplete combustion may vary depending on the end-user application.	Yes, this is the eventual combustion of the gas that was injected into the natural gas pipeline. Appendix B includes the default destruction efficiency for natural gas pipeline injection. A destruction efficiency of 98.1% is applied to all pipeline injection projects.		
4.4 Abandoned Underground Mine Methane Recovery Activities, Table 4, element 9	Emissions resulting from pipeline injection	Same comment: Does it refer to the methane emissions resulting from the incomplete combustion by the end-user? If so, how these emissions will be calculated considering that the percentage of incomplete combustion may vary depending on the end-user application…	Yes, this is the eventual combustion of the gas that was injected into the natural gas pipeline. Appendix B includes the default destruction efficiency for natural gas pipeline injection. A destruction efficiency of 98.1% is applied to all pipeline injection projects.		
5.1 Active Underground Mine Ventilation Air	Active Underground Mine Ventilation Air Methane Activities	If available, will ventilation air flow/CH4% values be verified with publicly available data for data? E.g. quarterly air flow and CH4% is available from MSHA or Subpart FF for GHGRP data in the US. Although the timeframe for	Yes. During the verification process, the verification body may use resources such as those cited to verify	I understand that VAM flow rate and methane concentration data reported to MSHA are based on punctual measurements performed underground by the mine (i.e. once a	On the use of MSHA data, the initial comment from the reviewer was misunderstood. MSHA

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Methane Activities		data collection is different for the ACR requirements/MSHA or GHGRP, it could serve as an easy way to verify data	general ranges for monitored parameters that are used in the equations. This would only be used in addition to site specific data collection as required by the methodology.	month). The average value reported may be estimated from the sum of several measurements. To my point of view, those values involve a high level of uncertainties and should not be used to assess the accuracy of data monitored in the Project. Drawing conclusions from the comparison of Project vs MSHA data could be highly misleading.	data cannot be used for comparison with project level data.
5.1 Active Underground Mine Ventilation Air Methane Activities	Active Underground Mine Ventilation Air Methane Activities	If available, will ventilation air flow/CH4% values be verified with publicly available data for data? E.g. quarterly air flow and CH4% is available from MSHA or Subpart FF for GHGRP data in the US. Although the timeframe for data collection is different for the ACR requirements/MSHA or GHGRP, it could serve as an easy way to verify data	Yes. During the verification process, the verification body may use resources such as those cited to verify general ranges for monitored parameters that are used in the equations. This would only be used in addition to site specific data collection as required by the methodology.		
5.1.1 Quantifying Baseline Emissions, equation 2: baseline emissions	**BE**_ $_{MR}$ Baseline emissions from release of methane into the atmosphere during the reporting period (MT CO_2e)	Suggest that this **BE**_ $_{MR}$ definition can be misleading, because only a part of VAM emissions released by the Vent shaft are captured and sent to the destruction device. Suggest the following definition: Baseline emissions corresponding to the total amount of methane captured and sent to qualifying destruction devices that would have been released to the atmosphere in the absence of the project.	The definition in Equation 2 was changed per the comment in sections 5.1.1, 5.2.1, 5.3.1, and 5.4.1.		
5.1.1 Quantifying Baseline	**BE** $_{MR}$ must account for the total amount of	Clarifies that according to his knowledge BE_{MR} corresponds to the total amount of methane	Changed per the comment in sections		

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Emissions, equation 2: baseline emissions	**methane destroyed** by all qualifying devices during the reporting period.	captured and sent to all qualifying devices during the reporting period.	5.1.1, 5.2.1, 5.3.1, and 5.4.1.		
5.1.1 Quantifying Baseline Emissions, equation 3: baseline emissions from release methane	Baseline Emissions Formula	Suggest adapting the formula and provides an example. In this equation, the total BE_{MR} for the all reporting period is determined by multiplying hourly average values of VA and C_{CH4}. Rather than calculating BE_{MR} from hourly average values, you may consider allowing project operators to calculate BE_{MRt} for each time interval (for example at the same frequency as data monitoring - i.e. every 2 minutes) and then calculate total BE_{MR} for the reporting period by summing the $BE_{MR,t}$. Based on this approach, the variables in this equation should have a "t" index referring to "time interval". $BE_{MRT} = \sum_{T} [(VA_{P_I T} \times C_{CH4T}) + MG_{SUPP_T} \times C_{CH4_{MGT}}] \times 0.0423 \times 0.000454 \times GWP_{CH4}$ (Each time interval should be limited to 1 hour maximum.) Then, BE_{MR} would be calculated by summing BE_{MRt} of each time intervals..	Authors agree. Hourly and daily calculation requirements were removed from the equations.	Equation 3 still refer to a "Weighted average concentration" and does not define how to calculate that Weighted average. To my point of view, the way calculations are developed could still lead to some confusion. Please find at the end of this document how calculations could be expressed based on time intervals. The equations were developed for Active UG VAM projects, but the same approach could be used for the other sections.	

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$$BE_{MR} = \sum_{t} BE_{MR,t}$$

This comment also applies for the calculation of PE...

Justification:

It is much simpler and more accurate to calculate baseline emissions (BE), project emissions (PE) and emission reduction (ER) every 2 minutes rather than calculating ER from hourly averages. In our past VAM project, the monitoring system directly calculated BE and PE emissions every 2 minutes (at the same frequency as data recording). Total emissions for the reporting period were then obtained by summing all ER calculated every 2 minutes (no averaging required). Here are some advantages of using this 2-min emission quantification approach:

- It is more accurate. As shown in the following example, multiplying average values may significantly bias the result.

Time interval	A (i.e. VA flow)	B (i.e. %CH4)	A*B (i.e. CH4 flow)
1	10	0.3	3
2	15	0.4	6
3	4	1	4
4	8	0.2	1.6
5	10	0.6	6
6	8	0.4	3.2
7	15	0.4	6
8	21	0.5	10.5
average	**11.375**	**0.475**	**5.038**
	$(A*B)_{avg}$	5.038	(real average CH4 flow)
	$A_{avg} * B_{avg}$	5.403	(apparent average CH4 flow)

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		• Also, calculating hourly averages may be challenging under some circumstances, for example when the system is stopped less than 1 hour after it was restarted. Therefore, eliminating the need to calculate averages is much simpler and straightforward. • For these reasons, the project operator should be allowed to perform baseline and project emission calculations at the same frequency as the data monitoring frequency, without having to calculate hourly averages.			
5.1.1 Quantifying Baseline Emissions, equation 3: baseline emissions (formula)	$\mathbf{BE_{MR}}$ Baseline emissions from release of methane into the atmosphere during the reporting period (MT CO_2e)	Suggest that this BE_{MR} definition can be misleading, because only a part of VAM emissions released by the Vent shaft is captured and sent to the destruction device. BE_{MR} could rather be defined as follows: Baseline emissions corresponding to the total amount of methane captured and sent to qualifying destruction devices that would have been released to the atmosphere in the absence of the project.	Comment addressed in all relevant sections.		
5.1.1 Quantifying Baseline Emissions, equation 3: baseline emissions (main formula)	$\mathbf{MG_{SUPP_i}}$ Volume of mine gas **that would have been** extracted from a methane drainage system and sent with ventilation air to qualifying devices for destruction	Suggest not to use conditional in the definition	Eliminated "that would have been" from the description of $\mathbf{MG_{SUPP_i}}$		

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	during the reporting period (scf)				
5.1.1 Quantifying Baseline Emissions, equation 3: baseline emissions	$\mathbf{C_{CH4_t}}$ Hourly average methane concentration of ventilation air sent to a destruction device (scf CH_4/scf) $\mathbf{VA_{FLOW_t}}$ Hourly average flow rate of ventilation air sent to a destruction device (scfm)	Refers to previous comment regarding formula adaptation, and invites to considers the deletion of the term "Hourly" from the definition of C_{CH4T} and reviewing it as follows: Average methane concentration of ventilation air sent to a destruction device during the time interval t.	Authors agree. Terms deleted from equations.		
5.1.1 Quantifying Baseline Emissions, equation 3: Baseline Emissions	Methane concentrations and flow rates must be recorded **every fifteen minutes** with averages calculated at least hourly.	Maintains that the 15-minute interval between each recording appears very long, especially for VAM Projects, and suggest that a 2-min interval could be more appropriate. If all parameters (flow, concentration, temperature and pressure) are all recorded at the same interval (i.e. 2min), emission reduction can be directly calculated at each time interval (i.e. every 2 minutes). Daily emission reduction can then be calculated by summing the 2-min ER. You may consider eliminating the requirement to calculate any average value (hourly or daily average). Should be continuously monitored and recorded every 2 minutes. Peer reviewer provides this option "Methane concentrations and flow rates must be recorded every two minutes, with averages	Authors consider 15-minute interval appropriate for all types of MMC projects, including VAM projects. Low variation in ventilation air flow and methane concentrations do not warrant increasing interval to every 2 minutes.	OK, but I understand that we can monitor data at a higher frequency if desired (i.e. every 2 minutes) as specified in the methodology (see below…): … If the Project Proponent monitors and records data at a higher frequency, this data may be used within appropriate variables of the above equations to reflect the higher frequency of data collection.	

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		calculated over time intervals not exceeding one hour."			
5.1.1 Quantifying Baseline Emissions, equation 4: Project emissions	Project Emissions	Same comment as for BE_{MR} above, the Project Operator should be allowed to calculate PE for each time interval (PE_t), and then calculate total PE for the reporting period by summing each PE_t. No need to calculate average values.	Authors agree. Hourly and daily calculation requirements removed from the equations.		
5.1.1 Quantifying Baseline Emissions, equation 7: Methane Destroyed	$\mathbf{C_{CH4_t}}$ Hourly average methane concentration of ventilation air sent to a destruction device (scf CH_4/scf)	No need to specify "Hourly"	Authors agree. Hourly and daily calculation requirements removed from the equations.		
5.1.1 Quantifying Baseline Emissions, equation 7: Methane Destroyed	y Hours during which destruction device was operational during reporting period (h)	Suggestion: Based on the above comment referring to the possibility of calculating BE and PE for each time interval and then summing BE_t et PE_t, the index "y" in this equation would be replaced by a "t" index referring to "time interval"	Changed to "time interval"		
5.1.1 Quantifying Baseline Emissions, equation 7: Methane Destroyed	$\mathbf{VA_{flow_{iy}}}$ Hourly average flow rate of ventilation air sent to a device for destruction through use **i** during the reporting period (scfm)	Suggestion: Based on the above comment referring to the possibility of calculating BE and PE for each time interval and then summing BE_t et PE_t, the index "y" in this equation would be replaced by a "t" index referring to "time interval"	Changed to "time interval"		

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5.1.1 Quantifying Baseline Emissions, equation 7: Methane Destroyed	$\mathbf{CA_{flow_{i_y}}}$ Hourly average flow rate of cooling air sent to a destruction device after the metering point of the ventilation air stream during period **y** (scfm)	Suggestion: Based on the above comment referring to the possibility of calculating BE and PE for each time interval and then summing BE_t et PE_t, the index "y" in this equation would be replaced by a "t" index referring to "time interval"	Changed to "time interval"		
5.1.1 Quantifying Baseline Emissions, equation 7: Methane Destroyed	60	Suggestion: This number 60 would be adjusted in accordance with the time interval used by the project operator (i.e. 2 if BE and PE are calculated every 2 minutes…)	Term removed from the equations.		
5.1.1 Quantifying Baseline Emissions, equation 7: Methane Destroyed	Methane concentrations and flow rates must be recorded every fifteen minutes with averages calculated at least hourly	Suggestion: This number 60 would be adjusted in accordance with the time interval used by the project operator (i.e. 2 if BE and PE are calculated every 2 minutes…)	Term removed from the equations.		
5.1.1 Quantifying Baseline Emissions, equation 8: Project Emissions from Uncombusted Methane	Formula	Suggestion: This number 60 would be adjusted in accordance with the time interval used by the project operator (i.e. 2 if BE and PE are calculated every 2 minutes…)	Term removed from the equations.		

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5.2 Active Underground Mine Methane Drainage Activities		Many comments on section 5.1 (ACTIVE UNDERGROUND MINE VENTILATION AIR METHANE ACTIVITIES) also apply to the subsequent section 5.2, 5.3 and 5.4. These comments are not repeated.	Authors agree. Hourly and daily calculation requirements removed from the equations. “hourly” changed to “time interval”		
5.2.2, equation 16	$\mathbf{DE_i}$ Efficiency of methane destruction device **i**, either site-specific or from Appendix B **(%)**	To be accurate and clear to the reader, this should be expressed as “decimal” or “fraction”. Applies to all variables when the efficiency of methane destruction device is mentioned.	Agreed. This has been changed in all sections where a destruction efficiency is cited.		
6.2 Instrument QA/QC, part B	Checked per manufacturer specifications by a trained professional for calibration accuracy with the percent drift documented, with the check occurring no more than two months before the end date of the reporting period	Consider clarifying that the project operator is allowed to carry field checks in accordance with manufacturer’s recommendations. The use of a third party shall not be mandatory.	This has been clarified in the methodology. Parenthetical was added stating that the project proponent may conduct the check.		
6.2 Instrument QA/QC	If a portable instrument is used (such as a handheld methane	Is there a specific precision expected from instruments? (air flow devices, methanometers, etc.)	No, the methodology does not prescribe a level of precision for individual instrumentation. The		

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	analyzer), the portable instrument must be calibrated according to manufacturer's specifications prior to each use.		methodology does contain accuracy requirements for gas flow and methane analysis instrumentation.		
6.2 Instrument QA/QC, part I, element C	Calibrated by the manufacturer or a certified calibration service per manufacturer's specifications or every 5 years, whichever is more frequent. Instruments are exempted from calibration requirements if the manufacturer's specifications state that no calibration is required.	Instruments should be exempted from re-calibration requirements if the manufacturer's specifications state that no calibration is required (only field checks). For example, a thermocouple cannot be recalibrated, it would need to be replaced after 5 years? Another example: most laser methane analyzers are constantly auto-calibrated. Suggestion: As long as field checks reveal accuracy within the ±5% tolerance, there should be no need to re-calibrate the instrument.	This language was already included in the methodology: *Instruments are exempted from calibration requirements if the manufacturer's specifications state that no calibration is required.* Language regarding calibrations every 5 years was removed.		
6.2 Instrument QA/QC, part VI	If the check on a piece of equipment reveals accuracy beyond a +/- 5% threshold (reading relative	1. The ±5% tolerance can be ambiguous for temperature and gauge pressure (what is 5% of 0°C?). In the case of temperature and pressure sensors, the 5% accuracy should apply on the absolute temperature (°K) and the absolute pressure	This section has been removed.	This comment, which also applies to the subsequence part (formerly Part VII), has not been addressed. For example, how do we determine if we are within the +/- 5% accuracy threshold if the check of a	Regarding temperature sensors, the footnote suggested by the reviewer has been adopted as follows:

Chapter	In regard to	Comment Peer Reviewer R1	Respond from Author	Comment Peer Reviewer R2	Respond from Author
	to the reference value), corrective action such as calibration by the manufacturer or a certified service provider is required for that piece of equipment.	2. Consider clarifying that recalibration is just one possible corrective action among others Recalibrating an instrument is not always the solution. For example, the discrepancy could be due to the fact that the instrument's reading is biased by its position in the duct. In that case, recalibrating the instrument would be useless. The correction action could consist in repositioning the instrument or applying a correction to its output based on reference values. VAM flow meter is a good example. Depending on the technique used, the flow rate measured may vary depending on the instrument's position in the duct relative to the velocity profile. Even if the flow meter is perfectly calibrated, there will most likely be a discrepancy between the flow rate measured and the average flow rate in the duct. One way to alleviate this discrepancy is to correlate the instrument's output with a reference flow rate as measured by Pitot traverses (performed according to a standard USEPA method).		temperature sensor is performed at 0°C? A suggestion of footnote: 1 Regarding checks of temperature sensors, the +/- 5% accuracy threshold shall be determined on the basis of absolute temperatures (value expressed in degree Kelvin or Rankine).	1 Regarding checks of temperature sensors, the +/- 5% accuracy threshold shall be determined on the basis of absolute temperatures (value expressed in degree Kelvin or Rankine).
6.3 Document Retention, part II, element D	Gas flow meter information (model number, serial number, manufacturer's calibration procedures);	Requirements D, E, F, G, H, I, J, K and P don't only apply to gas flow meters and methane analyzer, but also to all instruments used to monitor the data involved in ER calculations, including temperature and pressure sensors.	Requirement O is meant to apply to all other instrumentation employed in the context of a MMC project: *All maintenance records relevant to the methane collection and/or destruction device(s) and monitoring equipment;*	Alternatively, Requirements D to L could be merged as follows: The following information relative to each equipment/instrument used for the monitoring of ER calculations: - Instrument information (model number, serial number); - Manufacturer's check and calibration procedures - Maintenance and inspection records	The document retention requirements have been merged per the reviewer's recommendations.

Chapter	In regard to	Comment Peer Reviewer R1	Respond from Author	Comment Peer Reviewer R2	Respond from Author
				- Field check results - Calibration results (if required) - Corrective measures taken (if required) - Monitoring data Requirements P and Q could also be merged as follows: The following information relative to check/calibration performed with a portable instrument: Instrument information (model, serial number, certificate of calibration Check/Calibration report including date, time, name of technician, methodology, result and recommendations	
6.3 Document Retention, part II, element P	If using a calibrated portable gas analyzer for CH4 content measurement the following records must be retained: i. Date, time, and location of methane measurement; ii. Methane content of gas (% by volume	Not only for portable methane analyzer, but for all portable instruments used for check checks such as portable pitot tube flow meter, temperature probe, pressure probe, etc.)	We have added a new item P. to this section as follows: For any portable instrument used in the project, the following records must be maintained: -Measurement instrument information (model number and serial number);		

Chapter	In regard to	Comment Peer Reviewer R1	Respond from Author	Comment Peer Reviewer R2	Respond from Author
	or mass) for each measurement; iii. Methane measurement instrument information (model number and serial number); iv. Date, time, and results of instrument calibration; and v. Corrective measures taken if instrument does not meet performance specifications.		-Date, time, and results of instrument calibration; and -Corrective measures taken if instrument does not meet performance specifications.		
6.4 Active Underground Mine Ventilation Air Methane Activities	The flow rate of ventilation air entering the destruction device must be measured continuously, recorded every fifteen minutes, and adjusted for temperature and pressure, if	Suggest adapting the formula and provides an example. In this equation, the total BE_{MR} for the all reporting period is determined by multiplying hourly average values of VA and C_{CH4}. Rather than calculating BE_{MR} from hourly average values, you may consider allowing project operators to calculate BE_{MRt} for each	Authors agree. Hourly and daily calculation requirements removed from the equations.		

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	applicable, to calculate average flow per hour	time interval (for example at the same frequency as data monitoring - i.e. every 2 minutes) and then calculate total BE_{MR} for the reporting period by summing the $BE_{MR,t}$. Based on this approach, the variables in this equation should have a "t" index referring to "time interval". $$BE_{MRT} = \sum_{T}[(VA_{P_I T} \times C_{CH4T}) + MG_{SUPP_T} \times C_{CH4_{MGT}}] \times 0.0423 \times 0.000454 \times GWP_{CH4}$$ (Each time interval should be limited to 1 hour maximum.) Then, BE_{MR} would be calculated by summing BE_{MRt} of each time intervals.. $$BE_{MR} = \sum_{t} BE_{MR,t}$$ This comment also applies for the calculation of PE... Justification: It is much simpler and more accurate to calculate baseline emissions (BE), project emissions (PE) and emission reduction (ER) every 2 minutes rather than calculating ER from hourly averages. In our past VAM project, the monitoring system directly calculated BE and PE emissions every 2 minutes (at the same frequency as data recording). Total emissions			

<table>
<tr><th>Chapter</th><th>In regard to</th><th>Comment Peer Reviewer R1</th><th>Respond from Author</th><th>Comment Peer Reviewer R2</th><th>Respond from Author</th></tr>
<tr><td></td><td></td><td>for the reporting period were then obtained by summing all ER calculated every 2 minutes (no averaging required). Here are some advantages of using this 2-min emission quantification approach:

It is more accurate. As shown in the following example, multiplying average values may significantly bias the result.

<table>
<tr><th>Time interval</th><th>A (i.e. VA flow)</th><th>B (i.e. %CH4)</th><th>A*B (i.e. CH4 flow)</th><th></th></tr>
<tr><td>1</td><td>10</td><td>0.3</td><td>3</td><td></td></tr>
<tr><td>2</td><td>15</td><td>0.4</td><td>6</td><td></td></tr>
<tr><td>3</td><td>4</td><td>1</td><td>4</td><td></td></tr>
<tr><td>4</td><td>8</td><td>0.2</td><td>1.6</td><td></td></tr>
<tr><td>5</td><td>10</td><td>0.6</td><td>6</td><td></td></tr>
<tr><td>6</td><td>8</td><td>0.4</td><td>3.2</td><td></td></tr>
<tr><td>7</td><td>15</td><td>0.4</td><td>6</td><td></td></tr>
<tr><td>8</td><td>21</td><td>0.5</td><td>10.5</td><td></td></tr>
<tr><td>average</td><td>11.375</td><td>0.475</td><td>5.038</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>$(A*B)_{avg}$</td><td>5.038</td><td>(real average CH4 flow)</td><td></td></tr>
<tr><td></td><td>$A_{avg} * B_{avg}$</td><td>5.403</td><td>(apparent average CH4 flow)</td><td></td></tr>
</table>

Also, calculating hourly averages may be challenging under some circumstances, for example when the system is stopped less than 1 hour after it was restarted. Therefore, eliminating the need to calculate averages is much simpler and straightforward.
For these reasons, the project operator should be allowed to perform baseline and project emission calculations at the same frequency as the data monitoring frequency, without having to calculate hourly averages
</td><td></td><td></td><td></td></tr>
</table>

Chapter	In regard to	Comment Peer Reviewer R1	Respond from Author	Comment Peer Reviewer R2	Respond from Author
6.4 Active Underground Mine Ventilation Air Methane Activities, Table 5, equation 37	Hourly average methane concentration of ventilation air sent to a qualifying destruction device	Refers to previous comment Average methane concentration of ventilation air sent to a qualifying destruction device during time interval t	"Hourly" changed to "time interval"		
6.4 Same chapter, Table 5, equation 37	Readings taken every fifteen minutes to calculate average methane concentration per hour	2 minutes suggested, or consider specifying: "..**at least** every 15 minutes…"	Authors consider 15-minute interval appropriate for all types of MMC projects, including VAM projects. Low variation in ventilation air flow and methane concentrations do not warrant increasing interval to every 2 minutes.		
Table 1, SSR 3, CH_4	Excluded	If methane is used in the process to supply energy that will be used in the project, it should be included, e.g. if CMM is used to increase or levelized the CH4 concentration of the feed to ensure destruction, or if some of the heat energy is used to generate electricity to run destruction system fans	If the mine gas would have been vented to the atmosphere in the baseline scenario, any emission reductions from the destroyed methane will always be greater than project CO2 emissions from un-combusted methane.		
Figure 2	SSR10	SSR10 should be **included** within the project boundary. Gas will be lost when drilling and completing and dependent upon the type of equipment used, it may leak. In many cases the gas from the well is cannibalized to run	The drilling and completing of degas wells for safety reasons (venting methane) by the mine operator is		

Chapter	In regard to	Comment Peer Reviewer R1	Respond from Author	Comment Peer Reviewer R2	Respond from Author
		blowers or compressors which emit CO2 and unburned CH4.	outside the GHG project boundary.		
Table 2, SSR 2, CH_4	Excluded	What about the methane that goes undestroyed?	Any drainage gas destroyed for energy is converted to CO_2 or is un-combusted. In the baseline, all of the methane would have been vented. Destruction of methane and not quantifying as an eligible destruction device is conservative. Emissions from un-combusted methane and CO2 from the combustion of methane are always less than methane vented to the atmosphere in the baseline.		
Table 2, SSR 4, CH_4	Excluded	Again, undestroyed methane? Included in SSR5 and not SSR4.	SSR5 is a qualifying destruction device. Mine methane sent to be destroyed in vehicles is measured and credited. Because not all of the methane will be destroyed in the qualifying destruction device, the amount measured but not destroyed must be subtracted. Methane under SSR 4 would have been vented in the		

Chapter	In regard to	Comment Peer Reviewer R1	Respond from Author	Comment Peer Reviewer R2	Respond from Author
			baseline scenario. If that methane is destroyed in order to operate equipment, CO_2 emissions and un-combusted methane will occur but this will always be less than methane vented in the baseline. It is conservative to exclude this. If CO_2 emissions and un-combusted methane are included, then emission reductions from destroying the mine gas should also be claimed.		
Table 2, SSR 10, CH_4	Excluded	My point above in the drawing for SSR 10	If the mine gas would have been vented to the atmosphere in the baseline scenario, any emission reductions from the destroyed methane will always be greater than project CO_2 emissions from un-combusted methane.		
Figure 3	Offset Project Boundary for Active Surface Mine Methane Drainage Activities	SSR10 included here	The drilling and completing of degas wells for safety reasons (venting methane) by the mine operator is outside the GHG project boundary.		

Chapter	In regard to	Comment Peer Reviewer R1	Respond from Author	Comment Peer Reviewer R2	Respond from Author
Table 3, SSR 2, CH_4	Excluded	Should be included	The mine would drill a well in the absence of the project and vent the methane to the atmosphere. Any destruction of methane to run blowers and compressors would have remained un-destroyed. Excluding the destruction of this methane as a baseline source is conservative. Un-combusted methane, leaks from the well-head and CO_2 emissions from methane destruction will always be less than if the methane was allowed to vent.		
Table 3, SSR 3, CH_4	Excluded	Should be included, should include the pipelines, compressors, blowers etc.	See previous response.		
Table 3, SSR 4, CH_4	Excluded	Should be included, leakage, efficiency and loss, venting, scavenged gas for energy production, etc.	See previous response.		
Table 3, SSR 10, CH_4 from emissions	Excluded	Include	See previous response.		
Table 3, SSR 10, CH_4 from fugitive emissions	Excluded	Include	See previous response.		
Table 4, SSR 2, CH_4 from emissions	Excluded	Include	Any drainage gas destroyed for energy is converted to CO_2 or is		

Chapter	In regard to	Comment Peer Reviewer R1	Respond from Author	Comment Peer Reviewer R2	Respond from Author
			un-combusted. In the baseline, all of the methane would have been vented. Destruction of methane and not quantifying as an eligible destruction device is conservative. Emissions from un-combusted methane and CO_2 from the combustion of methane are always less than methane vented to the atmosphere in the baseline.		
Table 4, SSR 3, CH_4 from emissions	Excluded	Include	See previous comment.		
Table 4, SSR 3, CH_4 from fugitive emissions	Excluded	Include	See previous comment.		
Table 4, SSR 4, CH_4 from emissions	Excluded	Include	See previous comment.		
Table 4, SSR 4, CH_4 from fugitive emissions	Excluded	Include	See previous comment.		
Table 4, SSR 10, CH4 from fugitive emissions	Excluded	Include	The mine would drill a well in the absence of the project and vent the methane to the atmosphere. Any destruction of methane		

Chapter	In regard to	Comment Peer Reviewer R1	Respond from Author	Comment Peer Reviewer R2	Respond from Author
			to run blowers and compressors would have remained un-destroyed. Excluding the destruction of this methane as a baseline source is conservative. Un-combusted methane, leaks from the well-head and CO_2 emissions from methane destruction will always be less than if the methane was allowed to vent.		
Equation 4	If the project uses fossil fuel or grid electricity to power additional equipment required for project activities (e.g., capturing and destroying ventilation air, transporting ventilation air, etc.), the resulting CO_2 emissions from the energy consumed to capture and destroy methane (PEEC) must be quantified using Equation 5.	This is the basis for wanting to include methane that is released or used when drilling wells, producing and transporting and as detailed in equations which follow.	The difference here is that if the mine uses the mine gas to power this equipment, the assumption is that in the absence of the Project, that same mine gas would have been vented to the atmosphere. If the mine gas is destroyed to power equipment or transport the mine gas, this is an emission reduction. Not accounting for this emission reduction is conservative because the CO_2 emissions and un-combusted methane from the equipment will always be less than if		

Chapter	In regard to	Comment Peer Reviewer R1	Respond from Author	Comment Peer Reviewer R2	Respond from Author
			the mine gas was vented to the atmosphere		
Equation 7 $\mathbf{MD_{P_i}}$	Methane destroyed through **use i** by qualifying devices during the reporting period; calculated separately for each destruction device (MT CH4)	The word **use** implies that there was work done with the system employed, however, it could be simply destroyed for abatement purposes. Cut "through use" and leave "Methane destroyed i by qualifying…"	Revision made.		
Equation 7 $\mathbf{VA_{flow_{i_y}}}$	**Hourly** average flow rate of ventilation air sent to a device for destruction through use i during the reporting period (scfm)	This is not hourly flow until the scfm is multiplied by 60 as per the equation and then is hourly flow	This equation was removed per another reviewer comment. The equations have been modified/simplified to eliminate the rollup to hourly averages.		
Equation 7 $\mathbf{CA_{flow_{i_y}}}$	**Hourly** average flow rate of cooling air sent to a destruction device after the metering point of the ventilation air stream during period y (scfm)	This is not hourly flow until the scfm is multiplied by 60 as per the equation and then is hourly flow	This equation was removed per another reviewer comment. The equations have been modified/simplified to eliminate the rollup to hourly averages.		
Equation 7 $\mathbf{C_{CH4_{exhaust_y}}}$	Weighted average of measured methane concentration of	Of ventilation air This comment holds for all formulae, believing that greater specificity is better	Hourly average methane concentration of exhaust gas (scf CH4/scf)		

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	exhaust gas emitted from the destruction device during the reporting period (scf CH4/scf)				
Equation 8 $\mathbf{VA_{flow_{i_y}}}$	Hourly average flow rate of ventilation air sent to a device for destruction through use i during the reporting period (scfm)	Same as above, not hourly flow until multiplied by 60 minutes. This holds for other equations and this comment/correction will not be repeated	Hourly and daily calculation requirements removed from the equations.		
Definitions	Coal Bed Methane	The appropriate spelling is coalbed, one word, when it is referring to the gas and coal bed when referring to the seam. This should be changed throughout.	Definitions		
Definitions	End-use Management	Not certain why "management" is need in this term—what does the use connote	"Management" removed from the term in definitions.		
Definitions	Mountaintop Removal Mining	As before, I fully understand and agree with the sentiment that mountain top removal should not be encouraged—but methane has a greater potential for damage and should be mitigated at each opportunity	References to mountaintop removal mining deleted from methodology.		
Definitions	Device used to measure the amount of gas flowing through a pipe as measured at a specific point.	Just to mention that "as measured at a specific location" could be misleading. Some flow meters such as ultrasonic flow meters measure the flow rate between two sensors that may be located several feet apart.	Changed the definition to state "…as measured at a specific point*(s)*."		

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Appendix B: Device Destruction Efficiencies-Quantification Methodology, Table 7	Default Methane Destruction Efficiencies by Destruction Device	Any efficiency considerations for regenerative thermal oxidizers, regenerative catalytic oxidizers?	The destruction efficiency needs to be a measured value for VAM projects (methane input and output). Thermal oxidizer DE's can range from the low 90s% to 99.99% depending on the design, operating temperature, catalyst, etc.		
Appendix D	After point V	Spacing issue caused by wandering period	Revised.		
Appendix D: Data Substitution Methodology – Quantification Methodology, element III	This methodology is only applicable to gas flow metering and methane concentration parameters. Data substitution is not allowed for equipment that monitors the proper functioning of destruction devices such as thermocouples.	Suggest to clarify that the missing data substitution methodology is applicable to all monitored parameters used in the equations (not only flow rate and concentration, but also temperature and pressure data). For example, the standard flow rate can be calculated from the output of 3 distinct instruments: - a volumetric flow meter (for example a multipoint pitot tube); - a temperature sensor (to convert volume at reference temperature) a pressure sensor (to convert volume at reference pressure)	Agreed. This has been changed to state that data substitution applies to all monitored parameters.		
Appendix D: Data Substitution Methodology – Quantification Methodology, element III	Data substitution can only be applied to methane concentration or flow readings, but not both	As long as it can be demonstrated that the destruction device was operational, there should be no restriction on the number of parameters being substitute at the same time. For example, let's suppose a pressure sensor is broken and is in the process of being replaced within 2-3 days. Meanwhile, the reading of one	This requirement has been removed.		

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	simultaneously. If data is missing for both parameters, no reductions can be credited.	of the methane analyzers becomes erratic for a few hours due to a process issue. In this scenario, why shouldn't it be possible to substitute data for both pressure and methane concentration?			
Appendix D: Data Substitution Methodology – Quantification Methodology, Table 83	Data Substitution Duration and Methodology	Many scenarios may take place before and after the instrument outage. For example, a flow meter is down for 2 days. After 2 days of operation, the destruction device is stopped to fix the problem. Then the system is restarted, stopped again after a few hours for any other reason, then restarted again… In this scenario, we should base the substitution methodology on the 72 hours of normal operation preceding and following the instrument outage, excluding the start-up periods during which flow conditions were not relevant to normal operation expected while the instrument was down… The project operator needs some flexibility in the substitution methodology as long as the project operator use a methodology that is more **conservative** compared to what is specified in this Appendix. Also, it has to be noted that it can be quite challenging to determine the 95% confident limit of the 72 hours prior to and after the outage if the system is not operating consistently following the outage. The data used for the substitution should be relevant and conservative. In some circumstances, using the methodology specified in Table 83 could lead to a significant overestimation of emission reductions. Should the operating conditions immediately before and/or after the outage are not believed to be relevant or conservative compared to the	Proposed wording at the bottom of the comment accepted. The table was revised. Please note the corrected table number is now Table 13.		

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		conditions experienced during the outage (e.g. system restarted with a higher fan velocity following a flow meter outage), a conservative approach shall be used in selecting the relevant period of operation to use for substitution (this selection shall be justified)…or for simplicity purposes, **it should be allowed to use an even more conservative value**. For these reasons, I propose the following wording in Table 83: …Use the average of the 4 hours of normal operation immediately before and following the outage, **or an even more conservative value**. …Use the 90% **upper or** lower confidence limit (whichever results in greater conservativeness) of the 24 hours of normal operation prior to and after the outage, **or an even more conservative value**. (For example, in the case of a temperature sensor outage, using the 90% upper confidence limit on temperature data would be more conservative than using the 90% lower confidence limit...) …Use the 95% **upper or** lower confidence limit (whichever results in greater conservativeness) of the 72 hours of normal operation prior to and after the outage, **or a more conservative value**.			
Appendix E: Performance Standard for Gas Pipeline Sales	The predominant mine methane methodology in use in the United States is the compliance offset methodology	"end use" should have a dash in between to maintain consistency with the word usage	Please note that Appendix E has been removed from the methodology.		

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	from the California Air Resources Board. In that methodology, gas pipeline sales is an ineligible end use category in certain instances. In this methodology, gas pipeline sales is an eligible end use category based on the updated analysis of mines employing gas drainage systems as presented in this Appendix.				
Appendix E: E.1 Venting Methane	Several coal mines with CMM projects recover all methane from drainage systems without venting.	This sentence should be written to say that there are several coal mines that drain gas and all of the recovered gas is used. Recovery may have different meanings to some practitioners	Sentence has been edited.		
Appendix E: E.3 Increased Risk and Uncertainty	Accordingly, U.S. CBM reserves analyses project no new discoveries in any active coal mine basins, thus the development of any new CBM	This is a matter of economics and not certain. Costs of CBM recovery due to adoption of some shale gas practices. However, if there are new CBM fields they may be deeper and not near mines which are located at the margins of the basins.	Appendix E removed from methodology.		

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	fields and associated increases in CMM recovery and use are unlikely				
Appendix F: Coal Industry in Mexico	Geologic Mexican System	Should be the Mexican Geological Service	Appendix F: Coal Industry in Mexico		
Appendix F: Performance Standard for Canada and Mexico	The predominant mine methane methodology in use in the United States is the compliance offset methodology from the California Air Resources Board. In that methodology, only projectgs located in the United States are eligible. In this methodology, projects located in Canada and México are also eligible as presented in this Appendix.	Correct spelling	Revised.		

Proposed Structure for Equations from Peer Reviewer 1

Here is a proposed review of quantification equations based on time intervals, which eliminates the need for average calculations. Equations were developed for Active UG VAM projects, but the same approach could be used for the other sections.

5.1 Active Underground Mine Ventilation Air Methane Activities

...

5.1.1 Quantifying Baseline Emissions

...

$$BE_{MR} = \sum_{i}\sum_{t} BE_{MR_{t,i}}$$

Where

i = Use of methane (oxidation or alternative end-use) by qualifying destruction device *i*.

t = time interval (not exceeding 15 minutes)

BE_{MR} = Total Baseline emissions from methane captured and sent to all qualifying destruction devices that would have been released to the atmosphere in the absence of the project during the Reporting Period (MT CO_2e).

$BE_{MR_{t,i}}$ = Baseline emissions from methane captured and sent to qualifying destruction device *i* during time interval *t* that would have been released to the atmosphere in the absence of the project (MT CO_2e).

$$BE_{MR_{t,i}} = \sum_{t}\left[\left(VA_{flow_t} \times T \times C_{CH4_t}\right) + \left(MG_{flow_t} \times T \times C_{CH4\,MG_t}\right)\right] \times 0.0423 \times 0.000454 \times GWP_{CH4}$$

Where

i = Use of methane (oxidation or alternative end-use) by qualifying destruction device *i*.

t = Time interval (not exceeding 15 minutes).

$BE_{MR_{t,i}}$ = Baseline emissions from methane captured and sent to qualifying destruction device *i* that would have been released to the atmosphere during time interval *t* in the absence of the project (MT CO_2e).

VA_{flow_t} = Volume flow rate of ventilation air sent to qualifying device *i* during time interval *t* (scfm).

T = Duration of time interval (minutes)

C_{CH4_t} = Methane concentration of ventilation air sent to qualifying device *i* during time interval *t* (scf CH4/scf)

MG_{flow_t} = Volume flow rate of mine gas extracted from a methane drainage system and sent with ventilation air to qualifying device *i* during time interval *t* (scfm).

$C_{CH4\,MG_t}$ = Methane concentration of mine gas extracted from a methane drainage system and sent with ventilation air qualifying device *i* during time interval *t* (scf CH4/scf).

0.0423 = Standard density of methane (lb CH_4/scf CH_4)
0.000454 = MT CH_4/lb CH_4
GWP_{CH4} = Global warming potential of methane (MT CO_2e/MT CH_4)

…

5.1.2 Quantifying Project Emissions..

$$PE = PE_{EC} + PE_{MD} + PE_{UM}$$

…

Equation 5 of PE_{EC} is OK…

$$PE_{MD} = \sum_{i}\sum_{t} PE_{MD_{t,i}}$$

Where

i = Use of methane (oxidation or alternative end-use) by qualifying destruction device *i*.
t = time interval (not exceeding 15 minutes)
PE_{MD} = Total Project emissions from destruction of methane by all qualifying destruction devices during the Reporting Period (MT CO_2e).
$PE_{MD_{t,i}}$ = Project emissions from destruction of methane by qualifying destruction device *i* during time interval *t* (MT CO_2e).

$$PE_{MD_{t,i}} = MD_{t,i} \times CEF_{CH4}$$

Where
i = Use of methane (oxidation or alternative end-use) by qualifying destruction device *i*.
t = time interval (not exceeding 15 minutes)
$PE_{MD_{t,i}}$ = Project emissions from destruction of methane by qualifying destruction device *i* during time interval *t* (MT CO_2e).
$MD_{t,i}$ = Methane destroyed by qualifying destruction device *i* during time interval *t* (MT CO_2e).
CEF_{CH4} = CO_2 emission factor for combusted methane (2.744 MT CO_2e/MT CH_4).

$$MD_{t,i} = MM_{t,i} - PE_{NO_{t,i}}$$

Where

i = Use of methane (oxidation or alternative end-use) by qualifying destruction device *i*.

t = Time interval (not exceeding 15 minutes).

$MD_{t,i}$ = Methane destroyed by qualifying destruction device *i* during time interval *t* (MT CO_2e).

$MM_{t,i}$ = Methane captured and sent to qualifying destruction device *i* during time interval *t* (MT CH_4).

$PE_{NO_{t,i}}$ = Non-oxidized methane emitted as a result of incomplete oxidation of the ventilation air stream sent to qualifying device *i* during time interval *t* (MT CH_4).

$$MM_{t,i} = \sum_{t}\left[\left(VA_{flow_t} \times T \times C_{CH4,t}\right) + \left(MG_{flow_t} \times T \times C_{CH4\,MG,t}\right)\right] \times 0.0423 \times 0.000454$$

Where

i = Use of methane (oxidation or alternative end-use) by qualifying destruction device *i*.

t = Time interval (not exceeding 15 minutes).

$MM_{t,i}$ = Methane captured and sent to qualifying destruction device *i* during time interval *t* (MT CH_4).

VA_{flow_t} = Volume flow rate of ventilation air sent to qualifying device *i* during time interval *t* (scfm).

T = Duration of time interval (minutes)

$C_{CH4,t}$ = Methane concentration of ventilation air sent to qualifying device *i* during time interval t (scf CH4/scf)

MG_{flow_t} = Volume flow rate of mine gas extracted from a methane drainage system and sent with ventilation air to qualifying device *i* during time interval *t* (scfm).

$C_{CH4\,MG,t}$ = Methane concentration of mine gas extracted from a methane drainage system and sent with ventilation air qualifying device *i* during time interval *t* (scf CH4/scf).

0.0423 = Standard density of methane (lb CH_4/scf CH_4)

0.000454 = MT CH_4/lb CH_4

$$PE_{NO_{t,i}} = \sum_{t}\left[\left(VA_{flow_t} \times T\right) + \left(CA_{flow_t} \times T\right)\right] \times C_{CH4_{exhaust,t}} \times 0.0423 \times 0.000454$$

Where

i = Use of methane (oxidation or alternative end-use) by qualifying destruction device *i*.

t = Time interval (not exceeding 15 minutes).

$PE_{NO_{t,i}}$ = Non-oxidized methane emitted as a result of incomplete oxidation of the ventilation air stream sent to qualifying device *i* during time interval *t* (MT CH_4).

VA_{flow_t} = Volume flow rate of ventilation air sent to qualifying device *i* during time interval *t* (scfm).

T = Duration of time interval (minutes).

CA_{flow_t} = Volume flow rate of cooling air sent to qualifying device *i* after the metering point of the ventilation air stream during time interval *t* (scfm).

$C_{CH4_{exhaust,t}}$ = Methane concentration of exhaust gas emitted from the qualifying device *i* during time interval *t* (scf CH4/scf).

0.0423 = Standard density of methane (lb CH_4/scf CH_4)

0.000454 = MT CH_4/lb CH_4

$$PE_{UM} = \sum_{i}\sum_{t} PE_{NO_{t,i}} \times GWP_{CH4}$$

Where

i	= Use of methane (oxidation or alternative end-use) by qualifying destruction device *i*.
t	= Time interval (not exceeding 15 minutes).
PE_{UM}	= Project emissions from uncombusted methane during the reporting period (MT CO_2e)
$PE_{NO_{t,i}}$	= Non-oxidized methane emitted as a result of incomplete oxidation of the ventilation air stream sent to qualifying device *i* during time interval *t* (MT CH_4).
GWP_{CH4}	= Global warming potential of methane (MT CO_2e/MT CH_4)