Livestock
Project Verification Protocol

Capturing and combusting methane from manure management systems

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The Climate Action Reserve

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I. Introduction

The Climate Action Reserve's (Reserve) Manure Management Project Verification Protocol provides guidance to California Air Resources Board (CARB) and Reserve-approved verifiers for verifying greenhouse gas (GHG) emissions reductions associated with installing a biogas control system, in accordance with the Reserve's Manure Management Project Reporting Protocol. Verification occurs on an annual basis. This verification protocol supplements the California Registry's General Verification Protocol (GVP). It describes the core verification activities in the context of a livestock operation and provides information on project monitoring parameters.

The purpose of verification is to provide an independent review of data and information used to produce a GHG project report. It aims to ensure that a participant's emissions report meets the following quality criteria: completeness, consistency, accuracy, comparability and transparency. The intended audience of the project verification protocol is approved verifiers. However, livestock operators will also find it useful to review this document to develop a better understanding of the verification activities associated with reporting GHG reductions to the Reserve.

Agriculture sector verifiers must read and be familiar with the following reporting tools:

- California Registry General Reporting Protocol,
- Reserve Livestock Project Reporting Protocol,
- California Registry General Verification Protocol,
- Reserve Livestock Project Verification Protocol,
- Climate Action Registry Reporting Online Tool (CARROT).

The California Registry's General Verification Protocol and the Reserve's industry-specific verification protocols are designed to be compatible with each other and are available on the California Registry's website at www.climateregistry.org.

Only CARB- and Reserve-approved agriculture sector verifiers are eligible to verify manure management project reports. Approved verifiers under the California Registry's GVP are not automatically permitted to verify the project reports. To become an approved agriculture sector verifier, a general verifier must successfully complete an agriculture sector-specific application process. Information on the application process can be found at www.climateregistry.org.

II. Standard of Verification

The Reserve's standard of verification for manure management GHG projects is the Manure Management Project Reporting Protocol. To verify a livestock operator's project report, verifiers apply the verification guidance in the GVP and this document to the standards described in the project reporting protocol. It provides eligibility rules, methods to calculate reductions, performance-monitoring instructions, and procedures for reporting project information to the Reserve. The project reporting protocol:

- defines the GHG reduction project,
- defines project eligibility rules,
- delineates the project boundary,
- provides GHG reductions calculation methods,
- identifies procedures for project monitoring, and
- describes project reporting parameters**.**

Specifically, this verification protocol supports the verification of GHG reduction projects associated with is the installation of a biogas control system[1] that captures and combusts methane gas from manure treatment and/or storage facilities on livestock operations and that commences operation on or after January 1, 2001. Captured biogas could be combusted on-site, or transported for off-site use (e.g., through gas distribution or transmission pipeline), or used to power vehicles. Regardless of how project developers take advantage of the captured biogas, the ultimate fate of the methane must be combustion. "Centralized digesters" that integrate waste from more than one livestock operation also meet this definition of the GHG reduction project.[2]

The biogas control system destroys methane associated with the management of livestock waste that would have otherwise been generated through uncontrolled, anaerobic manure treatment and/or storage and emitted to the atmosphere.

Project verification occurs annually. GHG reductions associated with the biogas control system are accounted for on an ex-post. And project developers annually report reductions that occurred the preceding year. In keeping with the reporting rules of the General Reporting Protocol, the reporting deadline for project developers is August 31 the year following the reduction year, and the verification deadline is December 31.[3]

Furthermore, although total GHG reductions are registered on an annual basis, the procedures to calculate baseline and project emissions are run on a month-by-month basis. Monthly baseline emissions are summed together as well as monthly project emissions for the annual comparison.

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[1] Biogas control systems are commonly called digesters, which may be designed and operated in a variety of ways, from ambient temperature covered lagoons to heated lagoons to mesophilic plug flow or complete mix concrete tank digesters.

[2] The protocol also does not preclude project developers from co-digesting organic matter in the biogas control system. However, the additional organics could impact the nutrient properties of digester effluent, which project developers should consider when assessing the project's associated water quality impacts.

[3] General Reporting Protocol, IV.14.7. http://www.climateregistry.org/PROTOCOLS/GRCP/

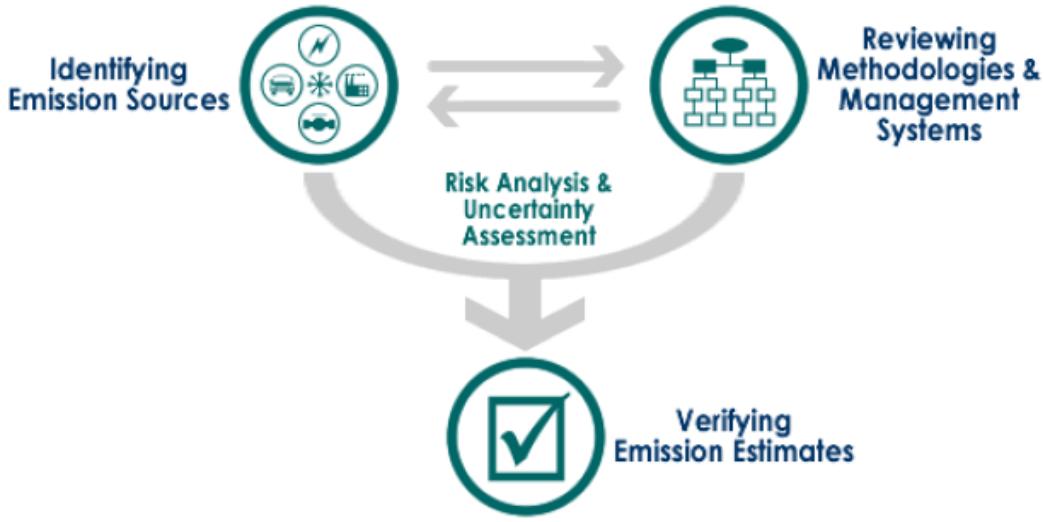
At this time, there is no deminimis reporting provision. All sources of direct methane, carbon dioxide, and nitrous oxide (if necessary) should be reported within the project boundary.

III. Core Verification Activities – Livestock Operations

Although the Reserve's Manure Management Project Reporting Protocol provides explicit guidance to determine the GHG impact associated with installing a biogas control system, the focus of this verification protocol is on the process to undertake a review and verify a livestock operator's GHG reduction report. However, it does include a list of project parameters to monitor.

The Reserve's core verification activities are a risk assessment and data sampling effort developed to ensure that the risk of a reporting error is assessed and addressed through appropriate sampling and review. An illustration of the core verification process is provided in Figure 1, and a description of the three-step procedure is provided below, which is adapted from the California Registry's GVP.

Figure 1. The Core Certification Process.



The GHG reduction project's impacts are determined within a project boundary. The project reporting protocol delineates the GHG sources and gasses assessed by project developers to determine the net change in emissions associated with installing a biogas control system. The boundary captures sources from waste production to disposal.

Within in the defined project boundary, project developers at livestock operations quantify the impact on methane, carbon dioxide, and nitrous oxide by comparing baseline emissions to project emissions. Therefore, a livestock operator's project report will consist of two main parts:

1. A baseline emissions determination
2. A project emissions assessment

The verification process identifies the emissions sources, reviews data management systems, and verifies emissions estimates for both the baseline scenario and the project case to verify the project's GHG impacts.

Reserve verifiers apply verification procedures consistently for all project developers. However, based on the size and complexity of a livestock operation, verification activities may vary.

Step 1: Identifying Emission Sources

Verifiers review the project developer's emission source categories (waste production, collection and transport, treatment and storage, disposal) to ensure that all sources are identified – for both the baseline scenario and after project implementation. Verifiers then determine the GHGs that will result from the identified sources and estimate their magnitude. Finally, verifiers rank by the total annual emissions the remaining reported emissions by CO2e to assess the environmental risk associated with the emissions.

Project verifiers review the GHG emission report and document whether the report reflects the characterization and scope of the operation. The "Pre-registration forms" from Section VII in the project reporting protocol should help this assessment. Questions to answer are:

1. Does the project meet the definition of the project as provided in the project reporting protocol?
2. Does the project satisfy the eligibility criteria?
3. Did the project developer sufficiently review and provide compliance with local, state and federal air and water quality regulations?
4. Does the report correctly depict the manure management system under the baseline scenario and project case?
5. Does the project report include all direct methane, carbon dioxide, and nitrous oxide (if necessary) sources within the project boundary – for the baseline case and post project implementation?

Step 2: Reviewing GHG Management Systems and Estimation Methodologies

After confirming the scope and comprehensiveness of the project developer's emission sources, verifiers review the methodologies and management systems that the livestock operator used to calculate baseline and project emissions. The objective is to assess the appropriateness of the data management systems that provide emissions information to the Reserve.

This is principally a risk assessment exercise, in which the verifier weighs the relative complexity of the scope of the project, the methodologies and management systems used to prepare the GHG project report, and the risk of calculation error as a result of reporting uncertainty or misstatement. A verifier's review of a project developer's GHG data

collection and organization system should consider following questions, and be applied to both the baseline and post-project case (as appropriate):

1. Are GHG sources within the project boundary correctly organized by source category?
2. Are the GHG sources differentiated by gas?
3. Are the livestock categories on the farm correctly differentiated?
4. Did the project developer identify the dominant livestock category?
5. For each livestock category, is the fraction of manure handled by the different manure management system components (i.e., GHG source) satisfactorily represented – the 'MS' value?
6. Did the project developer correctly calculate the 'VS' value for the dominant livestock category?
7. Did the project developer use 'MCF' values differentiated by temperature?
8. For other calculation variables, did the project developer use correct data inputs?
9. Did the project developer apply the calculation methodologies at the GHG source level?
10. Did the project developer run the methane equations for each livestock category?
11. Did the project developer correctly aggregate methane emissions from sources within each livestock category?
12. Did the project developer correctly total fossil fuel use?
13. Did the project developer apply the correct carbon dioxide emission factors?
14. Did the project developer correctly characterize the project's impact on the operation's nitrous oxide emissions?
15. Is the biogas control system operated in a manner consistent with the design specifications?
16. Are the captured biogas combustion devices operated and maintained in a manner consistent with the design specifications?
17. Did the project developer correctly aggregate methane, carbon dioxide, and nitrous oxide emissions (if necessary)?
18. Did the project developer assess baseline and project emissions on a month-by-month basis?
19. Is an individual responsible for managing and reporting GHG emissions? Is this individual qualified to perform this function?
20. Is appropriate training provided to personnel assigned to GHG emissions reporting duties?
21. If the project developer relies on external staff to perform required activities, are the contractors qualified to undertake such work? Is there internal oversight to assure quality of the contractor's work?
22. Are appropriate documents created to support and/or substantiate activities related to GHG emissions reporting activities, and is such documentation retained appropriately? For example, is such documentation maintained through reporting plans or procedures, fuel purchase records, etc.?
23. Are the mechanisms used to measure and review the effectiveness of GHG emissions reporting programs appropriate for this purpose? For example, are policies, procedures, and practices evaluated and updated at appropriate intervals?

Once the verifier has assessed the overall risk of misstatement associated with the GHG management systems, those risks should be assessed in conjunction with the project characterization and emissions source assessment in Step 1 (Identifying Emission Sources).

Verifiers then identify the areas with the greatest potential for material misstatements (either based on volume of emissions, lack of management systems, or both) to determine the best risk-based strategy to identify a representative sample of emissions to recalculate in Step 3 below.

Step 3: Verifying Emission Estimates

The final step in completing the core verification activities is to verify the emission estimates. To do so, verifiers re-calculate a subset of the livestock operation's emissions from the baseline case and post-project implementation and compare the sub-sample re-calculated results with the project developer's calculated results from the same sources to determine if the GHG emissions inventory is free of material misstatements.[4] It is possible that during the verification process differences will arise between the emissions estimated by the project developer and those estimated by the verifier. Differences of this nature may be classified as either material (significant) or immaterial (insignificant). A discrepancy is considered to be material if the overall reported emissions differ from the overall emissions estimated by the verifier by 5% or more. A difference is immaterial if this difference is less than 5%.

Similar to Step 2, this procedure is a risk assessment exercise, in which the verifier weighs the relative complexity of the scope and diversity of the livestock operation's GHG emissions, the appropriateness of the calculation methodologies and GHG management systems used to prepare the annual project report, along with the risk of a calculation or reporting error to determine the best risk-based strategy to identify a representative sample to sample and re-calculate. Verifiers must compare the emissions data and re-calculations to the project developer's emissions data and calculations for the same sources, and complete the following tasks:

1. Assess the areas of greatest impact and uncertainty in the emissions profile.
2. Select a representative sample of data to recalculate and sources to visit.
3. Develop and implement a strategy to recalculate the GHG emissions and visit the sources in the sample.
4. Assess the project developer's data collection.
5. Compare estimated GHG emissions in the baseline scenario and post-project implementation to those of the project developer to determine if any material misstatements exist.

[4] Based on a participant's identified emission sources, management systems, and corresponding risk profile of GHG emissions, certifiers should select a representative sample of calculations to verify and sites to visit.

Verifiers should concentrate their activities in the areas that have the greatest impact to the net change in emissions due to installing a biogas control system. The verification of emissions estimates should document the answers to the following questions:

1. Have you documented your process for determining the appropriate sampling plan?
2. Have you performed data triangulations where reasonable?
3. Are the current year's baseline and post-project implementation reported emissions significantly different from the prior year's emission levels? If so, do you understand the reasons for the changes, and to the best of your knowledge, do they explain the differences in emissions?
4. Are any discrepancies between your emissions estimates and the participant's material?

Completing the Verification Process

The California Registry's GVP provides general instructions for verifiers to finalize the verification process. It describes completing a Verification Report, preparing a Verification Opinion, conducting an Exit Meeting with the Reserve participant, and notifying the Reserve of the participant's verified status. Furthermore, verifiers should refer to the GVP for information on the Verification Activities Log. Verifiers are responsible for applying the guidance in a manner that meets the goals of project verification.

IV. Project Monitoring Parameters

To confirm that a project developer's GHG emissions have been reported accurately, verifiers should review appropriate data sources. Verifiers should verify the activity data for the calculation inputs to substantiate the baseline and project emissions determinations. Prior to the first meeting with the cement company, verifiers should review and identify the documents to expedite the verification process. Verifiers are free to request additional documents not included on this list.

The following project monitoring parameters are taken from the project reporting protocol.

General project parameters

Parameter:	Regulations
Data unit:	Air and water quality
Description:	Existence and enforcement of relevant air water quality regulations
Source of data:	Air and water quality control boards or management districts, state-level EPA
Measurement procedures (if applicable):	
Monitoring frequency:	Once, at beginning of project
Comments:	1) To demonstrate ability to meet the Regulatory Test – where regulation would require the installation of a biogas control system. 2) To demonstrate compliance with associated environmental rules, e.g., criteria pollutant and effluent discharge limits.
Verification comment	Determine regulatory agencies responsible for regulating livestock operation; Review regulations pertinent to livestock operation

Parameter:	L
Data unit:	Livestock categories
Description:	Type of livestock categories on the farm
Source of data:	Project developer, based on operating records.
Measurement procedures (if applicable):	
Monitoring frequency:	Monthly
Comments:	Select from list provided in the Manure Management Project Reporting Protocol, Appendix B, Table B.2.
Verification comment:	Review herd management software; Conduct site visit; Interview operator.

Parameter:	MS_L
Data unit:	Percent (%)
Description:	Manure management system components. Type of manure storage and treatment components used by livestock operator.
Source of data:	Project developer, based on operating records.
Measurement procedures (if applicable):	
Monitoring frequency:	Monthly
Comments:	Reflects the percent of waste handled by the system components 'S' that would manage manure in the baseline case – as if the project was never installed. Applicable to the entire operation. Within each livestock category, the sum of MS values (for all treatment/storage systems) equals 100%. Select from list provided in Appendix B, Table B.1.
Verification comment	Conduct site visit; Interview operator.

Parameter:	P_L
Data unit:	Population (# head)
Description:	Average number of animals contributing manure to the manure management system by each livestock category
Source of data:	Project developer, based on operating records on herd size.
Measurement procedures (if applicable):	
Monitoring frequency:	Monthly
Comments:	
Verification comment	Review herd management software; Review local air and water quality agency reporting submissions, if available (e.g., in CA, dairies with more than 500 cows report farm information to CARB)
Parameter:	$Mass_L$
Data unit:	Kg
Description:	Average live weight by livestock category (divided by 1,000kg)
Source of data:	Project developer. Calculated from operating records.
Measurement procedures (if applicable):	
Monitoring frequency:	Monthly
Comments:	Conduct site specific Interview livestock operator Review Average Daily Gain records

Parameter:	T
Data unit:	^{o}C
Description:	Average temperature at location of the operation
Source of data:	Project developer, based on National Weather Service data
Measurement procedures (if applicable):	
Monitoring frequency:	Monthly
Comments:	Used to choose MCF value
Verification comment	Review temperature records obtained from weather service

Baseline methane calculation variables

Parameter:	$B_{0,L}$
Data unit:	Fraction (m^3 CH_4/kgVS)
Description:	Maximum methane producing capacity for manure by livestock category
Source of data:	Manure Management Project Reporting Protocol, Appendix B, Table B.3, "Volatile Solids and Maximum Methane Potential by Livestock Category"
Monitoring frequency:	Annual
Comments:	
Verification comment:	

Parameter:	MCF_S
Data unit:	Percent
Description:	Methane conversion factor for manure management system component 'S'
Source of data:	Appendix B, Table B.5, (From IPCC v.4, Chapter 10, Table 10.17)
Monitoring frequency:	Annual
Comments:	Differentiate by livestock category
Verification comment:	Review value from look-up table

Parameter:	$VS_{in,L}$ (dominant)
Data unit:	Kg dry matter/day
Description:	Daily volatile solid excretion
Source of data:	Project developer
Measurement procedures (if applicable):	A calculated value
Monitoring frequency:	Monthly.
Comments:	Applicable to livestock categories that contribute at least 40% of the waste to baseline anaerobic storage/treatment systems; Calculated from GE, DE values.
Verification comment:	Review nutritionist rationing regime records. Review feed supplier information.

Parameter:	GE_L
Data unit:	MJ/day
Description:	Average daily gross energy intake for each livestock category
Source of data:	Project developer, based on operating records and/or nutritionist data
Monitoring frequency:	Monthly.
Comments:	Used to calculate VS (dominant category)
Verification comment	Review nutritionist rationing regime records. Review feed supplier information.

Parameter:	DE_L
Data unit:	Fraction (%)
Description:	Average digestible energy of the feed for each livestock category
Source of data:	Project developer, based on operating records and/or nutritionist data
Monitoring frequency:	Monthly.
Comments:	Used to calculate VS (dominant category)
Auditor	Review nutritionist rationing regime records. Review feed supplier information.

Parameter:	UE
Data unit:	Fraction (%)
Description:	Urinary energy expressed as a fraction of GE for each livestock category
Source of data:	Project developer, based on operating records and/or nutritionist data
Monitoring frequency:	Monthly.
Comments:	Used to calculate VS (dominant category)
Auditor	Review nutritionist rationing regime records. Review feed supplier information.

Parameter:	ASH
Data unit:	Fraction of the dry matter feed intake (%)
Description:	Ash content of the manure calculated as a fraction of the dry matter feed intake
Source of data:	Project developer, based on operating records and/or nutritionist data
Measurement procedures (if applicable):	
Monitoring frequency:	Monthly
Comments:	Used to calculate VS (dominant category)
Auditor	Review nutritionist rationing regime records. Review feed supplier information.

Parameter:	ED_L
Data unit:	MJ/kg
Description:	Average energy density of the feed
Source of data:	Project developer, based on operating records and/or nutritionist data
Measurement procedures (if applicable):	
Monitoring frequency:	Monthly.
Comments:	Used to calculate VS (dominant category)
Auditor	Review nutritionist rationing regime records. Review feed supplier information.

Parameter:	$VS_{in,L}$ (non-dominant categories)
Data unit:	Kg dry matter/animal/day
Description:	Daily volatile solid excretion for each livestock category
Source of data:	Appendix B, Table B.3 and Table B.4, "Volatile Solids and Maximum Methane Potential by Livestock Category."
Measurement procedures (if applicable):	
Monitoring frequency:	Annual
Comments:	

Parameter:	VS_{avail}
Data unit:	Kg dry matter
Description:	Monthly volatile solid available for degradation for each livestock category
Source of data:	Project developer. Calculated value from operating records.
Measurement procedures (if applicable):	
Monitoring frequency:	Monthly
Comments:	

Parameter:	VS_{deg}
Data unit:	Kg dry matter
Description:	Daily volatile solid excretion for each livestock category
Source of data:	Project developer. Calculated value from operating records.
Measurement procedures (if applicable):	
Monitoring frequency:	Monthly
Comments:	

Parameter:	*f*
Data unit:	
Description:	van't Hoff-Arrhenius equation
Source of data:	Project developer. Calculated from temperature.
Measurement procedures (if applicable):	
Monitoring frequency:	Monthly
Comments:	The proportion of volatile solids that are biologically available for conversion to methane based on the monthly temperature of the system

Project methane calculation variables

Parameter:	CH_4(combusted)
Data unit:	tCH_4
Description:	Amount of methane combusted in biogas control system
Source of data:	Project developer. Based on meter reading data.
Measurement procedures (if applicable):	See "V" and "CH4-fraction" parameters below.
Monitoring frequency:	
Comments:	Calculated from biogas flow and methane fraction.
Verification comment	Review meter reading data. Confirm proper operation, in accordance with the manufacturer's specifications.

Parameter:	V
Data unit:	scf/m
Description:	Biogas flow from digester to combustion devices
Source of data:	Project developer.
Measurement procedures (if applicable):	Direct measurement
Monitoring frequency:	Continuous metering
Comments:	Calculated by biogas control system metering equipment; corrects for temperature and pressure
Verification comment:	Review meter reading data Confirm proper operation, in accordance with the manufacturer's specifications.

Parameter:	CH_4-fraction
Data unit:	%
Description:	Fraction of biogas
Source of data:	Project developer.
Measurement procedures (if applicable):	Direct measurement
Monitoring frequency:	Quarterly metering
Comments:	Use a direct sampling approach that yields a value with at least 95% confidence. Calibrate monitoring instrument in accordance with the manufacturer's specifications.
Verification comment:	Review meter reading data. Confirm proper operation, in accordance with the manufacturer's specifications.

Parameter:	BDE
Data unit:	%
Description:	Biogas destruction efficiency of the biogas control system, accounts for incomplete combustion.
Source of data:	Manufacture rating for primary combustion device and flare
Measurement procedures (if applicable):	
Monitoring frequency:	Monthly
Comments:	Reflects the actual efficiency of the system to burn captured gas Accounts for different combustion devices.
Verification comment:	Confirm proper operation, in accordance with the manufacturer's specifications.

Parameter:	BCE
Data unit:	%
Description:	Biogas capture efficiency of the anaerobic digester, accounts for gas leaks.
Source of data:	Manufacture rating
Measurement procedures (if applicable):	
Monitoring frequency:	Annual
Comments:	

Parameter:	VS_{ep}
Data unit:	Kg dry matter/day
Description:	Average daily volatile solid of digester effluent to effluent pond
Source of data:	Project developer.
Measurement procedures (if applicable):	
Monitoring frequency:	Annually
Comments:	Equals 30% of the VS entering the digester; From ACM0010 (V2 Annex I)
Verification comment:	

Parameter:	Bo_{ep}
Data unit:	Fraction (m^3 CH_4/kgVS)
Description:	Maximum methane producing capacity for manure to effluent pond
Source of data:	An average of the Bo_{ep} value of the operation's livestock categories that contributes manure to the biogas control system.
Measurement procedures (if applicable):	
Monitoring frequency:	Annual
Comments:	Not differentiated by livestock category.
Verification comment:	

Parameter:	MCF_{ep}
Data unit:	Fraction
Description:	Methane conversion factor for biogas control system effluent pond
Source of data:	Appendix B, Table B.5, (From IPCC v.4, chapter 10, Table 10.17)
Monitoring frequency:	Annual
Comments:	Project developers should use the *liquid slurry* MCF value
Verification comment	

Project methane calculation variables – non BCS-related sources

Parameter:	$MS_{L,S}$
Data unit:	Fraction
Description:	Fraction of manure from each livestock category managed in manure management system component 'S'
Source of data:	Project developer, based on configuration of manure management system
Measurement procedures (if applicable):	
Monitoring frequency:	Monthly
Comments:	Differentiated by livestock category
Verification comment:	Conduct site visit; Interview operator.

Baseline and project carbon dioxide calculation variables

Parameter:	$EF_{CO2,f}$
Data unit:	Kg CO2/MMBTU
Description:	Fuel-specific emission factor for mobile and stationary combustion sources
Source of data:	California Registry GRP
Monitoring frequency:	Annual
Comments:	If heat or biogas produced from digester is used as an energy source, the EF is zero.

Parameter:	QF_c
Data unit:	MMBTU/year
Description:	Fuel used by project for manure collection, transport, treatment/storage, and disposal
Source of data:	Project developer, based operating records (e.g., fuel purchases records)
Measurement procedures (if applicable):	
Monitoring frequency:	Annually
Comments:	Fuel use should be differentiated by mobile and stationary combustion sources
Verification comment	Review fuel purchase records