Annex 10

CONCEPT NOTE
UNCERTAINTY OF MEASUREMENTS IN BASELINE AND MONITORING METHODOLOGIES

(Version 01.0)

I. Background and objective

1. The Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP), in its decision 9/CMP.7, paragraph 7(a), requested the CDM Executive Board (the Board), as part of its decision on implementing the concept of materiality, to "address the issue of uncertainties of measurements in baseline and monitoring methodologies, so that these types of uncertainties do not need to be considered in addressing materiality".

2. In response to this request, the Board included in its 2012 management plan a project on accounting of uncertainties in measurements in methodologies. The objective of the project is to develop a new standard or amend the project standard (PS) and the verification and validation standard (VVS) in order to address the uncertainties in measurements of parameters in baseline and monitoring methodologies in a systematic and consistent manner.

3. The new or amended standards would instruct project developers and DOEs how to address the uncertainty of measurements. Once approved, similar requirements included in some approved baseline and monitoring methodologies could be removed. The standard aims to address the uncertainty of measurements of parameters relevant for the evaluation of emission reductions, while at the same time providing project developers with more flexibility to optimise their measurement procedure and instrumentation based on cost-benefit considerations.

4. This concept note is prepared to enable the Board to provide direction on the way forward to implement the CMP request and the project included in the MAP. The Board may wish to endorse the scope and approach proposed in section III and/or provides further guidance on how the standards should be developed.

5. Feedback on a draft note was provided by the Methodologies Panel at its fifty-sixth meeting. The appendix to this concept note summarizes the comments made by members of the panel and explains how the comments were considered in finalizing the concept note.

6. The concept note is structured as follows: Section II provides an overview of the existing requirements with regard to the accounting of uncertainties of measurements. Section III outlines proposed scope and approach to address uncertainty of measurements. Section IV highlights the next steps for developing the new or amended standards.

II. Existing requirements in the CDM

7. Several methodologies and related standards already include specific guidance with regard to the quantification and accounting of uncertainties of measurements. However, the currently available guidance is not always consistent across methodologies. In addition, the guidance included in approved methodologies applies only to selected monitoring parameters and is not applied in a systematic manner.

8. For the purpose of quantifying the uncertainty of measurements, the following approaches are used in some methodologies:

(a) Several methodologies apply default values for the uncertainty of measurements, as provided in the 2006 IPCC Guidelines;

(b) The "Standard for sampling and surveys for CDM project activities and programme of activities" implicitly addresses the uncertainty related to surveys and sampling, and uses the confidence/precision concept. A procedure is provided to assess the statistical validity of a sample or survey;

(c) Some methodologies use the manufacturer information for obtaining a meter's uncertainty (e.g. methodology ACM0010 for manure management).

9. For the purpose of addressing the uncertainty of measurements, the following approaches are used in methodologies:

(a) Some methodologies use adjustment factors or discount factors to address the uncertainty of measurements in a conservative manner. Different approaches are used with regard to determining the adjustment:

(i) Some methodologies determine the adjustment factors based on the range of the uncertainty at 95% confidence interval. For example, methodology ACM0016 for mass rapid transport systems takes the upper value of the 95% confidence band for determining fuel consumption, in case the fuel consumption data is incomplete, and the lower value for other sampled parameters;

(ii) Some methodologies use adjustment factors that were derived from the adjustment of GHG inventories under Article 8 of the Kyoto Protocol, based on the approach set out in annex III of document FCCC/SBSTA/2003/10/Add.2. Based on these procedures, different factors are assigned to different uncertainty bands (see Table 1 below). The discount factor reflects the 25th or 75th percentile (whatever is conservative) of the uncertainty associated with the estimate. The adjustment factors are then selected based on the uncertainty of the respective parameter. For example, methodology ACM0014 for wastewater treatment uses a discount factor of 0.89 when conducting a measurement campaign for COD values, which is based on the assumption that this parameter has an uncertainty in the range of 30%-50%;

Table 1: Uncertainty related corrective factors in annex III of FCCC/SBSTA/2003/10/Add.2

Estimated uncertainty range (%)	**Assigned uncertainty band (%)**	**Conservative factor for the base year**	**Conservative factor for a year of the commitment period**
Less than or equal to 10	7	0.98	1.02
Greater than 10 and less than or equal to 30	20	0.94	1.06
Greater than 30 and less than or equal to 50	40	0.89	1.12
Greater than 50 and less than or equal to 100	75	0.82	1.21
Greater than 100	150	0.73	1.37

(iii) Some methodologies require to address the uncertainty in a conservative manner while calculating the emission reductions and request the project participants to describe the procedure for doing so in the CDM-PDD. However, the methodologies do not provide further guidance how this requirement should be implemented (e.g. methodology ACM0010);

(iv) Some methodologies use the standard error to account for the uncertainty (e.g. methodology AM0018 for steam optimization);

(v) Some methodologies apply fixed discount values to account for uncertainties. For example, methodology AM0021 for nitric acid production deducts 5% of the measured amount of N_2O to account for the uncertainties;

(b) Some methodologies address uncertainty by requiring to measure the same parameter twice. The more conservative value between the two measurements is then used to determine emission reductions (e.g. methodology AM0001 for HFC-23 destruction);

(c) The "Standard for sampling and surveys for CDM project activities and programme of activities" addresses the uncertainty by ensuring that the uncertainty remains smaller than a pre-defined value. This concept is also incorporated into several methodologies, such as AM0033 for the cement industry;

(d) Older methodologies (e.g. AM0005 for renewable energies and AM0008 for fuel switch) allow not to monitor an emission source if it is demonstrated that the emission source under consideration is smaller than the uncertainty of the most significant emission sources contributing to the emission reductions. However, no detailed guidance is provided how this requirement shall be implemented;

(e) One methodology (AM0009 for recovery of gas from oil wells) requires to evaluate the measured uncertainty of each parameter and to categorise it into low, medium or high uncertainty. However, the procedure was not clearly defined and was removed from the methodology in a revision;

10. In approved methodologies, the uncertainty of key parameters is not only addressed for parameters that are measured but also for parameters that are derived from other sources. For example:

(a) Many methodologies and tools allow to use IPCC default values. In a number of cases these default values are adjusted for their uncertainty;

(b) Similarly, many methodologies define default values in a conservative manner, thereby addressing the uncertainty associated with the use of default values;

(c) Some methodologies adjust historical data to address significant uncertainties. For example, in the case of retrofit or replacement projects ACM0002 for renewable energy generation deducts a standard deviation from the average historical electricity generation to adjust for the uncertainty associated with intermittent electricity generation patterns;

11. The Methodologies Panel, at its thirty-second meeting (MP32, Annex 14) provided draft guidance on how to deal with uncertainties in emission reduction calculations. The suggestions were presented to the Board at its thirty-ninth meeting. The Board requested the meth panel to continue working on the draft guidance, taking the following into account the following aspects:

(a) Procedure to assess level of uncertainty of a parameter;

(b) A maximum level of uncertainty should be defined as an upper limit of acceptable uncertainty;

(c) The implication of flexibility to choose level of uncertainty by project participants on prescribed frequency of monitoring;

12. However, this work stream was subsequently not prioritized and was not included in the work plans of the Methodologies Panel.

III. Proposed scope and approach to address the uncertainty of measurements

13. It is recommended that the scope for the new standard or the amendment of the PS and VVS should include the following three elements:

(a) Requirements on how to quantify the uncertainty of measurements (sub-section A below);

(b) Requirements on how to address the uncertainty of measurements (sub-section B below);

(c) Requirements for monitoring that are related to the uncertainty of measurements (sub-section C below).

A. Quantification of the uncertainty of measurements

14. As a general approach, it is recommended that the new standard or the amended PS and VVS provide flexible, clear and unambiguous requirements on the quantification of instrumentation uncertainties. The requirements should avoid any significant additional burden for project developers.

15. The requirements could:

(a) Refer to the use of international/local specific documents like the "Guide to the expression of uncertainty in measurement". This existing guide and similar other guidelines are widely used in the industry and provide guidance on how to quantify the uncertainty of measurements.[1] On the other hand, these documents are very detailed and not all information may be relevant in the context of a CDM project activity; and/or

(b) Specify how the uncertainty of measurements should be quantified. This could include requirements on:

(i) Handling errors of measurement;

(ii) Approaches to reflect in the calculation of the overall uncertainty the situation where different equipments are used to measure one parameter, providing formulae to calculate the aggregated uncertainty; and

(iii) The statistical treatment of measured data.

16. It is recommended to draw upon existing standards and guidelines to the extent possible, instead of developing new requirements for the CDM.

[1] Evaluation of measurement data - Guide to the expression of uncertainty in measurement, JCGM, 2008

17. Another important question is which sources of measurement uncertainty should be considered when quantifying the measurement uncertainty. The overall uncertainty of a measurement originates from several sources, inter alia:

(a) The instrumentation uncertainty, reflecting random error related to the accuracy of the measurement instruments used;

(b) Process related variations due to operation procedures or other time factors such as seasons and/or time of the day;

(c) Errors related to the skill of the operator; and

(d) Other non-random errors.

18. The instrumentation uncertainty is usually readily available. Manufacturer's of measurement equipment generally specify the instrumentation uncertainty of the equipment. For some type of measurements, the instrumentation uncertainty is the main source of the overall measurement uncertainty. It is recommended that in such cases the quantification of the overall measurement uncertainty be limited to the instrumentation uncertainty. The new standard or amended PS and VVS could specify for which type of measurements (e.g. electricity meters, volume flow meters, etc) it is sufficient to consider the instrumentation uncertainty.

19. Other uncertainties than the instrumentation uncertainty are usually more difficult to quantify. However, in some cases, these uncertainties are the main source of the overall measurement uncertainty. To address such situations, the following approach is recommended:

(a) Specific provisions can be included or retained in the relevant methodologies to quantify and address significant measurement uncertainties that are not related to the instrumentation uncertainty;

(b) The new standard or amended PS and VVS could include requirements that ensure that measurement uncertainties are reduced (see sub-section C below).

B. Accounting for the uncertainty of measurements

20. As a general approach, it is recommended that significant measurement uncertainties be addressed in a conservative manner by adjusting the measurement result. This approach is already used in many approved methodologies. A consistent approach towards adjusting the measurements result for uncertainty could provide flexibility to the project developers in weighting the costs and benefits of measurement instrumentation. It also ensures that the emission reductions are determined in a conservative manner and that the degree of conservativeness is consistent across project types and methodologies. While implementing this approach, a number of choices need to be made.

21. An important choice is whether each measured parameter is separately adjusted for its uncertainty or whether the aggregated emission reductions are adjusted to account for the overall uncertainty arising from all measured parameters. Adjusting the aggregated emission reductions relates the adjustment to the actual uncertainty arising from all measurements under the project activity. This approach better reflects the overall actual uncertainty. It also results in a less stringent adjustment in the case of methodologies that require measurement of several non-related parameters. However, the quantification of the aggregated uncertainty of overall emission reductions can be mathematically more complicated than quantifying only the uncertainty for individual parameters. Where complex equations or models are used in a methodology, usually more sophisticated tools, such as Monte-Carlo-Simulations, are used to quantify the uncertainty accurately. This could involve significant transaction costs. For this reason, in the

case of complex cases it may be necessary to use simplified approaches to quantify the uncertainty for the aggregated emission reductions.

22. Another important question is whether the emission reductions should always be adjusted to account for the instrumentation uncertainty or whether such adjustments should only apply if the uncertainty exceeds a threshold. If a threshold is used, another choice is whether the same threshold should be applied to all CDM projects or whether different thresholds should apply depending on the size of the CDM project, similar to the approach followed on materiality. Finally, values for the threshold(s) would need to be defined. The introduction of thresholds increases the emission reductions if the project participants use sufficiently accurate instrumentation. In this regard, the introduction of thresholds can provide an additional incentive to use instrumentation equipment which is more accurate in order to avoid an adjustment of the measurement results. At the same time, sufficiently low thresholds would ensure that emission reductions continue to be determined in a reasonably conservative manner. Finally, the introduction of a threshold would keep the requirements for project participants simple, as many projects with simple measurement requirements (e.g. renewable power generation) would most likely not need to implement any changes to their monitoring and calculation of emission reductions. It is therefore recommended to introduce a threshold below which adjustments to account for instrumentation uncertainty are not applied. The implications of using a single or several thresholds and the impact of different values require further assessment.

23. An important policy choice is the degree of conservativeness that should be used when adjusting measurement results to account for the instrumentation uncertainty. A more conservative adjustment reduces the calculated emission reductions and thus the amount of emission reductions to a larger extent, whereas a too lenient adjustment would result in a higher uncertainty of the overall emission reductions and provide less incentives to use more accurate instrumentation uncertainty. It is recommended to apply a 95% confidence level in adjusting for the uncertainty of measurements. This level may be more appropriate for single projects compared to the $25^{th}/75^{th}$ percentile used in for the adjustment of GHG inventories under Article 8 of the Kyoto Protocol (see Table 1 above), as contained in annex III of decision FCCC/SBSTA/2003/10/Add.2.

24. A related question is whether the adjustment factors should be determined in a step-wise approach applying uncertainty bands (as in Table 1 above) or whether the adjustment factor should be calculated based on a continuous approach where the adjustment is calculated based on the actual measurement uncertainty of the specific parameters. It is recommended to calculate the adjustment factor based on the actual uncertainty, since the calculation of the adjustment factor is not difficult to perform and the use of a simplified table with step changes would not ensure consistency across projects but could be perceived as unfair and arbitrary. For example, in the case of a step-wise approach as in Table 1 a project with an uncertainty of 31% would face a significantly higher adjustment factor (0.89) than a project with an uncertainty of 29% (0.94). The use of a step-wise approach could also provide disincentives to use more accurate measurement equipment if the use of such equipment would not result in a step-change, whereas the calculation of the adjustment factor based on the actual uncertainty would provide continuous incentives.

25. Another consideration is the relation between the new standard(s) and specific requirements on uncertainty already contained in approved methodologies. To avoid any ambiguity which requirements apply and to ensure a coherent and consistent approach, the following is recommended:

(a) Once the new standard or amended PS and VVS are approved, existing methodologies can be revised to align them with the requirements in the new standard or amended standard;

(b) The new standard or the amended PS and VVS could clarify that specific provisions in methodologies regarding uncertainty supersede the new standard or amended PS and VVS. This approach ensures that methodologies can provide specific requirements that may be needed in the context of a specific sector and clarifies which requirements are valid in the case of inconsistencies.

26. Furthermore, it is recommended that the new standard or amended PS or VVS applies only after a grace period of six months. This provision would give project participants and Designated Operational Entities (DOEs) sufficient time to prepare and implement the new requirements and ensure that ongoing validation and verification activities are not adversely affected by the new requirements.

C. Requirements for monitoring that are related to the uncertainty of measurements

27. It is recommended to include in the new standard or amendment of the PS and VVS requirements that aim to reduce the overall uncertainty of measurements. Such requirements could include the following:

(a) Requirements that instrumentation equipment should be installed, operated and calibrated according to the manufacturer instructions and that calibration shall be conducted by a laboratory accredited according to international standards, to ensure accuracy and traceability of the measurements;

(b) Requirements on how to implement QA/QC procedures to reduce measurement uncertainties of monitored parameters. This would include, inter alia, identifying key parameters, identifying the scope of QA/QC procedures required for each parameter, using back-up instrumentation, defining procedures to address missing data and evaluating the quality of data gathered;

(c) Addressing situations in which a measurement instrument is used that is not properly calibrated by defining a discount factor for the parameter value based on the instrument's precision and length of time the instrument is not calibrated, drawing upon existing guidelines, including the following:

(i) The "Guidelines for assessing compliance with the calibration frequency requirements" (EB 52, Annex 60); and

(ii) Relevant requirements in the VVM.

(d) Specifying in the case of sampling that the sampling schedule shall be pre-defined in a manner that avoids possible sources of bias, such as daily, seasonal or process variations;

(e) Requirements regarding the documentation of measurement results;

(f) Addressing situations where measurement equipment temporarily fails and no appropriate backup measurement is available;

(g) Addressing any ambiguity regarding the frequency of measurements and the processing of measured data, such as a clarification of how "continuous" monitoring, as required in some approved methodologies, should be conducted and guidance on when periodical or continuous monitoring of parameters is more appropriate.

IV. Next Steps

28. The following approach is recommended for the development, consultation and approval of the new standard or amendment of the PS and VVS:

(a) The concept note and possible elements of a draft standard text could be considered and discussed at the CDM round table scheduled for 10 August 2012;

(b) A draft new standard or an amendment of the PS and VVS is considered by the Board at its sixty-ninth meeting;

(c) The Board may wish to launch a call for public inputs on the draft and provide further direction on improving the draft;

(d) The new standard or amendment of the PS and VVS may be adopted by the Board at its seventieth meeting, taking into account the comments received from the call for public inputs, and may apply for requests for registration or requests for issuance submitted from 1 May 2013 onwards;

(e) Approved methodologies may be revised, starting in 2013, in order to ensure consistency with the new standard or amended PS and VVS.

Appendix 1

Feedback provided by the methodologies panel

29. At its fifty-sixth meeting, the methodologies panel considered a draft of this concept note and provided feedback to the secretariat. The comments by members of the panel are summarized in the table below. The table also contains information how the comments were addressed in preparing this version of the concept note.

Comment by members of the methodologies panel	How the comment was addressed
The concept note deals mostly with instrumentation errors, and does not deal with other measurement errors, which are likely to be more substantial	The concept note was modified and an approach was implemented where all types of measurement uncertainties are considered, including reproducibility and repeatability related uncertainties, while ensuring practicability in quantifying other sources of uncertainty than the instrumentation uncertainty.
The concept note focuses on stability errors, and ignores reproducibility, repeatability, etc.	
The concept note should address the issue that project participants could choose favourable measurements/samples	This aspect was integrated into the concept note.
Different views were expressed by the panel regarding the degree of conservativeness. Both a 75th/25th percentile and a 95% confidence level were supported.	The revised concept note recommends a 95% confidence level, as this is regarded more appropriate for measurement uncertainties at project level, whereas the 75th/25th percentile is used for entire GHG inventories. Furthermore, the threshold of 5% instrumentation error will be considered in establishing the standard but different values may be evaluated in the further process of preparing the standard.
A 5% threshold value for when an adjustment of the measurement result needs to be conducted is proposed because this is consistent with the guidelines on surveys.	
The standard should refer as much as possible to existing guidelines and best practice documents	This issue is incorporated in the concept note.
It is more appropriate to use a continuous adjustment of the uncertainty rather than uncertainty bands	This issue is incorporated in the concept note.
The requirements or suggestions of the concept note must not be too demanding for the project participants	A simple approach is proposed which would require minimal additional work by the project participants. Best practice guidelines should be followed by all projects, so the effort is justified, and
Project participants should not be over burdened by the requirements. Concrete monitoring options (equipment, procedure, etc.) meeting the requirements of the	

uncertainties guidelines should be provided in the methodologies.	quantifying instrumentation uncertainties is envisioned as a simple calculation. Moreover, methodologies would still be able to address specific uncertainties concerns within the methodology.
Project developers in many developing countries do not have the capacity to follow the suggested approach and it will be unrealistic to enforce it in small scale projects. However, the concept may be appropriate for large scale projects, such as super critical coal and natural gas power plants, industrial gases projects or flaring of gas projects.	
Some methodologies already consider the measurement uncertainty. AM0030 version 1 followed a procedure using a 15% baseline emission discount to account for the expected uncertainties associated in the specific technology. In subsequent versions, uncertainty evaluation has been integrated into the monitoring methodology.	
Uncertainty requirements should be methodology specific, not on project level, whenever possible. Only methodologies for certain gases should require uncertainty calculation as part of the monitoring methodology	
Only specific equipment, necessary for the determination of the emission reductions, should be relevant in the context of instrumentation uncertainties	This approach is inherent in the procedure for quantifying instrumentation errors, and was further explained in the applicability of the concept note.
There are existing procedures to deal with missing measurement data and no calibration	A reference to these procedures was added to the concept note.
The uncertainty measurement should be imposed only to cases where a simple error could lead to large change in emission reductions, for example, projects with high GWP gases	It is not proposed to impose a measurement of the uncertainty. In many cases, measurement uncertainty can be limited to addressing the instrumentation uncertainty. This data is usually readily available from providers of the measurement equipment. Notwithstanding, methodologies could have specific requirements to account for other sources of uncertainty than the measurement uncertainty.

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History of the document

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