ARTICLE 6.4 MECHANISM

A6.4-MEP014-A06

Information note

Sampling and surveys requirements for designated operational entities

Version 01.0

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COVER NOTE

1. Procedural background

1. The Supervisory Body of the Article 6.4 mechanism, at its fifteenth meeting, approved the 2025 workplan for the Methodological Expert Panel (MEP) and requested the MEP to continue working on the revision of clean development mechanism methodologies, methodological tools, standards and guidelines, including the “Standard: Sampling and surveys for CDM project activities and programmes of activities” and “Guidelines: Sampling and surveys for CDM project activities and programmes of activities”.

2. Purpose

2. This information note provides sampling-related requirements pertaining to validation and verification activities by designated operational entities (DOEs), including the sampling approach to be undertaken by the validating/verifying DOEs, and related guidelines.

3. Key issues and proposed solutions

3. While working on the revision of the “Standard: Sampling and surveys for CDM project activities and programmes of activities” and the “Guidelines: Sampling and surveys for CDM project activities and programmes of activities”, the MEP identified that these documents included requirements pertaining to DOEs’ validation and verification activities, as well as the related guidance to the DOEs.

4. The MEP concluded that the requirements and guidance directed at DOEs should not be included in a standard or a methodological tool and therefore the text relevant to DOE activities related to sampling and surveys are provided in this information note for the Supervisory Body’s consideration.

5. The Information Note has been updated to reflect the revised approach in the “Methodological tool: Sampling and surveys”, including the possibility of applying a common sampling plan across more than one component project (CP) within a programme of activities (PoA). While such an approach may improve efficiency where justified, it may also create a risk that sampling is concentrated in larger, more accessible or better-performing CPs, thereby masking underperformance in smaller, higher-risk or lower-performing CPs, as was observed under the CDM.

6. To address this risk, the Information Note includes enhanced evaluation criteria for DOEs. In particular, where a common sampling plan covers more than one CP, the DOE is expected to assess whether: (a) the grouping of CPs is based on objective, documented and verifiable criteria; (b) the CPs are sufficiently homogeneous with respect to the parameter of interest, or any heterogeneity is appropriately addressed through stratification or another statistically valid sampling approach; (c) the sampling frame identifies the CP to which each sampling unit belongs and is sufficiently disaggregated to assess representation across CPs; (d) the allocation of sampled units does not systematically under-represent smaller, higher-risk, less accessible or potentially lower-performing CPs; and (e) the sampling approach is capable of detecting material differences in performance across CPs.

7. The Information Note further clarifies that simple random sampling across a combined population of CPs may be appropriate only where the relevant CPs are demonstrated to be sufficiently homogeneous. Where material differences exist among CPs, the DOE should confirm that stratified random sampling or another statistically valid approach has been applied to ensure that the relevant CPs or strata are adequately represented and that CP-specific underperformance is not masked.

8. Additional safeguards have also been included regarding sampling-frame integrity and the treatment of selected units that are missing, inaccessible, non-operational, abandoned or otherwise unavailable. The DOE should assess whether such units remain appropriately reflected in the sampling frame, whether their treatment is documented and justified, and whether replacement, exclusion or other corrective measures could introduce bias or result in overestimation of emission reductions or net greenhouse gas (GHG) removals.

9. These additions are intended to preserve the flexibility provided by the methodological tool while strengthening assurance that common sampling plans are implemented in a transparent, representative and conservative manner.

4. Impacts

10. The consideration by the Supervisory Body of the requirements for DOEs' validation and verification activities related to sampling and surveys will allow these to be placed optimally within the relevant standards of the Article 6.4 mechanism.

11. The updated Information Note strengthens the DOE's ability to identify potential bias in common sampling plans across CPs and to assess whether sampling designs, sampling frames and sample allocation arrangements could conceal biases that could lead to overestimation of emission reductions or net GHG removals at the PoA level.

5. Subsequent work and timelines

12. The MEP agreed to seek public inputs from stakeholders on this draft version of the information note. The MEP will incorporate the stakeholders' inputs received and recommend a revised draft of the information note for consideration by the Supervisory Body.

6. Recommendations to the Supervisory Body

13. Not applicable, as the document is published as a call for public inputs.

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1. Introduction

1. This document provides sampling-related requirements and guidance applicable to the validation and verification of Article 6.4 projects and programmes of activities (PoAs), including the sampling approach to be applied by the validating/verifying designated operational entities (DOEs) when validating or verifying sampled data and related monitoring results.

2. This document focuses on DOE validation and verification considerations related to sampling and surveys, including the assessment of a sampling plan, implementation of sampling data collection procedures, treatment of non-response or missing sampled units, evaluation of reliability requirements, and review of corrective actions where reliability requirements are not achieved. General methodological requirements and guidance on sampling design, sampling methods, sample size determination, and the preparation of sampling plans are provided in the "Methodological tool: Sampling and surveys" (hereinafter referred to as "Sampling Tool") and its appendices.

3. Furthermore, this document outlines considerations for DOE assessment where prescribed confidence/precision requirements have not been achieved, consistent with the conservativeness requirements of the applicable mechanism methodology.

2. Validation and verification of sampling plans

4. The proposed sampling plan shall be validated by a DOE[1] to determine whether the plan can provide unbiased and reliable estimates of the relevant parameters. The validation shall determine:

    (a) Whether the proposed sample size and sampling method are adequate to achieve the minimum confidence level/precision requirements. The DOE shall be able to reproduce the sample size calculation in order to validate the proposed sample size; and

    (b) Whether the proposed sampling plan ensures that samples are randomly selected and are representative of the population.

5. The DOE shall verify whether the activity participants have implemented the sampling and surveys according to the sampling plan in the registered monitoring plan. The verification includes determining:

    (a) Whether the required confidence level /precision requirements have been met; and

    (b) Whether the selected sample is representative of the population.

6. The DOE may apply its own sampling approach for on-site visits and/or remote surveys as part of validation/verification, applying section 5.4 of the Sampling Tool, irrespective of whether the participants or the coordinating/managing entity have undertaken sampling surveys. Where the activity participants have not applied a sampling approach, the DOE may apply its own sampling approach using confidence/precision requirements different from those indicated in the Sampling Tool or specified in the relevant mechanism methodology, provided that samples are randomly selected and are representative of the entire population.

[1] Recommended evaluation criteria are included in Annex 1.

7. Where the activity participants have applied a sampling approach, the DOE may apply acceptance sampling as described in the steps indicated in paragraph 8 as part of validation[2]/verification activities.

8. For applying acceptance sampling, the DOE shall follow the steps below:

   (a) Take a random sample of the activity participants' sample records;

   (b) Check, using its own professional judgement, the acceptability (or otherwise) of the data for each record in the activity participants' sample records; and

   (c) Based on the number of records where there is agreement, determine whether the activity participants' sample records meet the requirements.

9. In order to determine the sample size, the DOE should specify in advance, using its own professional judgement:

   (a) The acceptable quality level (AQL) or the level of assurance, that is the proportion of acceptable discrepancies between the activity participants' sample records and the DOE sample records (i.e., DOE field/on-site inspection results) (e.g., 1 per cent); and

   (b) The unacceptable quality level (UQL), that is the proportion of unacceptable discrepancies between the activity participants' records and the DOE sample records, e.g., 20 per cent.

10. The maximum errors associated with the determination indicated in paragraph 9 above should remain at levels indicated below:

   (a) A 10 per cent chance that the DOE will wrongly reject the activity participants' records (i.e., reject a set of records of acceptable quality);[3] and

   (b) A 10 per cent chance that the DOE will wrongly accept the activity participants' records (i.e., accept a set of records which is unacceptable).[4]

11. Using provisions under paragraphs 9 and 10 above, the DOE should determine:

   (a) *n*: the size of the sample;[5] and

   (b) *c*: the acceptance number.

12. If the number of discrepant records is equal to or less than *c*, the activity participants' set of records is accepted. Table 2 below showing "Sample size and acceptance number based on producer and consumer risk" may be used as reference.

13. Table 2 provides only idealised numerical targets. As indicated in paragraph 11 the DOE may exercise professional judgement to determine whether its records are compatible with the activity participants' records and, accordingly, whether they can be accepted. The DOE may take into account factors that could affect individual measurements, leading to

[2] Assessment of parameters determined ex ante by the activity participants is included.

[3] This is called the "producer's risk".

[4] This is called the "consumer's risk".

[5] A DOE shall determine a sample size for each parameter. If there are multiple parameters, the DOE should take the largest sample size from the different parameters, for example if the sample size for parameter 1 is 50 and sample size for parameter 2 is 55, sample size chosen to cover both the parameters is 55.

discrepancies. For example, the DOE may consider if the discrepancy observed between the activity participants' set of records and the DOE's record is attributed to:

(a) A temporal issue (e.g., technology retention rate/performance is known to deteriorate over time); or

(b) A weather-related issue (e.g., flooding, in which project technology or measuring instrument was affected during a specific period); or

(c) Another issue not under the control of the activity participants (e.g., unexpected high or low voltage incidence in the grid); or

(d) Other issues related to technology characteristics and survey methods (see section 5.6 of the Sampling tool, on Survey and data collection methods.

14. In this respect, the DOE may reclassify initial discrepant records into conforming measurements and provide justification. The DOE shall check that physical measurements were collected as per established methods in accordance with the applicable provisions in Appendix 3 of this Information Note to DOEs.

15. If the number of discrepant records is greater than *c*, the DOE should ensure that due consideration was given to reasonable adjustments when comparing the DOE's and the activity participants' set of records and document this.

16. Table 1 provides illustrative considerations for determining whether records obtained by the DOE and the activity participants are discrepant for parameters relevant to the applicable mechanism methodology

Table 1. Example points to be considered when comparing the DOE's and the activity participants' records

Parameter	How the activity participants conducted sampling surveys (to obtain the activity participants' records)	How the DOE could obtain records for verification	Criteria for deciding what ultimately constitutes a discrepancy
Ψy Percentage activity households qualifying as user households in year *y*	Usage survey and visual inspection, or stove use monitor (SUM) data, to confirm that the project cookstove is present, functioning and used at least once per week, or at a higher frequency specified for the Article 6.4 activity	Cross-check a random sample of activity participants' records through on-site inspection, remote verification supported by available evidence, or review of corresponding SUM data	Whether the project cookstove is present and functioning, and whether the recorded use meets the applicable user-household criterion
$FEC_{proj,i,y}$, Total energy consumption of activity fuels (*i)* in year *y*	Based on results of a Kitchen Performance Test (KPT) campaign conducted on a sample of activity households	Re-perform or witness KPT tests for a random sample of households or review KPT records, equipment, calibration records/reports and field procedures and data processing.	Whether the KPT was conducted in accordance with approved established international/national standards and procedures; or test methods prescribed by the applicable mechanism

Parameter	How the activity participants conducted sampling surveys (to obtain the activity participants' records)	How the DOE could obtain records for verification	Criteria for deciding what ultimately constitutes a discrepancy
		Check qualifications/capability of testers	methodology; and whether any difference between the DOE's and the activity participants' measurements exceeds the pre-established tolerance for measurement variation
H_y, Average household size of user households in year *y*	Pre-activity survey conducted on a sample of activity households, using the household-member definition specified in the applicable mechanism methodology	Cross-check a random sample of activity participants' records through on-site inspection, remote interviews supported by available evidence, or review of underlying survey records	Whether the number of household members recorded by the activity participants is consistent with the applicable household definition and the DOE's verification evidence, allowing for any documented changes in household composition during the monitoring period

17. If the DOE observes greater than *c* discrepant records in the sample, the activity participants' set of records shall not be accepted unless the discrepancies are adequately explained and resolved. Where the discrepant records exceed the threshold c, the DOE, if requested by the activity participants, may consider assessing additional samples (increasing the sample size by decreasing the UQL but not decreasing the consumer and producer risk). Denote the new acceptance number by c_{new}. If the resulting discrepancy is within the new specified limits (i.e., less than or equal to c_{new} discrepant records), the activity participants' set of records is accepted. If the number of discrepant records remain greater than the acceptance number, now c_{new}, the DOE may raise a corrective action request to activity participants (e.g., revised estimation of emission reductions to error on the conservative side, undertaking additional surveys). Where the discrepancies remain unresolved, the DOE shall not accept the affected records or sampled results as a basis for its validation or verification conclusion; or

18. Where the reliability requirements for sampling are not achieved, the DOE shall verify that the activity participants have applied the provisions of the applicable mechanism methodology for addressing uncertainty associated with the sampled parameter.

19. A DOE may select a different sample size than the one indicated in paragraph 11 above, either by choosing a different value for the consumer risk and producer risk (e.g., 20 per cent for the consumer risk) when applying acceptance sampling or by using another approach, in cases where the security conditions in the region of the Article 6.4 activity prevents inspection the number of samples required under paragraph 11 (e.g., in areas affected by security constraints); or

20. Any alternative sample size or sampling approach shall be justified, documented and demonstrated to provide an appropriate level of assurance, taking into account the risks associated with the verification.

Table 2. Sample size and acceptance number based on AQL, UQL, and producer and consumer risks

Producer risk (per cent)		5		5		5		5	
Consumer risk (per cent)		5		10		15		20	
AQL (per cent)	UQL (per cent)	Sample size (n)	Acceptance number (c)	Sample size (n)	Acceptance number (c)	Sample size (n)	Acceptance number (c)	Sample size (n)	Acceptance number (c)
0.5	10	46	1	38	1	33	1	29	1
0.5	15	30	1	25	1	22	1	10	0
0.5	20	22	1	18	1	9	0	8	0
1.0	10	61	2	52	2	33	1	29	1
1.0	15	30	1	25	1	22	1	19	1
1.0	20	22	1	18	1	16	1	14	1
Producer risk (per cent)		10		10		10		10	
Consumer risk (per cent)		5		10		15		20	
AQL (per cent)	UQL (per cent)	Sample size (n)	Acceptance number (c)	Sample size (n)	Acceptance number (c)	Sample size (n)	Acceptance number (c)	Sample size (n)	Acceptance number (c)
0.5	10	46	1	38	1	19	0	16	0
0.5	15	19	0	15	0	12	0	10	0
0.5	20	14	0	11	0	9	0	8	0
1.0	10	46	1	38	1	33	1	29	1
1.0	15	30	1	25	1	22	1	10	0
1.0	20	22	1	18	1	9	0	8	0

Appendix 1. Recommended evaluation criteria for validation by designated operational entities

1. The following questions and evaluation criteria serve as examples and should be utilized by DOEs to validate the proposed sampling plans:

    (a) Does the sampling plan present a reasonable approach for obtaining unbiased, reliable estimates of the relevant parameters?

        (i) In terms of assessing reliability, are the objectives and reliability requirements complete? Do the requirements specified agree with those stated in the appropriate standards? If not, is there a reason why they are not met?

        (ii) Where a single sampling plan covers more than one CP within a PoA, has the activity participant demonstrated that the CPs are sufficiently homogeneous for the parameter of interest, or that any heterogeneity is appropriately addressed through the sampling design, including stratification or another statistically valid approach?

        (iii) Does the sampling frame identify the CP to which each sampling unit belongs and include all relevant units across the CPs covered by the sampling plan?

        (iv) Is the allocation of sampled units across CPs or strata statistically justified and sufficiently representative of the populations concerned? In particular, does the sampling design avoid systematically allocating a disproportionate share of samples to larger, better-performing, more accessible, or otherwise lower-risk CPs, while under-representing or excluding smaller, higher-risk, poorly performing, or less accessible CPs?

        (v) Is there any reason to suspect that the sampling design, sampling frame, sample allocation replacement of sampled units, treatment of non-response or exclusion of records could introduce bias or mask differences in performance across CPs? For instance, is the population under consideration only urban households or high performing CPs? Or does it exclude rural, remote, inactive, non-operational, abandoned, or difficult-to-access units without adequate justification and conservative treatment. Might this cause a bias when the data are extrapolated to emission reductions?

    (b) Is the population clearly defined and how well does the proposed approach to developing the sampling frame represent that population?

        (i) The population should be clear from the population description. Whether or not the sampling frame is possible or appropriate will depend on the detail and the particular situation. For example, if a map is going to be used, a question would be whether a map already exists, and how reliable it is. If a map does not exist, then who is going to create it?

    (c) Is the proposed sampling approach clear?

        (i) Is it clear which sampling method is being proposed? For example, is it simple random sampling, or some other method of sampling?

(ii) Does the method agree with the description of the population? Are there clusters or strata, and if so, does the method state what they are? For example, are they buildings, villages, etc.?

(d) Is the proposed sample size adequate to achieve the minimum confidence/precision requirements? Is the ex-ante estimate of the population variance needed for the calculation of the sample size adequately justified?

(i) All the information set out in the sampling plans should help answer this question. If not all the information is provided, then the question cannot be answered;

(ii) Is the target value for the population parameter reasonably anticipated?

(iii) Does the estimate of variability seem reasonable?

(e) Is the sample representative?

(i) Is it clear how the sample is to be selected? For example, is it to be selected randomly?

(ii) Does the plan indicate that the sampling frame will be kept (e.g., in hard copy or a computer file of a screen shot copy), and that random numbers will be generated and these random numbers will then be used to select the sample?

(f) Is the data collection/measurement method likely to provide reliable data given the nature of the parameters of interest and project, or is it subject to measurement errors?

(i) Are the methods of data collection clear and unambiguous? Are there questions which could be subject to respondent error due to sensitivity (e.g., “How much money do you spend on heating?”), lack of recall (e.g., “How many times did you buy fuel last year?”), and the like?

(ii) Are there questions that could be subject to measurement error? For example, is a particular measurement method known to under-record key data, such as the weight of bricks?

(g) Are the procedures for the data measurements well defined and do they adequately provide for minimizing non-sampling errors?

(i) Is the quality control and assurance strategy adequate?

(ii) Are there mechanisms[1] for avoiding bias in the answer?

(h) Does the frame contain the information necessary to implement the sampling approach?

(i) Are the proposed skill sets, qualifications and experience of the personnel to be engaged to conduct sampling adequate?

[1] Mechanisms for avoiding non-sampling errors (bias) include good questionnaire design, well-tested questionnaires, possibly pilot testing the data collection.

Appendix 2. Recommended practices for conducting survey and data collection

1. Survey and data collection methods in relation to validation/verification purposes by designated operational entities

1. The following subsections contain guidance with regard to:

   (a) Methods of survey and data collection for validation/verification purposes, and criteria to be used by DOEs for selecting an appropriate survey method; and

   (b) Data processing and report generation: minimum requirements for documentation.

1.1. Recommended evaluation criteria for designated operational entities validation of survey and data collection methods used by activity participants

2. Activity participants may choose to use different survey and data collection methods to implement a survey design, but they should justify the selection. This should be scrutinized as part of the validation/verification process. The following questions and evaluation criteria serve as examples and should be utilized by DOEs to validate a survey and data collection method proposed by activity participants:

   (a) Why did the activity participants choose the method used?

      (i) Is the selected method compliant with the requirements of the mechanism methodology?

   (b) Does the proposed data collection method match the available sampling frame?[1]

      (i) The appropriateness of a sampling frame will depend on the selected data collection method. Conversely, the selection of a data collection method may be influenced by which type of information is collected about the participating households. For example, a telephone survey requires a sampling frame that accurately records the telephone numbers of eligible households. If such a sampling frame does not exist, is the process of its creation and maintenance included in the plan?

      (ii) What measures are in place to ensure that non-participating households are excluded from survey and data collection methods, that do not rely on physical on-site visits?

      (iii) What mechanisms are in place to ensure that the intended recipient of the survey is the same person who completes the questionnaire? This is relevant to all survey and data collection methods.

   (c) Is the proposed survey and data collection method approach clear and suitable?

      (i) Is there a mechanism for ensuring that the data collected are of high quality? For example, during a telephone interview, the interviewer relies on the

[1] A sampling frame is a complete listing of all individual units (elements, members) that can be considered as a representation of the whole population, and which can be used as a basis for selecting a sample, such as a list of all households in an area that have had solar cookers installed.

respondent giving an accurate answer to the question that is being asked. Have these mechanisms been tested in pilot telephone interviews?

(ii) Does the chosen data collection method suit the capability of the intended recipients? For example, a mail-based questionnaire method would be unsuitable for a population with a low literacy levels.

(d) Is the response rate required to achieve the target sample size reasonably attainable within the planned data collection period? Is the anticipated response rate reasonable for the selected survey and data collection method?

(i) Is the planning information described above contained in the data collection plan? This is essential, as some methods afford weak control over the achievable response rate;

(ii) Is the anticipated response rate too low to match the number of required valid returns?

(e) Is the selected survey and data collection method likely to yield results that are representative of the entire population?

(i) Some survey and data collection methods (e.g., web-based surveys) are known to suffer from respondent self-selection, thereby yielding results that are not representative of the entire population. Is a mechanism for redressing the bias proposed? If so, is it clearly explained and supported by existing endorsed methods?

(ii) Does the data collection plan indicate that the existing sampling frame is fit for the intended purpose? For example, a sampling frame with telephone numbers of many digits is prone to recording errors, thus excluding eligible households whose telephone numbers are incorrectly recorded. What mechanisms are in place to maximize the accuracy of the sampling frame?

(f) Is the survey and data collection method likely to provide reliable data given the nature of the parameters of interest or is it subject to measurement errors by its very nature?

(i) Are there questions whose answers could be susceptible to respondent error due to the delivery mechanism of the data collection method itself? For example, the answer “forty” units as opposed to “fourteen” units, in a telephone interview when the respondent is asked to read a meter;

(ii) Some data collection methods are known to suffer from under-coverage, which occurs when sections of the population do not appear in the sampling frame. For example, do all eligible households have reliable access to the Internet? Is a mechanism for mitigating the effect of under-coverage proposed? If so, is it clearly explained and supported by existing endorsed methods?

(g) Are the procedures for the selected survey and data collection method unambiguously defined and do they adequately provide for minimizing non-sampling errors?

(i) Is the quality control and assurance strategy adequate? For instance, given the common use of mobile phones, does the plan establish whether a respondent has to be physically inside the eligible household to be able to accurately respond to a telephone interview?

(ii) Have potential sources of bias inherent in the selected data collection method, such as self-selection and under-coverage, been anticipated? Have mechanisms for mitigating these been considered?

(h) Does the proposed data collection plan contain the information necessary to implement the selected survey and data collection method?

(i) Are the proposed skill sets, qualifications and experience of the personnel engaged in conducting the data collection exercise adequate?

(ii) Is adequate training of personnel provided?

1.2. Survey and data collection methods for use by designated operational entities for validation/verification of sample records of activity participants

3. The DOEs may use acceptance sampling where necessary, as described in the Sampling Tool, in the validation/verification process to verify that the activity participants have implemented a sampling plan to a satisfactory standard. This involves selecting a random sample of the activity participants sample records and cross-checking against DOE records, i.e., data collected by the DOE. In general, different methodologies may be employed to collect survey data as described above.

4. The physical on-site visit, or inspection, utilizing a face-to-face interview has a clear advantage in many cases, however for simple parameters such as retention rates monitored through data sensors or pay-as-you-go systems, value addition from a site visit may be limited.

5. If a less preferred method such as telephone interviewing is to be conducted by a DOE this should be justified as reasonable, taking precautions to minimize bias, non-response and its effects, and implementing appropriate quality control procedures:

(a) Respondents require a telephone and a reliable telephone network to enable a telephone interview to take place. Bias problems would arise if not all the households have access to a telephone, as the validation of corresponding records would not be possible; and

(b) The telephone is not suitable for long interviews, long or complex questions, and the recording of technical data that may require training. Further, in telephone interviewing, it may not be clear who the respondent is, bringing into question the reliability of any answers.

1.3. Selecting a survey and data collection method and preference for use

6. DOEs may select one of the survey and data collection methods described in 1.3 above. Reasonable justification (e.g., cost-benefits) should be documented taking precautions to minimize bias, non-response and its effects, and appropriate quality control procedures. For example, where a telephone interview method is selected, the DOE should justify why other preferable methods (e.g., physical visits) were not feasible or appropriate. Prior to the implementation of the telephone interview, the DOE should ensure that all the users within the population have reliable access to a telephone line. This is to ensure that randomly selected respondents can be reached through the same survey method in an unbiased, statistically valid manner.

7. Where a less preferred survey and data collection method is used, then the DOE should justify the selection and explain how potential limitations associated with lower quality data, including non-response and bias, will be appropriately addressed.

8. There may be strong practical reasons for using a less preferred survey and data collection method, such as security issues within a country or region. Before excluding on-site visits, due consideration should be given to the use of qualified local third parties to conduct such visits, where feasible. Other survey data collection methods may be applied, provided that the considerations in paragraph 7 above are addressed.

9. If there is a possibility that planned on-site visits may not be practicable in the future due to, for example, a deteriorating security situation, DOEs should consider appropriate contingency measures at the planning stage of the survey.

Appendix 3. Best-practice examples – acceptance sampling

1. Introduction

1. This annex illustrates how a designated operational entity (DOE) may select a validation or verification sample and apply acceptance sampling to assess whether activity participants' sampled records are acceptable. The example concerns a numeric parameter determined through a survey.

2. Example: LED project – numeric parameter

2. The parameter of interest is the mean daily operating time of light emitting diode (LEDs), expressed in hours, for the population of 420,000 households to which one LED was distributed. The activity participants selected a simple random sample of 140 households and recorded the daily operating time of each LED to estimate the mean daily operating time.

3. To validate or verify the activity participants' sampled records, the DOE selects a simple random sample from the activity participants' sample and compares its observations with the corresponding records. Before undertaking the assessment, the DOE shall establish criteria for determining what constitutes a discrepancy between the two sets of records.

4. The DOE shall also specify:

   (a) The acceptable quality level (AQL), which is the proportion of discrepant records that is considered acceptable; and

   (b) The unacceptable quality level (UQL), which is the proportion of discrepant records that is considered unacceptable.

5. For this illustrative example, the AQL is assumed to be 1 per cent and the UQL is assumed to be 10 per cent.

6. The determination of the DOE's sample size and acceptance number also requires specification of:

   (a) The producer's risk (α), which is the probability of wrongly rejecting records that are of acceptable quality; and

   (b) The consumer's risk (β), which is the probability of wrongly accepting records that are of unacceptable quality. For this illustrative example, both the producer's risk and consumer's risk are assumed to be 5 per cent.

7. These inputs determine:

   (a) The DOE's sample size; and

   (b) The acceptance number, that is, the maximum number of discrepant records that may be observed for the activity participants' sampled records to be accepted.

8. The calculation may be undertaken using appropriate statistical software, published acceptance-sampling tables or manual calculations.

9. Table 1 provides illustrative sample sizes and acceptance numbers for selected combinations of AQL and UQL.

Table 1 Sample size and acceptance number[1]

AQL (per cent)	UQL (per cent)	Sample Size	Acceptance number
1	10	61	2
1	15	30	1
1	20	22	1
0.5	10	46	1
0.5	15	30	1
0.5	20	22	1

10. For an AQL of 1 per cent, a UQL of 10 per cent, and producer's and consumer's risks of 5 per cent, the DOE sample size is 61 households, and the acceptance number is 2. Therefore, where the DOE identifies no more than two discrepant records, the activity participants' sampled records are accepted. Where the DOE identifies more than two discrepant records, the sampled records are not accepted, subject to the procedures set out in this information note.

2.1. Worked example

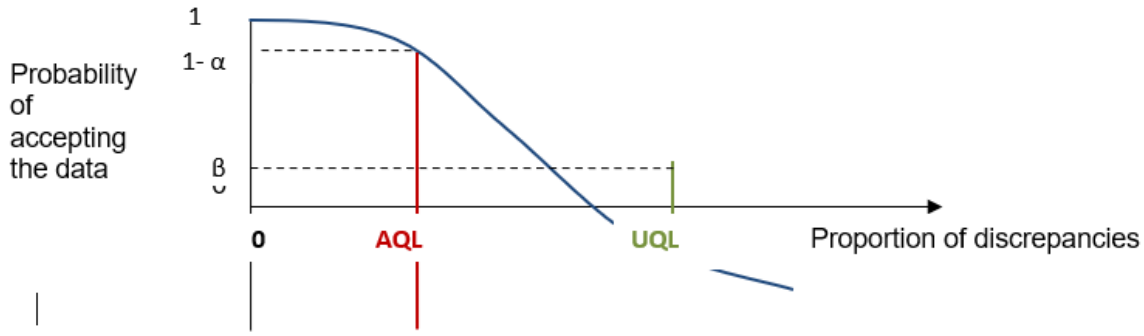
11. The operating characteristic curve in Figure 1 below shows the probability that the activity participants' sampled records will be accepted for different proportions of discrepant records. The acceptance-sampling plan is designed to provide:

(a) A high probability of accepting records where the true proportion of discrepancies is at or below the AQL, namely a probability of at least (1- α); and

(b) A low probability of accepting records where the true proportion of discrepancies is at or above the UQL, namely a probability of no more than β.

12. In this example, the AQL is 0.01, the UQL is 0.10, and both α and β are 0.05.

Figure 1 Acceptance sampling operating characteristic curve



[1] The table is based on both the Producer's risk and the Consumer's risk being 5 per cent.

13. We need to find a sample size and acceptance number that satisfy (or nearly satisfy) these probability statements. Owing to the discreteness of the data it may not be possible to satisfy them exactly.

14. The approach is based on the Chi-square distribution with 2(c+1) degrees of freedom. It determines the acceptance number first and then the sample size.

2.2. Step 1: Acceptance number

$$\text{Let } r(c) = \frac{x^2_{1-\beta}}{x^2_{\alpha}}$$ Equation (1)

Where:

x^2_{α} = 100α percentile and $x^2_{1-\beta}$ the $100(1-\beta)$ percentile of the x^2 distribution with $2(c+1)$ degrees of freedom.

15. Then *c* is the smallest value satisfying:

$$r(c-1) > \frac{UQL}{AQL} > r(c)$$ Equation (2)

16. Here the ratio of $\frac{UQL}{AQL}$ is 10 and so we need to find a value of *c* that satisfies the above.

17. Since acceptance numbers are going to be small we can construct a table of Chi-square values and the corresponding ratios for different values of c from c = 0, 1, 2, 3, etc. as shown in Table 2.

Table 2 Chi-square values and the corresponding ratios for different values of c

Tabulated values of a Chi-square distribution with 2(c+1) degrees of freedom where α=0.05 and β=0.05			
c	**A**	**1-β**	**ratio**
0	0.1026	5.9915	58.40
1	0.7107	9.4877	13.35
2	1.6354	12.5916	7.70
3	2.7326	15.5073	5.67
4	3.9403	18.3070	4.65
5	5.2260	21.0261	4.02

18. *c* = 2 is the smallest value which satisfies the above.

2.3. Step 2: Sample size

19. The required sample size, *n*, is such that:

$$\frac{x^2_{1-\beta}}{2 \times UQL} \leq n \leq \frac{x^2_{\alpha}}{2 \times AQL}$$ Equation (3)

Where:

x_{α}^{2} and $x_{1-\beta}^{2}$ = are defined as before, but now $c = 2$, and the distribution has $2(c + 1 = 6)$ degrees of freedom

20. With c = 2 this is:

$$\frac{12.59159}{2 \times 0.1} \leq n \leq \frac{1.635383}{2 \times 0.01} \qquad \text{Equation (4)}$$

$$i.e\ 62.96 \leq n \leq 81.77$$

21. So we have a sample size of 63 and an acceptance number of 2.

2.4. Step 3: Refining the calculation

22. The above steps used a Chi-square approximation, but the data actually have a binomial distribution. The calculations can now be refined to see if the value of n could be modified. Table 3 shows the exact values of α and β, for an acceptance number of 2, and different sample sizes around 63. While the above calculation showed that we needed a sample size of 63, Table 3 shows that sample sizes of 62 and 61 would both also have α and β below 0.05.

23. The required sample size is therefore 61 with an acceptance number of 2.

Table 3 Different sample sizes with values of α and β for an acceptance number of 2

Acceptance number (c)	Sample size (n)	Exact probabilities based on Binomial distribution	
		alpha	beta
2	60	0.022	0.053
2	61	0.023	0.049
2	62	0.024	0.045
2	63	0.025	0.042
2	64	0.027	0.039

2.5. Microsoft Excel functions

24. The calculations may be undertaken using appropriate statistical software. In current versions of Microsoft Excel, for Table 2, the relevant functions used is `CHISQ.INV.RT(probability, degrees_freedom)` and for Table 3 I `BINOM.DIST(number_s, trials, probability_s, cumulative), where PROB is either the AQL or the UQL.

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