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English Version

**Characterization of waste - Sampling of waste materials - Part 1:
Guidance on selection and application of criteria for sampling
under various conditions**

Caractérisation des déchets - Prélèvement des déchets -
Partie 1 : Guide relatif au choix et à l'application des
critères d'échantillonnage dans diverses conditions

Charakterisierung von Abfall - Probenahme - Teil 1:
Richtlinien zur Auswahl und Anwendung von Kriterien für
die Probenahme unter verschiedenen Bedingungen

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Foreword

This Technical Report (CEN/TR 15310-1:2006) has been prepared by Technical Committee CEN/TC 292 "Characterization of waste", the secretariat of which is held by NEN.

This Technical Report has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

This Technical Report is one of a series of five Technical Reports dealing with sampling techniques and procedures, and provides essential information and instructions for the application of the EN-standard:

EN 14899 Characterisation of Waste - Sampling of waste materials - Framework for the preparation and application of a Sampling Plan

The principal component of the EN Standard is the mandatory requirement to prepare a Sampling Plan. This EN 14899 standard can be used to:

- produce standardised sampling plans for use in regular or routine circumstances (i.e. the elaboration of daughter/derived standards dedicated to well defined sampling scenarios);
- incorporate specific sampling requirements into national legislation;
- design and develop a Sampling Plan on a case by case basis.

The Technical Reports display a range of potential approaches and tools to enable the project manager to tailor his sampling plan to a specific testing scenario (i.e. a 'shop shelf' approach to sampling plan development for waste testing). This approach allows flexibility in the selection of the sampling approach, sampling point, method of sampling and equipment used.

This Technical Report describes the statistical principles related to sampling, and provides methods based on these principles enabling a testing programme to be defined that will produce results sufficiently reliable for the decision-making process for which they are required.

Wastes arise in a wide variety of types (e.g. pastes, liquids, granular materials, mixes of different materials) and sampling situations (e.g. during a waste production process, stockpiles, tanks, drums). There can also be a variety of sampling objectives within each of the three broad categories (basic characterisation, compliance testing and on-site verification). Consequently the Report cannot provide definitive instructions for each and every case on the practical details of the testing programme, such as the required number of samples, the size of these samples, and whether they should be spot or composite samples. Instead, its aim is to expose the factors that influence the choice of these detailed components of the sampling exercise, and to provide statistical tools that can then be applied to determine the most appropriate testing programme for any given sampling scenario.

Introduction

Wastes are materials, which the holder discards, or intends or is required to discard, and which may be sent for final disposal, reuse or recovery. Such materials are generally heterogeneous and it will be necessary therefore to specify in the testing programme the amount of material for which the characteristics of interest need to be defined. The testing of wastes allows informed decisions to be made on how they should be treated (or not), recovered or disposed of. In order to undertake valid tests, some sampling of the waste is required.

The principal component of the standard EN 14899 is the mandatory requirement to prepare a Sampling Plan, within the framework of an overall testing programme as illustrated in Figure 1 of EN 14899:2005 and can be used to:

- produce standardised sampling plans for use in regular or routine circumstances (elaboration of daughter/derived standards dedicated to well defined sampling scenarios);
- incorporate the specific sampling requirements of European and national legislation;
- design and develop a Sampling Plan for use on a case by case basis.

The development of a Sampling Plan within this framework involves the progression through three steps or activities:

- 1) define the Sampling Plan;
- 2) take a field sample in accordance with the Sampling Plan;
- 3) transport the laboratory sample to the laboratory.

This Technical Report provides information to support Key Step 1 of the Sampling Plan process map and describes the selection of sampling approach that can be used in the recovery of a sample for a wide variety of waste types and arisings. Specifically this Technical Report provides information to support 4.2.7 (Select sampling approach) of the Framework Standard. Due consideration and selection of statistical criteria is of key importance in the production of a Sampling Plan as it provides the sole means of ensuring that, wherever possible, the type and number of samples taken will address a clearly identified objective and will provide results that achieve a tolerable level of reliability.

Table 1 - Main statistical steps in defining a sampling plan for a testing programme

Step	Subject
Specify the objective of the Testing Programme	
1	Specify the objective of the Testing Programme
Develop the Technical Goals from the objective	
2	Define the population to be sampled
3	Assess variability
4	Select the sampling approach
5	Identify the scale
6	Choose the required statistical approach
7	Choose the desired reliability
Determine the practical instructions	
8	Choose the sampling pattern
9	Determine the increment/ sample size
10	Determine the use of composite or individual samples
11	Determine required number of samples
Define the Sampling Plan	
12	Define the Sampling Plan

To illustrate the application of these principles, a series of 14 examples of sampling scenarios for a single waste stream are provided in Annex E.

This Technical Report should be read in conjunction with the Framework Standard for the preparation and application of a Sampling Plan as well as the other Technical Reports that contain essential information to support the Framework Standard. The full series comprises:

- EN 14899 Characterization of waste - Sampling of waste materials - Framework for the preparation and application of a Sampling Plan;
- CEN/TR 15310-1, Characterization of waste – Sampling of waste materials – Part 1: Guidance on selection and application of criteria for sampling under various conditions;
- CEN/TR 15310-2, Characterization of waste – Sampling of waste materials – Part 2: Guidance on sampling techniques;
- CEN/TR 15310-3, Characterization of waste – Sampling of waste materials – Part 3: Guidance on procedures for sub-sampling in the field;
- CEN/TR 15310-4, Characterization of waste – Sampling of waste materials – Part 4: Guidance on procedures for sample packaging, storage, preservation, transport and delivery;
- CEN/TR 15310-5, Characterization of waste – Sampling of waste materials – Part 5: Guidance on the process of defining the Sampling Plan.

The Technical Reports contain procedural options (as detailed in Figure 2 of EN 14899:2005) that can be selected to match the sampling requirements of any testing programme.

1 Scope

This Technical Report discusses the statistical principles of sampling, and provides a number of statistical tools to assist in the design of testing programmes for application to sampling under various conditions.

NOTE 1 Given the great variety of waste types, sampling situations and objectives, this Technical Report cannot provide definitive instructions that cover all scenarios. Instead, it discusses the basic statistical approach to be followed, and provides statistical tools that can be applied to determine the amount and type of sampling (e.g. number of samples and sample size) in any given situation to achieve results of adequate reliability (i.e. precision and confidence).

NOTE 2 The document provides considerable detail on current best practice, but is not exhaustive.

NOTE 3 To clarify the text, the document provides a number of worked examples.

2 Terms and definitions

For the purposes of this Technical Report, we have used or adapted the definitions of ISO 3534 Parts 1, 2 and 3 wherever possible. In a minority of cases, however, those definitions are couched in technical statistical language, which is likely to be unhelpful to the intended readership. In these instances we have either supplemented the formal definition with an additional note, or provided an alternative simpler definition.

NOTE In order to keep the list of definitions as compact as possible, some terms that are used only occasionally in the main text have been omitted. B.1 provides an additional list of definitions that are specifically relevant to the various annexes.

2.1

analytical error

collective term for the imprecision and bias associated with the analytical method

2.2

characteristic

property, which helps to identify or differentiate between items of a given population
[ISO 3534-1]

NOTE The characteristic may be either quantitative (by variables) or qualitative (by attributes).

2.3

coefficient of variation

for a non-negative characteristic the ratio of the standard deviation to the average
[ISO 3534-1]

2.4

compliance (and non-compliance)

compliance is achieved when the sample values from a monitoring programme meet a pre-defined set of criteria. Conversely, non-compliance occurs when the sample values fail to meet the pre-defined criteria

NOTE Examples of compliance criteria are:

- The estimated mean should be ≤ 20 mg/kg;
- Fewer than 3 sample values out of 20 should exceed 50 $\mu\text{g/l}$.