中欧碳市场政策对话与合作项目

师资培训强化培训（第二天）：采样与分析

16/09/2025

项目由欧盟资助

项目执行方：

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《监测与报告条例》中最需要采样的环节：计算因子。

示例：基于计算的燃料燃烧监测

$$Em = AD \cdot NCV \cdot EF \cdot OF \cdot (1 - BF)$$

式中：

Em ....排放量【吨二氧化碳】

AD.....活动水平数据（=燃料数量）【吨或标准立方米】

计算因子：

NCV..净热值【太焦/吨或太焦/标准立方米】

EF .....排放因子【吨二氧化碳/太焦，吨二氧化碳/吨或吨二氧化碳/标准立方米】

OF.....氧化因子【无量纲】

BF .....生物质比例【无量纲】

根据《监测与报告条例》第30条第1款规定，这些因子可通过以下方式之一确定：

a. 采用默认值；或
b. 通过实验室分析测定。

采用何种方式由适用的监测层级决定。

基于实际分析的欧盟碳排放交易体系（EU ETS）计算因子要求

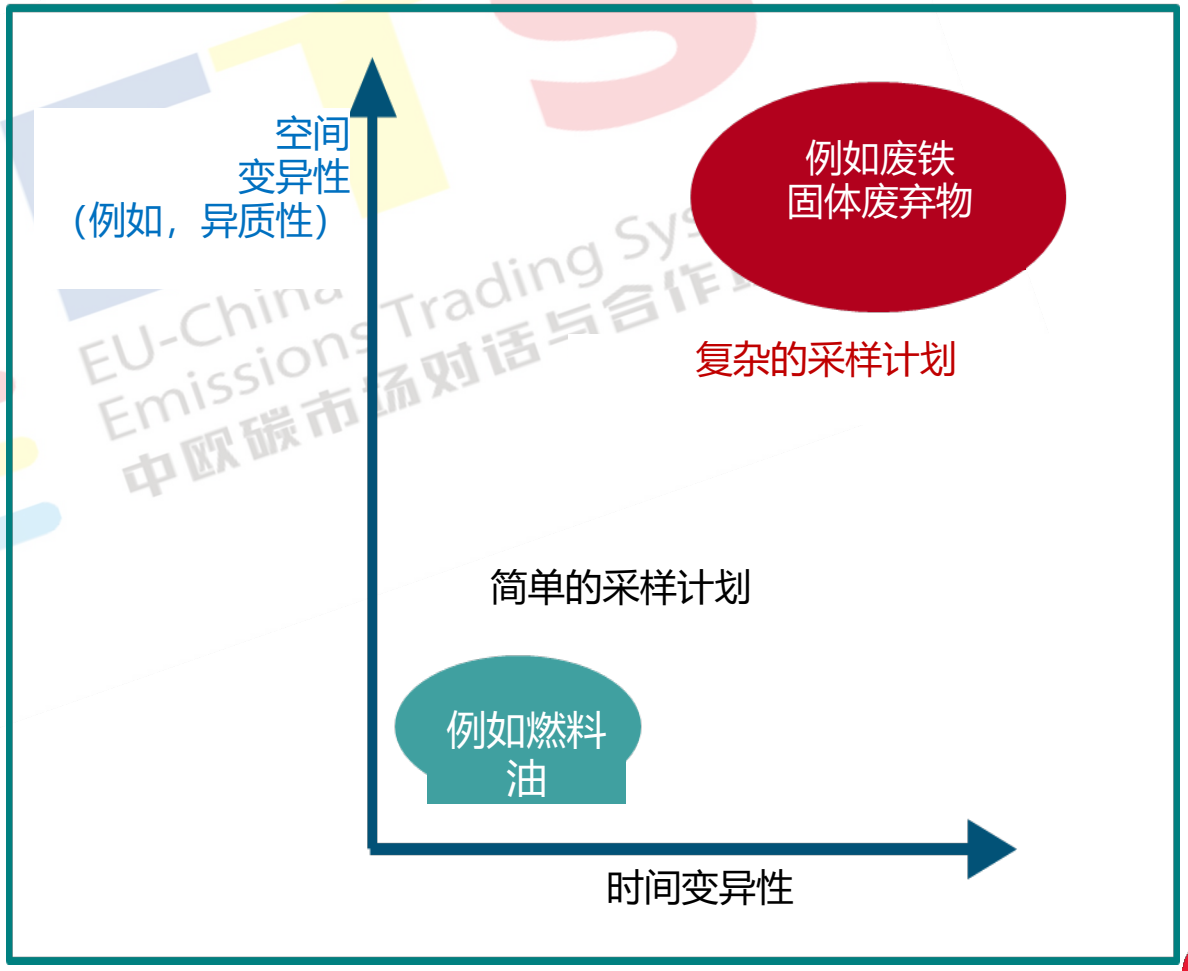
- 为确定计算因子而进行的分析、采样、校准和验证工作，必须按照以下标准层级体系适用欧洲标准（ENs）或其次最适用的标准：

  *【欧洲标准（**ENs**） > 国际标准（**ISOs**） > 国家标准 > 行业最佳实践指南或其他科学验证方法，需限制采样和测量偏差】*

- 用于测定气体燃料及材料成分的分析仪必须进行初始验证及年度验证。
- 任何分析结果仅适用于所采样及用于碳排放交易体系活动的特定燃料或材料的交付周期或批次。
- **必须使用所有分析方法，不得“挑选”最有利的结果。**

欧盟碳排放交易体系对采样（用于实际分析）的要求

- 《监测与报告条例》第33条明确规定，运营商需通过分析测定燃料或材料的计算因子的，必须就每种燃料或材料**向主管部门提交采样计划**并获批准。
- 采样必须能代表相应批次或交付周期间的真实情况，且确保无偏差。
- 设施运营方须为每种燃料或材料编制相应的**采样计划**，并**报请主管部门批准**。
- 每份**采样计划需明确规定**样品制备**方法**、责任主体、采样点位、频次、数量、存储及运输方式等具体信息。
- 采样计划的相关要素还需与**分析实验室**进行充分沟通并达成一致。
- 该采样计划同时需向**核查方**提供，以便其开展助核查工作。



采样计划的复杂性

- **采样计划的复杂性**在很大程度上取决于燃料或材料的异质性程度。
- **在许多情况下，现有用于其他目的（如质量控制或过程控制）的采样方案可直接适用，无需额外调整。**

欧盟碳排放交易体系对分析实验室及最低分析频次的要求

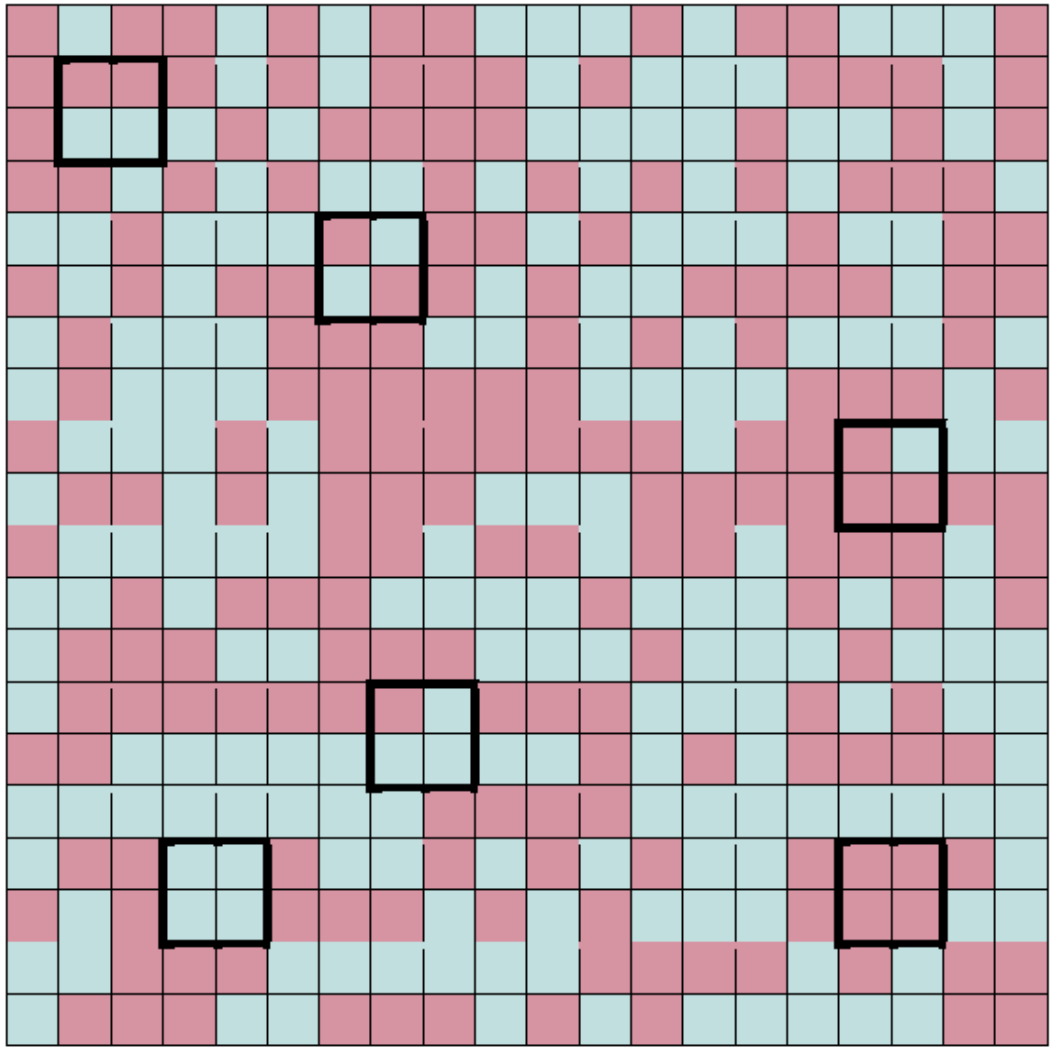
- 实验室必须通过 EN ISO/IEC 17025 认证，且其认证范围中需明确涵盖与确定相关计算因子有关的分析方法。
- 仅在运营商能提供下列必要证明材料的情况下，方可破例使用非认证实验室：
  - 使用认证实验室将导致产生不合理成本或在技术上不可行，同时该实验室满足EN ISO/IEC 17025等效要求，并能证明其质量管理体系与技术能力符合标准。
  - 或者作为替代方案，年排放量较低（低于25,000吨二氧化碳当量）的设施可使用任何技术能力达标的实验室，但须证明其质量保证体系具备等效性。
- 最低分析频次要求详见《欧盟碳排放交易体系监测与报告条例》，且须经主管部门批准。
- 实验室分析的相关要求实际上意味着要确保各实验室采用可比的检测标准，这可能会增加运营商的成本。

Example for a (relatively simple) sampling plan procedure

（较简单的）采样计划程序示例

依据第12条第2款所述项目	可能包含的内容（示例）
程序标题	废油采样计划
可追溯且可验证的程序标识参考	ETS 01-SP
负责实施程序的岗位或部门，以及负责相关数据管理的岗位或部门（如不同）。	设施实验室废弃物管理部门主管[11]
程序简要说明[12]	• 从每辆卡车的储罐中抽取容量为1000毫升的样本（每年约250辆卡车）。 • 负责人安排值班经理或其指定的代表，对采样过程实施监督（每周进行现场随机抽查）。 • 样本需密封在专用密封瓶内，瓶身清晰标注采样日期和具体时间、燃料供应商ID编号以及采样人员的姓名。 • 样本需统一存放于实验室的指定区域（LA-007房间），在室温条件下储存。 • 当累计收集满10个样本后，需立即将其充分混合使其均匀，制成“混合样本”。每季度约产生6个混合样本。 • 应按要求每季度一次，将制备好的混合样本送至监测计划中指定的认证实验室进行分析。
相关记录与信息存放位置	纸质文件：实验室储藏室27/9号架 标识为“ETS 01-SP”的文件夹。 电子文件：“P:\ETS MRVAnalyses\ETS 01-SP.xls“
所用计算机系统名称（如适用）	不适用（常规网络驱动器）
适用的欧洲标准（EN）或其他标准清单（如适用）	EN 14899

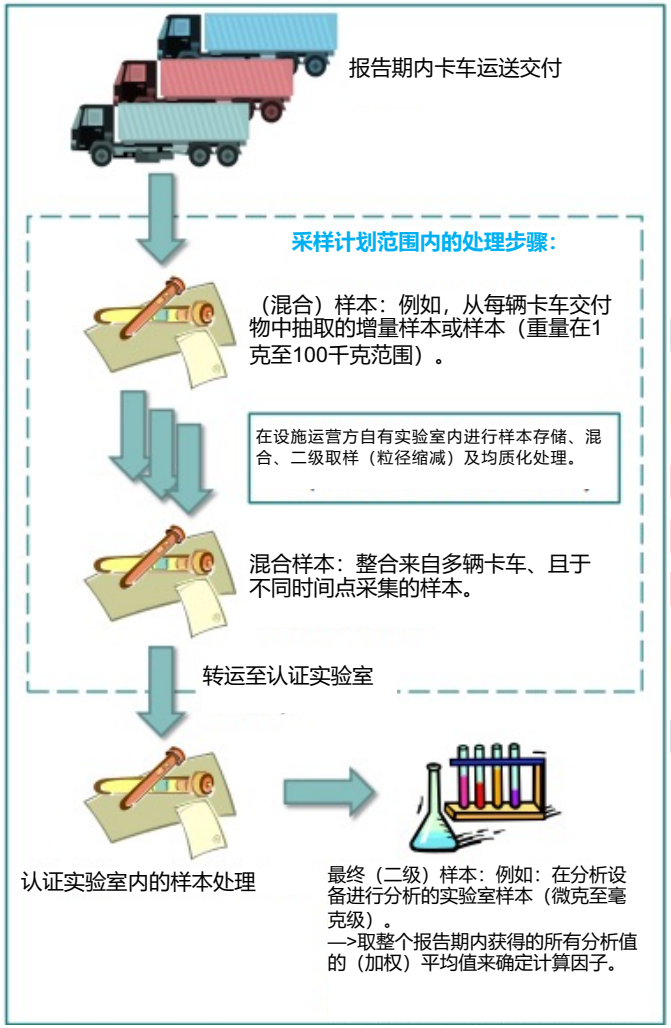
样品异质性示例：具有高度均匀粒径分布的随机双组分混合物



加粗框标识表示可选采样点位示例。

该图展示了一个由两种组分组成的物理混合物群体，这两种组分在某一目标材料特性上存在差异（以两种颜色表示），例如净热值（NCV）。研究的重点在于该群体各项属性的平均值。假设只能抽取尺寸为2x2的方框（即图中加粗框）的增量样本。此示例帮助我们理解：即便是相对简单的情况，也需要投入一定的精力来制定适当的采样计划，以确保通过分析能够获得具有代表性的结果。**虽然群体中绿色方框和红色方框的数量相同，但每个2×2增样样本可能包含不同数量的绿色和红色方框。**由于该问题，即实践中待测材料可能不会表现出肉眼可见的明显差异，因此采样计划的一项主要任务是确定获取足够代表性结果所需的增量样本数量（即，为分析提供均衡的绿色和红色方框比例）。

如何确保采样具有代表性：采样与分析流程表示例



- 采样通常需经过**连续多个步骤**：首先从大批堆料中选取增量样本，然后将其混合成新样本，再缩减样本粒径，并从中提取新（更小）样本，再重复混合并缩减粒径等，直至最终获得满足实验室分析要求的样本。
- **材料的异质性越强**，其颗粒料径就越大，则完成此流程所需投入的工作量就越大。
- 该图所示为一个流程图的示例，直观展示了采样在确定计算因子的过程中所起的作用。

“采样频率”与“分析频率”对比

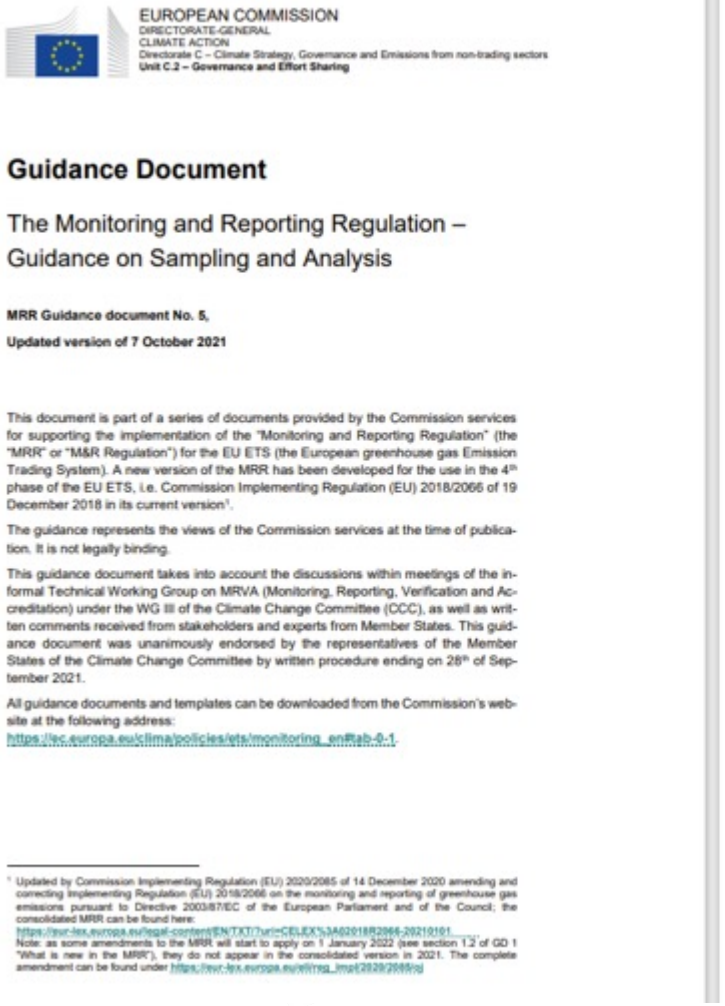
《监测与报告条例》（MRR）第35条中的“分析频率”需根据具体情境确定。经批准的监测计划中对运营商的关键要求可能为：特定源流排放因子的最低分析频次为每年四次。**“分析频次率”一词不可与“采样频次”混淆；后者指从燃料或物料的批次或交付中提取样本或增量样本的频率。**通常情况下，为了获得具有代表性的结果，全年实际采集的样本或增量样本数量通常远多于四次。

示例：某一体化钢厂每年煤炭消耗总量50万吨。根据《监测与报告条例》（MRR）附件七的要求，运营商至少需每20,000吨煤炭进行一次分析。据此推算，这意味着每年至少产生25份来自不同实验室的分析样本。采样计划（包括采样频次规定）的主要目标是：制备（至少）25份能代表每20,000吨批次特性的实验室样本。 为了确保最终获得的实验室样本具有充分代表性，**每20,000吨批准需采集的样本或增量样本数量应无不止一个。**

最低分析频次（《监测与报告条例》附件七）

燃料/物料	最低分析频次
天然气	至少每周一次
其他气体（尤其是合成气及各类工艺气体，例如炼厂混合气、焦炉煤气、高炉煤气、转炉煤气、油田气和气田气）	至少每日一次，需在一天中的不同时段采用适当程序。
燃料油（如，轻质、中质、重质燃料油、沥青）	每20,000吨，且每年至少进行六次分析。
煤炭、焦煤、焦炭、石油焦、泥炭	每20,000吨，且每年至少进行六次分析。
其他燃料	每10,000吨燃料，且每年至少进行四次分析。
未经处理的固体废弃物（纯化石或生物质/化石混合物）	每5,000吨，且每年至少进行四次分析。
液体废弃物、经预处理的固体废弃物	每10,000吨，且每年至少进行四次分析。 year
碳酸盐矿物（包括石灰石与白云石）	每50,000吨，且每年至少进行四次分析。
黏土与页岩	对应50,000吨二氧化碳排放量的物料，且每年至少进行四次分析。
其他物料（初级、中间及最终产品）	根据具体物料类型及其成分变化情况，需对产生50,000吨二氧化碳排放量的物料进行分析，且每年至少进行四次分析。

补充阅读



EUROPEAN COMMISSION
DIRECTORATE-GENERAL
CLIMATE ACTION
Directorate C – Climate Strategy, Governance and Emissions from non-trading sectors
Unit C.2 – Governance and Effort Sharing

Guidance Document

The Monitoring and Reporting Regulation – Guidance on Sampling and Analysis

MRR Guidance document No. 5,

Updated version of 7 October 2021

This document is part of a series of documents provided by the Commission services for supporting the implementation of the "Monitoring and Reporting Regulation" (the "MRR" or "M&R Regulation") for the EU ETS (the European greenhouse gas Emission Trading System). A new version of the MRR has been developed for the use in the 4th phase of the EU ETS, i.e. Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 in its current version[1].

The guidance represents the views of the Commission services at the time of publication. It is not legally binding.

This guidance document takes into account the discussions within meetings of the informal Technical Working Group on MRVA (Monitoring, Reporting, Verification and Accreditation) under the WG III of the Climate Change Committee (CCC), as well as written comments received from stakeholders and experts from Member States. This guidance document was unanimously endorsed by the representatives of the Member States of the Climate Change Committee by written procedure ending on 28th of September 2021.

All guidance documents and templates can be downloaded from the Commission's website at the following address:
https://ec.europa.eu/clima/policies/ets/monitoring_en#tab-0-1

[1] Updated by Commission Implementing Regulation (EU) 2020/2085 of 14 December 2020 amending and correcting Implementing Regulation (EU) 2018/2066 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council; the consolidated MRR can be found here:
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02018R2066-20210101
Note: as some amendments to the MRR will start to apply on 1 January 2022 (see section 1.2 of GD 1 "What is new in the MRR"), they do not appear in the consolidated version in 2021. The complete amendment can be found under https://eur-lex.europa.eu/eli/reg_impl/2020/2085/oj

TABLE OF CONTENTS

https://climate.ec.europa.eu/eu-action/carbon-markets/eu-emissions-trading-system-eu-ets/monitoring-reporting-and-verification_en

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指导文件

《监测与报告条例》采样与分析指南
采样计划示例

感谢您的关注！

如需进一步了解或有相关问题需要澄清，请联系：

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Fraunhofer ISI

SQ consult sustainable quality

adelphi

附件：抽样方案要素（1）

8 ANNEX II: EXAMPLE FOR A SAMPLING PLAN TEMPLATE

1. General information

Operator name:
Installation ID: *Fill in the installation ID (as used by your competent authority)*
Title of sampling plan:
Reference of procedure:

2. Responsibilities

Sampling plan completed by: *Fill in the name of the author of the sampling plan*
Post or department responsible for sampling: *Fill in the name of the post or department responsible for the actual sampling*
Post or department responsible for sampling data: *Fill in the name of the post or department that is responsible for the collection of sampling data*
Laboratory responsible for analysis: *Fill in the name of the laboratory that is responsible for analysis of the sample*
Other parties: *If applicable, fill in the names of other parties involved in sampling and describe their relevance*

3. Sampling objectives

Sampling objectives: *Describe the objective(s) of the sampling, e.g. determination of net calorific value, emission factor, oxidation factor*
Analysis required: *Describe what the laboratory is testing for, e.g. identify constituents to be tested.*

4. Specifications of source stream

Name of material or fuel: *Fill in the name of the source stream, as used in the monitoring plan*
Characteristics of the source stream: *Describe the relevant characteristics, such as its phase (gas, liquid or solid), if relevant common or maximum particle size of the fuel or material, density, viscosity, temperature, etc., if those properties are relevant for the sampling procedure*
Source and origin of the material or fuel: *Describe the source and origin of the source stream, e.g. is the source stream delivered continuously, in batches, produced on site, etc.?*
Heterogeneity of the fuel or material and causes of variability (spatial and in time): *Describe the heterogeneity of the fuel or material, both spatial and in time, and justify (e.g. origin of source stream, stability of manufacturing process).*

5. Sampling methodology

Sampling frequency: *Describe the sampling frequency (e.g. "every Monday morning", "every 3 hours", "once per truck load", "once every 200 tonnes", etc.)*
Relevant standards: *Describe the relevant standards for the sampling methodology*
Define place and point of sampling:

Specify the place (e.g. the stockpile) and point of sampling (e.g. after delivery or after completion of a deposit). Please note that the sample should be as representative as possible
Equipment used for sampling: *Describe the equipment used for sampling*
Sampling approach: *Describe how the sample is taken, e.g. by probabilistic or judgmental approach*
Sampling pattern: *Define how the sample is taken, e.g. in the case of random sampling describe how inaccessible parts of the population are dealt with; define how a probabilistic approach is implemented, and/or how decisions are made for a judgmental approach*
Sample composition: *Describe whether each increment (amount of material obtained through one single sample action) is analysed individually, or combined with other increments to form a composite sample*
Number of increments to be collected: *Describe the number of increments that make up a sample*
Increment and sample size: *Describe the size of one increment (the amount of material that is obtained through one single sampling action). The increment size should accommodate all particle sizes present. Describe the minimum sample size. The minimum sample size must take into account the level of heterogeneity of individual particles, to ensure representativeness of the sample.*
Sample reduction or sub sampling (if applicable): *If the overall sample is too large for transport to a laboratory, a sub-sample should be prepared in such a way that the integrity of the sample is protected. If relevant, describe this procedure and justify the representativeness of the final sample*
Justification of representativeness: *Give a justification that the chosen approach leads to a representative sample. Take into account the source stream information and characteristics of the population (i.e. the amount of fuel or material represented by the sample)*

附件：抽样方案要素（2）

Access, health and safety: *Identify access problems or restrictions that may affect the sampling programme. Identify health and safety precautions*

6. Procedures for packaging, preservation, storage and transport

Packaging: *Briefly describe the size, shape and material of the containers used, taking into account the risk of adsorption/absorption/reaction*
Sample coding methodology: *Describe how samples are coded. All sample containers should be marked with a unique identifier that is recognized by sampler and laboratory*
Preservation: *Justify how samples are packed and transported in such a way that the conditions at the time of sampling are preserved*
Storage: *Describe how the sample is stored on site and in the laboratory*
Transport: *Describe relevant conditions during storage. Describe or refer to a chain of custody form that should be completed and sent with each sample*
Data storage system: *Briefly describe the location and functioning of the data storage system and the information it contains, such as sample date, sample code, stockpile reference number, product type, specific location, size, etc.*

7. Analytical laboratory

Company: *Fill in the name of the laboratory responsible for analyses of the sample*
EN ISO/IEC 17025 Accreditation: *Justify to what extent the scope of accreditation of the laboratory covers analysis of samples described in this sampling plan. If the laboratory is not accredited, please refer to the provided evidence that it meets the relevant criteria of Article 34(3)*
Contact details: *Fill in contact details of the analytical laboratory*
Analyses carried out: *Describe the properties to be analysed (e.g. net calorific value, emission factor, oxidation factor, carbon content)*
Standards used: *Describe the relevant standards used for each parameter analysed*

8. Signatures

Operator and laboratory have agreed on the content of this sampling plan; in case of evidence that the described heterogeneity of the source stream differs significantly from the information described above, the sampling plan will be updated and notified to the competent authority

	Name	Signature	Date
Operator			
Analytical laboratory			