Renewables Obligation: Fuel Measurement and Sampling Guidance

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Overview:

This document provides generators burning biomass fuels with guidance on how to meet the fuel measurement and sampling requirements of the Renewables Obligation. It details the requirements of the legislation, what we expect from generators, and suggestions on how generators can best satisfy these requirements. It is not intended to be a definitive legal guide.

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Target Audience: This document will be of most interest to generators burning biomass and/or waste, trade associations and fuel suppliers.

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Office of Gas and Electricity Markets
Promoting choice and value for all gas and electricity customers

Context

The Government's aim is that renewable energy will make an increasing contribution to energy supplies in the UK, with renewable energy playing a key role in the wider climate change programme.

The Renewables Obligation, the Renewables Obligation (Scotland) and the Northern Ireland Renewables Obligation are designed to incentivise renewable generation into the electricity generation market. These schemes were introduced by the Department of Trade and Industry, the Scottish Executive and the Department of Enterprise, Trade and Investment respectively and are administered by the Gas and Electricity Markets Authority (whose day to day functions are performed by Ofgem). The schemes are provided for in secondary legislation.

The Renewables Obligation Order came into effect in April 2002, as did the Renewables Obligation (Scotland). The Northern Ireland Renewables Obligation Order came into effect in April 2005. These Orders were subject to review in 2005/06 and new Orders are due to come into effect in April 2006 covering England and Wales, Scotland, and Northern Ireland respectively.

The Orders place an obligation on licensed electricity suppliers in England and Wales, Scotland, and Northern Ireland respectively to source an increasing proportion of electricity from renewable sources. In 2006/07 it is 6.7 per cent (2.6 per cent in Northern Ireland). Suppliers meet their obligations by presenting sufficient Renewables Obligation Certificates ("ROCs") to cover their obligations. Where suppliers do not have sufficient ROCs to meet their obligation, they must pay an equivalent amount into a fund, the proceeds of which are paid back on a pro-rated basis to those suppliers that have presented ROCs.

Accredited generators are issued ROCs (which they can then sell on to suppliers) for each MWh of eligible electricity generated each month. In order to be issued ROCs accredited generators must meet certain criteria, detailed in the Orders. This guidance explains how generators burning biomass can meet the requirements of the legislation.

Associated documents

Readers should be aware of the following documents which support this publication. These documents are available on our website at www.ofgem.gov.uk.

- Renewables Obligation : guidance for generators over 50kW
- Renewables Obligation : guidance for generators under 50kW
- Application forms for accreditation and preliminary accreditation (including guidance)
- Monthly data template and instructions

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Foreword

I am delighted to introduce the first version of Ofgem's Fuel Measurement and Sampling Guidance in relation to biomass fuels within the Renewables Obligation (RO).

Biomass is one of the most complex parts of the RO and the guidance aims to clarify how to meet the requirements of the RO for generators burning biomass, co-firing and waste fuels. It is intended to be a living document which is updated and developed over time.

The DTI has worked closely with Ofgem on the development of this guidance and I know that the Ofgem team has put a lot of time and effort into it. The document also reflects real input from industry through our Biomass Working Group. I am extremely grateful for all the hard work and contributions that have gone into its production. I believe it will make a real difference to companies active in this area.

It is important to understand that much of the detail of the guidance flows from the requirements of the legislation for which DTI has policy responsibility. Ofgem's role is to administer the RO consistently with those requirements. DTI and Ofgem will continue to work together closely in these areas. Our joint aim is an approach to biomass fuels within the RO which is transparent and clear and strikes the right balance between rigour and practicality. I believe this guidance represents a major step forward in this regard and encourage you to use it as much as possible.

Kristian Armstrong
Director, Renewables Policy and Deployment
DTI

1. Introduction

Chapter Summary

This Chapter explains why we have produced this guidance and our approach to fuel measurement and sampling.

1.1. This guidance explains the fuel measurement and sampling (FMS) requirements for biomass, co-fired and waste generating stations under the Renewables Obligation (RO). It covers all aspects of the RO that are unique to those generating stations. It does not cover, except in passing, aspects of the RO that relate to other types of generating stations. These are set out in the generator guidance (see associated documents).

1.2. This guidance applies to England & Wales, Scotland and Northern Ireland. Where used in this document, the term "RO" refers to the Renewables Obligation, the Renewables Obligation (Scotland) and the Northern Ireland Renewables Obligation. Similarly, the term "the Orders" is used to describe The Renewables Obligation Order 2006, The Renewables Obligation Order (Scotland) 2006 and The Renewables Obligation Order (Northern Ireland) 2006. The term "ROCs" refers to Renewable Obligation Certificates (ROCs), Scottish Renewables Obligation Certificates (SROCs) and Northern Ireland Renewable Obligation Certificates (NIROCs).

1.3. The onus is on generators to meet the requirements of the legislation. We will work with them, where we can, to help them achieve this. Some areas of the legislation are prescriptive, others give us limited discretion. Where the legislation is prescriptive, this guidance will help generators understand what we require. Where the legislation gives us discretion, the document gives guidance as to how we will exercise that discretion. It also explains what we need, practically, from generators, to enable them to meet these requirements.

1.4. This document sets out examples of best practice and accepted measurement techniques. It is important to appreciate that there is often more than one way for a generator to meet the requirements in the legislation. The examples set out in this document are not the only ways of doing so.

1.5. When proposing how it will measure and sample biomass, a generator can either follow such an example or propose a new method. Proposals should include an explanation of how the proposed measurement and sampling techniques will result in accurate and reliable information. We will assess all FMS procedures in the same way and against the same criteria, although new methods may take longer for us to assess than established methods.

1.6. This guidance draws on our experience of administering the RO. We have not been able to do this to the same extent for some of the newer aspects, such as off-site measurement, waste and energy crops. We plan to keep this guidance under review and to update it when we have further experience in these areas. We also plan to do further work on some aspects of the guidance. For example, we intend to review circumstances under which we would accept reduced sampling. We may also need to update the guidance to reflect changes to the legislation, the introduction of new fuels, the development of best practice and to incorporate feedback from industry.

Our approach

Open and consistent

1.7. We have already taken several steps to increase the openness of our decisions and our decision-making processes. We will continue to be transparent in these areas, and others, where we can. Four examples of changes that we have made or are in the process of making are listed below.

1. Publication of this guidance. All stations will have access to examples of good practice at other stations.

2. A standard set of questions to approve FMS procedures (see Appendix 5). In this way we can assess all procedures on the same basis.

3. Consulting with stakeholders on important decisions. For example, through the Biomass Working Group. This will make clear how we are making decisions and will provide those affected with an opportunity to have an input.

4. Developing standard templates for fuel specific calculations. We aim to pilot two fuel-specific templates in summer 2006. Should they receive a positive response, more templates will be introduced.

1.8. Circumstances and requirements may change over time. If our requirements change, we will explain the changes and give generators enough notice to adapt their procedures. If the legislation changes, we will do our best to inform generators what the changes are and the impact they might have. It should be appreciated, however, that the onus is on generators to ensure that they are complying with the legislation. If they are in any doubt they should seek independent legal advice.

Practical but rigorous

1.9. We cannot issue ROCs unless we are satisfied that the measurement and sampling conducted at a generating station has provided accurate and reliable data on the energy content of the biomass used. We accept that it is not possible to reach an absolute level of accuracy. Measurement equipment and the sampling process will always have an in-built level of uncertainty. However, it is important to be as accurate as practically possible. Where measurement is difficult, we will be receptive to solutions presented to us and, where we can, we will provide advice. If, however, after exploring the issue fully with the generator, a solution cannot be found, our only option will be to refuse to issue ROCs.

2. Eligibility

Chapter Summary

This Chapter details the requirements for fuel to be eligible under the RO and the circumstances in which the burning of such a fuel qualifies for ROCs. In particular it contains a section on energy crops.

The definition of biomass

2.1. To claim ROCs for electricity generated from biomass, the biomass used in a generating station must meet the definition in the Orders. The definition relates to each fuel that is used in the generating station. To be biomass, fuel has to have an energy content of at least 90 per cent that is derived directly or indirectly from plant or animal matter. This means that, for a generating station to be eligible for ROCs, each of the biomass fuel streams fuelling the station must meet the biomass definition. If any of the biomass fuel streams does not, then the station will not be eligible as a biomass or a co-firing station. Generators should contact us for advice if they are unclear about what constitutes a fuel.

2.2. Where a fuel is a fraction of a mixture of wastes that, taken as a whole, is itself biomass (i.e. at least 90% of its energy content is derived directly or indirectly from plant or animal matter) then that fuel is classed as biomass.

2.3. In general, waste is not eligible under the RO unless it qualifies as biomass (as described above) or unless specific criteria are met. These criteria are set out in the legislation and described later in this Chapter.

The definition of fossil fuel

Fossil fuel is dealt with in two contexts under the Orders.

1. Classifying a station, for example as biomass or co-fired

2. Issuing of ROCs

Classifying a station

2.4. A generator will be a biomass station if it is fuelled wholly by biomass, or a co-fired station if it is fuelled partly by biomass and partly by ‘fossil fuel’. In considering if a station is fuelled partly by fossil fuel, the definition of fossil fuel as set out in Article 8 (1)(a) must be used. This states that fossil fuel means coal, lignite, natural gas and crude liquid petroleum and anything derived directly or indirectly from any of these substances, that has been created for the purpose of being used as a fuel. Accordingly fossil fuel, for the purposes of classifying a station as either biomass or co-fired, does not include fossil fuel contaminants of biomass fuels, for example, plastic contamination in biomass.

Issuing of ROCs

2.5. There is a different definition of ‘fossil fuel’ set out in Article 9 which is to be used when calculating how many ROCs should be issued. Under Article 9, fossil fuel means coal, lignite, natural gas and crude liquid petroleum and anything derived directly or indirectly from any of these substances. Unlike Article 8, it includes all substances irrespective or whether or not they were created for the purpose of being used as a fuel. This means it does include fossil fuel contaminants of biomass fuels.

Co-firing

2.6. Co-firing is the term used to describe a generating station fuelled partly by biomass and partly by fossil fuel. Output from such stations may be eligible for ROCs under the RO. For ease of reference, such ROCs are, in the main, referred to as "co-fired ROCs" in this document. ROCs issued in respect of biomass eligibility are referred to as "biomass ROCs".

Co-firing Limits

2.7. From 1 April 2009, for the output from a co-fired station in any month to be eligible for ROCs, a specified percentage of the biomass used in a co-fired generating station must be from energy crops. The minimum percentages, by energy content, of energy crops co-fired in order to be eligible under the RO increase incrementally between 2009 and 2016. These percentages are:

1 April 2009 – 31 March 2010: 25%
1 April 2010 – 31 March 2011: 50%
1 April 2011 – 31 March 2016: 75%

2.8. From 1 April 2016 co-firing will no longer be eligible under the RO.

2.9. In meeting its renewables obligation, there is a limit to the number of co-fired ROCs a supplier may present. For obligation periods between 1 April 2006 and 31 March 2011, no more than 10% of a supplier's total obligation for the particular obligation period can be satisfied by the production of co-fired ROCs and between 1 April 2011 and 31 March 2016, the figure is no more than 5%.

Is a station 'biomass' or 'co-fired'?

2.10. We accredit a generating station as being capable of generating electricity from eligible renewable sources on the basis of information provided in the application form for accreditation. If the information provided shows that the station can meet the conditions regarding biomass eligibility then the generating station will be accredited as a biomass station. Similarly, if the information shows that the station can meet the conditions for co-fired eligibility, the generating station will be accredited as a co-fired station. If they expect to meet the conditions for eligibility for co-fired ROCs in some months and biomass ROCs in other months generators should apply to be accredited as both biomass and co-fired.

2.11. Generators converting to biomass that were previously co-fired, or visa versa, should inform us of their plans in advance of their conversion. This information should include changes at the station enabling them to meet the conditions for claiming biomass ROCs or co-fired ROCs.

2.12. To be issued biomass ROCs in any month, the station must ensure that both:

- each biomass fuel burned meets the biomass definition in the Orders; and
- any fossil fuel or waste burned meets Article 8(3) in the Orders (see below);

and at least one of the following criteria must be met:

- the station was first commissioned on or after 1 January 1990; or
- the station was first commissioned before 1 January 1990 and has renewed its main components (including all boilers and turbines); or
- the station meets the requirements of Article 5(4), (see below).

2.13. To be issued co-fired ROCs in any month, the station must ensure that both:

- each biomass fuel burned meets the biomass definition in the Orders; and
- fossil fuel and/or waste is burned (which does not meet Article 8(3)) (see below).

2.14. 'Co-fired' (biomass and fossil fuel) and 'biomass only' generators that are using waste are only eligible for co-fired or biomass ROCs if the waste used meets one of the following criteria - biomass waste meets the biomass definition, the waste used is a liquid waste comprised wholly or mainly of hydrocarbon compounds such as Recycled Fuel Oil (RFO) or that the waste is only used for Article 8(3) purposes.

Article 8(3) purposes

2.15. Article 8(3) allows fossil fuel or waste used for certain purposes not to be considered as fuel used to generate electricity. In addition, fuel used for Article 8(3) purposes has to account for less than ten per cent of the total energy content of fuel used in the generating station. ROCs are issued on the basis of electricity that is generated. As a result Article 8(3) can have the effect of allowing a station which uses fossil fuel or waste, or both, to be classified as a biomass station.

2.16. The purposes that fuel can be used for to come within Article 8(3) are:

- the ignition of gases of low or variable calorific value;
- the heating of the combustion system to its normal operating temperature or the maintenance of the temperature;
- emission control; or

- standby generation or the testing of standby generation.

2.17. For fuel not to be considered as generating electricity, it also has to amount to less than ten per cent of the total energy content of fuel used in the generating station.

2.18. Where fossil fuel or waste used in the station is used only for Article 8(3) purposes and does not exceed the ten per cent limit the station will be eligible for biomass ROCs.

Conversion to biomass only - stations commissioned before 1 January 1990

2.19. Under Article 5(3)[1] of the Orders, a station commissioned before 1 January 1990 which is partly fuelled by fossil fuel and partly by biomass (co-fired) may be issued ROCs even if it has not renewed its main components. Main components are defined in Article 5(5)[2].

2.20. Article 5(4)[3] concerns stations commissioned before 1 January 1990 (which have not renewed their main component parts) wishing to convert to be fuelled wholly by biomass.

2.21. These stations (referred to in Article 5(4)) are eligible provided that:

- prior to 1 April 2003 at least 75% of the energy content of the fuel by which they were fuelled was derived from fossil fuel; and
- during no month (after March 2004) after the first month during which they were fuelled wholly by biomass has the energy content of the fuel by which they were fuelled been derived as to more than 75% from the fossil fuel.

2.22. We know from our records that all stations that might want to convert to wholly biomass and claim biomass ROCs meet the requirement that, prior to 1 April 2003, at least 75% of the energy content of the fuel by which they were fuelled was derived from fossil fuel.

2.23. The following table sets out an example of the application of this provision. In this example, the generator concerned was fuelled mainly by fossil fuel prior to April 2003 and had not renewed its main component parts.

[1] Article 5(4) to the Northern Ireland Order
[2] Article 5(6) to the Northern Ireland Order
[3] Article 5(5) to the Northern Ireland Order

Table 1: Conversion to biomass only

Month of generation	**Proportion of energy content from biomass**	**Eligibility**	**ROCs issued?**
April 2006	100%	The generating station is wholly fuelled by biomass and so is eligible under Article 5(4) during this month. Monitoring of the Article 5(4) requirements starts from this month[4].	Yes - Biomass
May 2006	50% (and 50% by fossil fuel)	The generating station is fuelled partly by fossil fuel and partly by biomass. The generating station is eligible under Article 5(3) during this month. As fossil fuel use is below 75%, it continues to meet the requirements of Article 5(4) during this month.	Yes - Co-fired
June 2006	100%	The generating station is wholly fuelled by biomass during this month. In addition, fossil fuel use (by energy content) has been less than 75% in each month since the first month in which it was wholly fuelled by biomass ie it meets the requirements of Article 5(4). The generating station is therefore eligible under Article 5(4) during this month.	Yes - Biomass
July 2006	20% (and 80% by fossil fuel)	Fossil fuel use by energy content exceeds 75% during this month. The generating station no longer meets the requirements of Article 5(4) and therefore cannot (in any month where it is fuelled wholly by biomass) be eligible (for biomass ROCs) again under Article 5(4). To be eligible for biomass ROCs again, it will have to renew its main components. The station is still eligible under Article 5(3) and can be issued co-fired ROCs.	Yes - Co-fired
August 2006	100%	The generating station is wholly fuelled by biomass during this month. However, as fossil fuel use (by energy content) has exceeded 75% in a month (in this case during July) since the first month in which it was wholly fuelled by biomass it no longer meets the requirements of Article 5(4). This station, for this particular period, is therefore not eligible for ROCs.	No – not eligible for co-fired or biomass
September 2006	50% (and 50% fossil fuel)	The generating station is fuelled partly by fossil fuel and partly by biomass and so it is eligible under Article 5(3) during this month.	Yes Co-fired

[4] This relates to the second bullet in paragraph 2.21 only.

Energy Crops

Introduction

2.24. From 2009 onward, a specified percentage of biomass used in a co-fired generating station must be from energy crops. The policy intention behind this is to create a sustainable market for energy crops. We will be rigorous in the application of the legislation in relation to energy crops.

Definition

2.25. Where an energy crop meets the definition of biomass it will be an eligible fuel under the RO.

2.26. Article 2(1) to the Orders describes an 'energy crop' as "a plant crop planted after 31 December 1989 and grown primarily for the purpose of being used as fuel".

2.27. Examples of energy crops include miscanthus[5] and short-rotation coppice willow.

Interpretation

2.28. The first part of the definition is relatively straightforward. To meet the requirements of the Orders an energy crop must be a plant crop planted after 31 December 1989.

2.29. The second part states that it must also be grown primarily for the purpose of being used as fuel. This means that the main intended purpose, at (or, in exceptional circumstances, very shortly after) the time of planting, for the crop must be for use as fuel. 'Fuel' can mean fuel used to generate electricity, transport fuel or fuel used to generate heat.

2.30. For crops planted shortly after 1989, where an explicit contract may not have been signed at the time of planting, other evidence should be provided that the crop has been primarily grown for the purposes of being used as fuel. Contractual evidence is not the only means by which a generator can demonstrate that a crop is an energy crop. Any form of evidence submitted by a generator will be considered. If, however, sufficient evidence is not provided, a fuel will not be considered to be an energy crop and as such the number of ROCs issued to a station may be affected.

2.31. Should a crop, at the time of planting, be being grown for a number of purposes (including for use as fuel) then the term 'grown primarily for the purpose...' means that the main purpose of the crop must be for use as fuel. In coming to a view on whether the main purpose for which a crop was planted was for use as fuel, we will consider the proportion of the crop that is to be used as fuel. When looking at the various proportions of a particular crop we will consider criteria such as energy content, financial value, weight, volume, and acreage. Crops will be considered on a case by case basis and it will be for the generator concerned to provide the necessary evidence to support its case.

[5] A perennial grass

2.32. The crop burned at the generating station must be the same physical crop as that referred to in the contract for it to qualify as an energy crop.

2.33. Energy crops grown overseas are eligible provided they meet the criteria set out in this guidance.

2.34. Article 7(4) is specific in detailing the minimum percentage of the energy content of the biomass derived from energy crops that must be co-fired each month in order to be eligible under the RO (see paragraph 2.7). These percentages are set out in the legislation and we have no discretion. This means that the minimum percentage must be met each month for ROCs to be issued. It will be up to the generator to provide evidence that the minimum percentage, by energy content, has been met.

2.35. To ensure that the minimum percentage has been met, generators will be required to submit FMS data for each of their fuel streams.

Evidence

2.36. The generator has the responsibility to provide us with sufficient evidence that the fuel that it is using is an energy crop, as defined under the Orders, in order that ROCs can be issued. However, we can provide generators with an indication of the sort of evidence that would be required in order to satisfy us.

2.37. One main piece of evidence that we will generally require will be contractual, although this is by no means the only evidence that could be presented. We do not wish to be prescriptive about the content of the contracts. However, there are a number of areas that we will consider. Generators will be asked to provide contractual evidence (or alternative evidence where contracts are unavailable) that there was a contract with an energy crops grower, completed at the time of planting, for the fuel that they are now burning. It should be clear from the contract that the crop was being grown for the purpose of being used as a fuel and, in the case of a multi-purpose crop, that the primary purpose for which the crop was being grown was for use as a fuel. Contracts should detail what is being grown. It would be helpful if both the common and latin names of the crop could be specified to limit the risk of ambiguity. The duration of the contract will also be relevant. Contracts in respect of energy crops grown overseas should be translated into English (where the original is in another language).

2.38. If the generator has a contract with a fuel processor (eg in the production of bioethanol) then, in addition to the contract between the processor and the generator, we will also require access to the contracts between the energy crops grower and the processor. Similarly if a generator has a contract with a bulk supplier of energy crops then we will require access to all the contracts between the growers and the bulk supplier.

2.39. Although contractual evidence is stated as the main method by which generators can satisfy us, other methods are not excluded. Should a generator have other evidence to prove that a crop was an energy crop, we would assess this against the requirements of the legislation, on a case by case basis.

2.40. The are a number of agricultural schemes already in operation that have similar requirements to the RO in relation to the provision of evidence that the crop is an energy crop to be used primarily for fuel. We believe that, if a crop satisfies these requirements, it is highly likely to satisfy the requirements of the RO. The two main schemes are the Energy Aid Payments Scheme (in the EU) and the Energy Crops Scheme (England only). We would, however, require copies of contracts relevant to those schemes in the same way as we would require copies of contracts from generators/growers not participating in those schemes.

2.41. Inclusion in either of these schemes is not a prerequisite for a crop to qualify as an energy crop under the RO. However we consider that crops that meet the requirements of these schemes are likely to meet the definition of energy crops under the RO.

Comfort Letters

2.42. We are aware that generators may wish to enter into contracts with growers a number of years before the crop is mature enough for harvesting and burning. This potentially creates uncertainty for the generator as to whether Ofgem will consider the crop an energy crop at the time of burning. In order to address this we are prepared (upon receipt of satisfactory contractual evidence) to provide generators with non-binding comfort letters.

Waste

Definition

2.43. Waste is defined in Article 2(1)[6] of the Orders. This refers to section 75(2) of the Environmental Protection Act 1990 (b) definition of waste which describes waste as including:

- any substance which constitutes a scrap material or an effluent or other unwanted surplus substance arising from the application of any process; and
- any substance or article which requires to be disposed of as being broken, worn out, contaminated or otherwise spoiled;
- Waste does not include a substance which is an explosive within the meaning of the Explosives Act 1875.

2.44. Where we refer to waste in this guidance we mean any fuel which meets the waste definition in the Orders but does not meet the biomass definition.

[6] In the Northern Ireland Order 'waste' has the meaning given to it in Article 2(2) of the Waste and Contaminated Land (Northern Ireland) Order 1997, and does not include gas derived from landfill sites or gas produced from the treatment of sewage.

Complying with waste requirements

2.45. Article 7(1) of the Orders makes clear that if a generating station is fuelled by waste, and the waste fuel burned does not meet the biomass definition, we can only issue ROCs under certain circumstances. If a generating station does not meet these criteria, no ROCs will be issued in the month in which the waste is burned.

2.46. Circumstances under which a generating station can be issued ROCs if burning waste are if:

- the waste by which it is fuelled in that month has been converted to a liquid or gas using an Advanced Conversion Technology (ACT);
- it is a CHP generating station with CHPQA accreditation; or it
- the waste is a liquid fossil fuel (eg RFO).

2.47. To be eligible for ROCs for the biomass fraction of waste, generators will need to be able to accurately measure the biomass fraction. See Chapter 6 for further information on measuring and sampling waste.

Advanced Conversion Technology

2.48. An Advanced Conversion Technology (ACT) can be gasification, pyrolysis or anaerobic digestion and any combination of these. If these processes are used to manufacture a fuel (gas or liquid) from waste then that fuel is eligible under the RO.

Combined Heat and Power Quality Assurance programme

2.49. CHP generating stations burning waste will need to be accredited under the RO and under the CHPQA programme before they can be issued ROCs. The CHPQA programme is a scheme that Future Energy Solutions (FES) run on behalf of Defra. A qualifying station will hold a valid Secretary of State Combined Heat and Power Exemption Certificate 2 (SoS Certificate) and a CHPQA Certificate. To become accredited under the RO, stations should complete an application form for accreditation and submit it to Ofgem.

2.50. We will require a copy of the details of the station that are sent to FES annually for qualification under the CHPQA scheme. We will already be in receipt of these details if a generator claims for CHP Levy Exemption Certificates. If we are not in receipt of these details, then consent for Defra to disclose information about the station to us will be required.

2.51. The number of ROCs issued to a station will depend on the efficiency of that station. This will be determined by the relationship between its qualifying power output (QPO) and total power output (TPO). See Appendix 6 for further information on issuing ROCs to CHP stations burning waste.

Liquid fossil fuel

2.52. Waste liquid fossil fuels can be used for generation provided they are comprised wholly or mainly of hydrocarbon compounds. This includes Recycled Fuel Oil (RFO).

3. Submitting monthly information

Chapter Summary

This Chapter explains what information generators are required to submit each month and how that information should be submitted.

Monthly data template

3.1. To enable ROCs to be issued generators are required to submit information each month. The information should be submitted by the end of the second month following the month of generation, using the Ofgem monthly data template. All generating stations must submit the following information:

- gross electrical output;
- input electricity;
- the energy content template, detailing renewable fuels and fossil fuels used and their respective volumes and GCVs; and
- any supporting analysis and information.

3.2. Further information on output and input electricity and the data submission process is contained in the generator guidance (see associated documents).

Fuel supply contracts

3.3. In addition to the other information provided each month, generators are asked to provide information on their fuel supply contracts. Some contracts provide a minimum specification for the fuel and this can provide a useful cross-check to the actual measurement and sampling data provided by the station.

3.4. Common examples of what generators provide are:

- a copy of the supply contract for each fuel used; or
- where a generator intends purchasing fuel on the spot market, the names and addresses of the suppliers for each of the fuels that they intend purchasing and the fuel delivery schedule each month; or
- invoices from the purchase of the fuel.

Clear and accurate information

3.5. All monthly information for the ROC issue should be sent together by email to monthlyoutputdata@ofgem.gov.uk, by fax to 020 7901 7387, or by post to:

Renewables and CHP team
Ofgem
9, Millbank
London
SW1P 3GE

3.6. Generators should ensure that the information they send to us is clear and accurate. Generators should put in place checking procedures to ensure the accuracy of calculations. If information does not appear clear or accurate, we will not be able to issue ROCs until our queries have been answered. We check a vast amount of information each month, so being able to locate the key information quickly is of great value.

3.7. Ways to make the information clear are:

- to make sure all agreed information is provided;
- to put totals in bold, or otherwise to highlight important numbers;
- to indicate (clearly) the content of each sheet of fuel sampling information;
- to explain any non-standard calculations;
- to ensure that the sampling date relates to when the sample was taken and not to when the sample was analysed; and
- to explain the origin of all figures every step of a calculation should be included. For example, if an average GCV calculated from several analysed samples has been included, two key pieces of information should be given. These are which sampling analysis sheet was used to calculate the average in the monthly template. The average should appear on both the analysis sheet and the monthly template.

3.8. All these examples are based on our experience. The provision of clear and accurate information will allow us to operate efficiently and effectively reducing the possibility of delay in issuing ROCs.

3.9. We are also keen to increase our efficiency in checking calculations. One way we are doing this is by creating more fuel-specific spreadsheets for stations with more complicated calculations.

4. Agreeing fuel measurement and sampling procedures

Chapter Summary

This Chapter explains when and how a generator should agree its fuel measurement and sampling procedures with us.

4.1. Agreeing FMS procedures means agreeing a methodology for measurement and sampling that should be satisfactory for the issue of ROCs. Before we can issue ROCs, we will also need to be satisfied of the reliability and accuracy of the information provided to us each month.

4.2. To claim ROCs generators are required to measure and sample the biomass fuel used at the station. Generators are advised to agree their FMS procedures with us **before** they claim ROCs as this means we are more likely to be satisfied with the reliability and accuracy of the information they submit each month. So that generators understand what we need to assess their FMS procedures, and so that we can assess all proposals on the same basis, we have designed a standard questionnaire. This is set out at Appendix 5.

When to submit FMS procedures

4.3. Please allow us as much time as you can to consider your proposed FMS procedures.

4.4. We expect to see FMS procedures or revised FMS procedures when a generator is:

- applying for preliminary accreditation;
- applying for accreditation;
- using a new type of fuel at an existing accredited generating station; or
- changing procedures for measurement (for example, if new equipment at the station makes it easier to measure using a belt weigher rather than a weighbridge).

4.5. In general, we will aim to run the accreditation or preliminary accreditation process in parallel with the process of agreeing FMS procedures. It is not a requirement of accreditation or pre-accreditation that procedures are agreed in advance. However, we encourage it because, in order to accredit or pre-accredit a generating station, we have to be satisfied that the station will be capable of generating electricity from eligible renewable sources. This includes being satisfied that it is possible for the biomass energy content of the fuel to be determined.

4.6. For generators using a new type of fuel or, where existing procedures change, the amount of information needed will vary. If the new fuel is similar to an existing fuel, a generator can simply ask us to approve their existing procedures for use with the new fuel. If the new fuel is very different (for example, a liquid fuel where previously only solid fuels had been used) then the generator should submit a revised questionnaire for the new fuel. Similarly, if new equipment makes a minor change to existing procedures a generator should inform us. A major change requires a revised questionnaire.

Completing the questionnaire

4.7. All procedures should be submitted as responses to the FMS procedures questionnaire in Appendix 5. Please give detailed answers to the questions as this will reduce the need for supplementary questions, thus making the process more efficient.

4.8. Sampling analysis of the intended fuel should be included with the questionnaire. This will help us to understand what information a generator is planning to send in each month and whether this is likely to be appropriate for the fuel(s) being used.

Dialogue with generators

4.9. We would like to agree FMS procedures through meetings, telephone discussions and where possible, visits to the station. We think this will be a good way for us to secure a detailed and clear understanding of the practices at a particular station.

4.10. When we can, we are happy to share experience and to suggest ideas for FMS procedures. However, it remains the responsibility of the generator to ensure compliance with the relevant legislation. We will, of course, have no experience of completely new fuels. In those circumstances, the onus will be very much on the generator to perform the necessary analysis and to formulate FMS procedures that meet the legislative requirements.

4.11. To increase our knowledge of what generators are doing we have already been on several visits to generating stations. We intend to continue to expand our knowledge in this way.

5. Measurement and sampling

Chapter Summary

The general requirements for measuring and sampling fuel are explained in this Chapter. The Chapter also contains a section on off-site measurement.

Measuring and sampling

5.1. We can only issue ROCs for electricity generated from eligible renewable sources. Article 9 of the Orders sets out how to calculate the amount of electricity generated from eligible renewable sources. In the case of a generating station fuelled partly by fossil fuel and partly by another fuel or fuels, the amount of electricity generated from fossil fuel is determined according to the respective energy contents of the fuels used. Energy content of a fuel means the gross calorific value (GCV) of that fuel (as expressed per unit of weight or volume) multiplied by the weight or volume of that fuel.

5.2. In order to meet the requirement to calculate the proportion of electricity generated from biomass, a generator will need to:

- measure the weight or volume of each biomass fuel burned each month;
- take representative monthly samples of each biomass fuel (to determine GCV and contamination); and to
- account for fossil fuel or waste each month.

5.3. For more information on biomass calculations see Appendix 6.

Accurate and reliable information

5.4. Article 16[7] of the Orders sets out the criteria for the issue of ROCs. It makes it clear that we must be satisfied that information provided to us for the issue of ROCs is accurate and reliable. This is why we ask that samples be representative of the fuel burned and that the weight or volume of biomass burned in the month is accurately measured. Similarly, the information provided should relate to the month for which ROCs are being claimed. If sampling and measurement does not relate to the month in which the biomass is burned then it will not be a true reflection of the energy content of the biomass actually used to generate the electricity for which ROCs are being issued.

5.5. Generators' FMS arrangements are subject to audit by Ofgem.

[7] Article 15 to the Northern Ireland Order

Measuring biomass burned within a month

5.6. The main focus of FMS is on the energy content of biomass used for generation. Weight or volume measurements of biomass are necessary to work out the energy content of biomass burned each month. The most common ways of doing this are by measuring opening and closing stocks and deliveries or by continuous measurement, for example using a flow meter. It is also important that the amount of fossil fuel used is measured, to enable the relative energy content of the biomass to be determined against the total fuels burned.

5.7. The weight or volume of stocks carried over from the previous month must be measured in the month of burn. This is because ROCs are issued for electricity generation in a particular month. To accurately measure the amount of biomass used for electricity generation in a month, volume measurements must relate to the month of burn.

5.8. A strict interpretation of the requirement to account accurately for the weight or volume of biomass burned within a month would mean that measurements had to be taken at the stroke of midnight on the last day of each month. We realise that there are practical implications, for some generating stations, in achieving this. We will therefore accept measurements and samples taken within twelve hours before or after midnight on the last day of the month, and at the same time each month.

5.9. In deciding when to take volume and/or weight measurements of stock carried over from one month to the next, good practice would include:

- re-sampling and measuring at the same time (together) to ensure that the sample is representative of what is burned;
- using the same weight or volume for the end of one month and the beginning of the following month[8], thus reducing the risk of double counting; and
- measuring the fuel and take a sample at the same time each month. While there is some flexibility, measurements should be taken at the same time each month so that ROCs can be issued for generation over the period of a month, for example, at 06:00 on the first day of each month.

5.10. Generators are not required to follow the three bullets above. If they choose not to do so, then some other method should be used to ensure that measurement is an accurate and reliable account of the biomass burned in the month. If generators generally choose to follow this, but find or have found it difficult in a particular month, they should contact us to agree a practical solution.

5.11. When assessing measuring and sampling information for stock carried over from one month to the next we will take a practical approach. For example, we will accept reliable estimates of stock levels (as opposed to requiring sheds to be

[8] It is possible there may be occasion where beginning of month measurements are not exactly the same eg some stock is removed. In such circumstances measurements should be taken at the same time.

emptied and stock taken back over weighbridges) in conjunction with sampling information in certain circumstances. FMS procedures will be agreed and information assessed on a case by case basis.

Excluding biomass not used for electricity generation

5.12. Ofgem can only issue ROCs for biomass burned that has resulted in the generation of electricity. This is because, under the Orders, a ROC is issued to an accredited generator for each MWh of electricity generated from eligible renewable sources, provided that all relevant criteria have been met.

5.13. If the generating station is on hot standby, being tested or there is a cancelled start it is likely that electricity has not been generated. Any biomass burned for these purposes should be measured and deducted. Alternatively it can not be included in the initial calculation of the weight or volume of biomass burned.

5.14. This will not be a concern if:

- the station only uses 100% biomass and the energy content of biomass burned does not need to be calculated;
- no biomass is used until the station is generating electricity; or if
- the station uses no biomass which does not result in generation.

5.15. The following examples show how a generator might measure biomass not resulting in generation:

- a belt weigher/flow meter measures the fuel is used during the cancelled start, hot standby
- the amount used is derived from the number of burners in service at initial light-up, burner tipping rating, time from initial light up to cancelled start
- the change in stock levels is calculated
- a measurement is taken of the change in tank levels

Sampling - procedures

5.16. Sampling is a statistical technique based on probability. It can be defined as the operation of removing a part, which is convenient in quantity for analysis, from a whole is such a way that the proportion and distribution of the quantity to be tested are likely to be the same in both the sample and the whole. Samples are usually taken either from each delivery or from the fuel stream as it goes to be burned.

5.17. The procedure that should invariably be used is to:

- develop a sampling plan;
- take a series of incremental samples;

- combine these to form a composite sample; and then to
- extract a representative sub-sample of the composite sample for analysis.

5.18. The factors that can affect the precision and accuracy of the sampling procedure are:

- the size of the sample relative to the whole;
- the number of increments taken during the sampling period to produce a composite sample;
- the method used to extract the sample; and
- the method used to extract a sub-sample from the composite sample for subsequent analysis.

5.19. Generators should take these principles into consideration when developing their FMS procedures.

Sampling - frequency

5.20. The biomass definition in Article 2(1) allows us to determine the period over which, and the frequency with which, measurements must be taken. To ensure that ROCs are issued for fuel burned in the month, the energy content used in the calculations must relate to the fuel burned in that month. This means that monthly sampling is necessary.

5.21. We normally expect generators to sample every delivery[9]. Sampling every delivery does not mean that generators need to send each individual sample to the laboratory for analysis. They may form a composite sample from multiple samples, and send a sample of that to the laboratory.

5.22. Where stations are taking samples immediately before combustion or from fuel in storage the amount of samples necessary to ensure that sampling information is representative of the fuel burned will depend on the circumstances at the station. In general, larger generators will need to take more than one sample per month for example daily or weekly. When considering how frequently to take samples generators should consider how consistent the GCV is of their biomass fuels are, how many fuel sources they have and how much biomass they are using.

Gross Calorific Value (GCV)

5.23. GCV measurements are necessary to calculate the energy content of biomass burned each month. The GCV of a biomass fuel used in calculations of electricity generated from eligible renewable sources will generally be the GCV of representative analysed samples. To enable the relative energy content of the

[9] For the purposes of this document 'delivery' means an individual lorry load.

biomass to be determined against what is burned it is also important that the GCV of any fossil fuel used be calculated.

Estimating / assuming GCVs

5.24. We prefer generators to measure rather than to estimate the GCV of their biomass fuels. Where a biomass fuel is contaminated with a fossil fuel, we will consider using estimated GCVs where the overall GCV of the biomass fuel is measured, but it is virtually impossible to measure the constituent GCVs of that fuel. We have agreed this for the deduction of fossil fuel contamination from biodiesel. Should a generator wish to estimate GCVs, then the method of estimation must be agreed with us in advance.

5.25. For estimating GCVs for new fuels the generator concerned should propose a figure, from a reputable source.

What happens if the GCV falls within a range?

5.26. Calculating the GCV of a substance can sometimes give an accurate figure, but it is not an exact science. If analysis of a single sample provides a range within which a GCV will almost certainly fall, the middle figure should be used unless there is reason to believe that the GCV is more likely to be generally higher or lower than the middle figure. In such circumstances we will consider what is most appropriate. Where measurement is less accurate a conservative estimate may be agreed, this could involve taking a lower figure than the middle figure.

Contamination

5.27. Contamination in this guidance refers to any fossil fuel, as defined in Article 9 of the Orders, which is a component of a biomass fuel. This is different from the meaning of contamination used by the Environment Agency.

5.28. The contamination of biomass fuels with materials derived from fossil fuels can be difficult to establish. However, generators must determine the amount of any contamination in a fuel, as this will affect the calculation of the amount of electricity generated from eligible renewable sources. Generators must:

- identify all possible contaminants; and
- put in prevention measures; or
- measure contamination.

5.29. We can only issue ROCs when contamination has been prevented or measured. The identification step is vital because, without this, contamination cannot be prevented or measured. The table below might be helpful when considering where contamination could occur.

Table 2: Processes that can cause contamination

Could my fuel be contaminated?	**Example**
In a previous use?	Paints or oils on waste wood
During the fuel production process?	The addition of alcohol in production of biodiesel
In storage away from the station?	Liquid bio-fuel stored in a storage tank previously used for fossil fuel
During transportation?	Tanker had a fossil fuel load before biomass load
From packaging?	Twine around straw bales, plastic packaging
During storage at the station?	Liquid bio-fuel stored in a storage tank previously used for fossil fuel
When sharing the same feed as fossil fuel if sampling has not yet been done?	Joint pipes for biodiesel and diesel to engine.

5.30. This is not an exhaustive list, but is designed to stimulate thinking about the contamination of which generators should be making us aware. For more information on common contaminants of fuels currently used and how they can be prevented, see Appendices 3 and 4.

Generating stations burning 100% biomass

5.31. FMS will be simpler for generating stations burning 100% biomass and not using any fossil fuel as the energy content of the biomass burned does not need to be known. In practice, this means they will not need to measure the weight or volume of that biomass. They may still need to perform representative sampling of the fuel, to show that it is not contaminated. Where generators can satisfy Ofgem that there is no fossil fuel contamination, they will not need to do monthly sampling. Several months' worth of consistent evidence that there is no contamination of the fuel is likely to be sufficient.

5.32. Where generators use 100% biomass for generating electricity, but use some fossil fuel for Article 8(3) purposes, they will need to measure the weight or volume of all the fuels used and carry out representative sampling. This will be used to work out the amount of fossil fuel used for these purposes to determine whether to issue biomass or co-fired ROCs.

Storage

5.33. To avoid significant deterioration fuels should be stored appropriately (see Appendices 3 and 4). Where significant deterioration occurs, the original sample taken will no longer reflect the properties of the fuel in the store and ultimately the fuel being burned. For example, if the GCV of the analysed sample is higher than the GCV of the stored fuel, more ROCs could be issued than should be for the energy content of the fuel burned. For an indication of how fuels should be stored and for how long, without material deterioration occuring, see the appendices.

5.34. It is important that the risk of contamination during storage is minimised. Whilst storage conditions and times should be considered, it is important to remember the fundamental principle behind all fuel measurement and sampling under the RO - that each fuel must be accurately and reliably sampled and measured in the month in which it is burned. In relation to storage, this means that fuels can be kept for long periods, even if they deteriorate, as long as they are sampled and measured in the month of burn.

Off-site measurement

5.35. It is important that we receive accurate and reliable information on the fuel or fuels burned at a generating station and therefore that accurate and reliable measurements are taken. Traditionally this measurement and sampling has taken place on-site, at the generating station. Article 17(4)[10] of the Orders, however, now recognises that sampling and measurement may be conducted off-site. The arrangements for measuring and sampling fuels at a location away from the generating station should be as robust as existing arrangements for measuring fuels on-site.

5.36. In addition to the requirements that must be met when fuel is measured on site, Article 17(4) of the Orders allows us, when determining whether information is accurate and reliable where it has originated off-site, to have regard to:

- the distance over which the fuel was transported;
- the conditions under which the fuel was prepared and transported;
- the resources required for Ofgem to verify the accuracy and reliability of the information; and
- any other matters that we consider relevant.

5.37. As we have not yet agreed any proposals for off-site measurement, we do not have any examples of good practice to include in this guidance. We hope to be able to include some when we publish an updated version of this document.

5.38. As for on-site measurement, the fuel must be sampled and measured within the month of burn. Data submitted to us each month must be an accurate reflection of what has been burned in that particular month. We recognise that this might cause practical difficulties when off-site measurement takes place at the very end of the month and the fuel is burned in the following month. When reviewing their FMS procedures, we will work with generators to try to find ways to address this.

Distance

5.39. It is important to ensure that the fuel does not change in composition while it is being transported. When considering the distance covered, it is also appropriate for us to consider the time taken for the fuel to travel that distance as this could impact on the state of the fuel. We will therefore check that the fuel does not

[10] Article 16(4) in the Northern Ireland Order

change in composition over the time (and distance) taken to transport it from the facility where it was sampled and measured to the place where it is burned.

Transport conditions

5.40. The conditions under which the fuel is transported are also important in ensuring consistency in the quality of the fuel from the measuring and sampling facility to the place where it is burned. In other words, it is important to ensure that the fuel that arrives at the station is in the same condition as it was when it left the facility where it was sampled and measured. Conditions that might cause a fuel to deteriorate over time or change in composition (for example due to exposure to moisture causing the fuel to decompose) need to be taken into account. If the fuel has changed in composition during transit, the generator will need to re-sample that fuel.

5.41. It is also important for us to be able to verify that a particular batch of fuel that has been sampled and measured off-site is the same batch of fuel that is being burned (and on which ROCs are being claimed). We will therefore require generators to provide evidence that particular batches of fuel are being accurately tracked. This will be scrutinised during audit.

Resources required for Ofgem to verify accuracy of information

5.42. Under Article 17(4) we may take the cost of auditing into account when considering the accuracy and reliability of information from a location other than the generating station.

5.43. To help us assess the potential cost of auditing a generator which is considering off-site measurement and sampling, we will ask for information on the practicalities of conducting such an audit in the questionnaire (see Appendix 5). We will assess whether these off-site measurement arrangements can be audited practically and at a reasonable cost. Should we consider the cost to be too high and/or the audit impractical, we will not approve those off-site FMS procedures.

5.44. To address our concerns about audit costs, generators may wish to propose employing an independent auditor to verify that the information they are providing is accurate and reliable and that their FMS procedures are robust. This might allow us to reduce the frequency of our own audit visits. We will consider these proposals on a case by case basis, taking into account factors including the independence of the auditors, their technical skills, their understanding of relevant aspects of the legislation, the scope of the audit and the quality of the audit reports.

5.45. In order to conduct an audit, we require access to a generator's premises. The granting of such access is one of the Standard Conditions of Accreditation to which all accredited generators are subject. The condition relates to the granting of access to premises owned and operated by the generator.

5.46. In the case of a generator which wishes to measure and sample fuel off-site, we will require access (for audit purposes) to the facility where that measurement and sampling takes place. As facilities are often owned and operated by parties other than the generator being audited, from April 2006, a new Standard Condition of Accreditation will require the generator to do all it can to ensure that we get access to such off-site measurement facilities for audit purposes.

Other relevant matters

5.47. As for on-site measurement, we will take account of how long and under what conditions the fuel is stored. There will be an interaction between this and the length of time and conditions under which it was transported. We will also take into account any other matters that we consider relevant when reviewing a generator's procedures.

5.48. As we develop experience with off-site measurement further relevant matters might arise. We will address these as they come up and they will be reflected in subsequent versions of this document.

6. Waste – Measurement and Sampling

Chapter Summary

Where electricity is generated from waste, the sampling and measurement explained in Chapter 5 will apply. Additionally there are issues unique to the measurement and sampling of waste. These are addressed in this Chapter.

6.1. The measurement of waste is more difficult than the measurement of biomass fuels principally because it is much more heterogeneous in nature. Rather than being made up of one biomass component, or one biomass component with one or two non-biomass components, waste can comprise any number of components, both biomass and non-biomass. This makes it more difficult to measure the energy content and to carry out representative sampling. As a general rule, the more processed or refined the waste, the easier it will be to develop robust FMS procedures.

Agreeing FMS Procedures

6.2. For the reasons described above, generators' FMS procedures will need to include more information than if the station is burning a biomass fuel. When we can, we are happy to offer help and advice to generators compiling FMS procedures, but we cannot undertake statistical analysis for them.

6.3. In addition to meeting the measurement and sampling requirements applicable to all fuels, an acceptable FMS procedure for waste will almost certainly need to include:

- a standard method for measuring the biomass fraction of waste – as described in CEN/TS 15440 (see measuring weight or volume and GCV);
- an initial set of sampling from one delivery of fuel from each fuel source (see initial sampling requirements);
- an initial set of sampling across several deliveries of fuel from each fuel source (see initial sampling requirements); and
- a separate method of sampling to be used for verification (see verifying results).

6.4. It may also include:

- quality assurance procedures (see verifying results); and
- conservative estimation (see using estimates).

6.5. When agreeing a waste FMS procedure, we will consider whether a proposal will result in information that is accurate and reliable enough for the issue of ROCs. In doing this, we will take the following factors into account:

- whether the sampling information from the fuels is likely to be a realistic reflection of the fuels used (see representative sampling)
- the variance of an initial set of samples from the same delivery of fuel (see initial sampling requirements)
- the variance of an initial set of sampling across different deliveries of fuel (see initial sampling requirements)
- a set of sampling to satisfy the two bullets above for each fuel source (see initial sampling requirements)
- the type of fuel (see general sampling requirements)
- how closely any sampling analysis from a back up method matches the biomass fraction sampling analysis from the main method (see verifying results)
- how the generator proposes to deal with large variances in sample results, if applicable (see using estimates)

6.6. We will also consider anything else that might affect the accuracy and reliability of the information.

Issuing ROCs

6.7. In deciding whether the sampling data accurately reflects the biomass content that has been burnt in that month we will consider:

- how closely the sample results each month match the initial set of samples (see initial sampling requirements); and
- how closely any validating methods match the biomass fraction from the main method (see verifying results).

Measuring weight or volume and GCV

6.8. Calculating the biomass percentage by energy content of a waste fuel presents two difficulties. It requires accurate measurement of the percentage of biomass in the fuel by weight and accurate measurement of the GCV of the biomass in the fuel. Only if these two measurements are accurate can the biomass energy content in a sample be calculated. This differs from the majority of biomass fuels where it is just the quantity and GCV of the whole fuel that needs to be measured.

6.9. Any method for measuring the biomass fraction of waste should include a repeatable and auditable process that is transparent and can be shown to result in an accurate measurement. Following a methodology set out in a standard may help generators to avoid additional work in creating a methodology which is rigorous enough to satisfy us. Also, it is helpful for us if generators use a common methodology as this ensures consistency of measurement between generators.

Industry Standards (CEN 343)

6.10. CEN343 is set of standards covering many aspects of the production, handling and measurement of solid recovered fuel (SRF). SRF is a type of fuel that is processed from any kind of non-hazardous waste. This can include municipal solid waste, industrial waste or construction and demolition waste. The standards are in draft format at the time of publication of this document. Although the standards only apply directly to SRF, the methodologies explained in the standards can be applied to other fuels

6.11. Because eligible generators[11] may also use unprocessed waste, we have extracted the relevant parts of the CEN343 standards to provide guidance that can be applied to other fuels.

6.12. CEN/TS 15440 is one of the CEN343 standards. It provides methodologies for working out the biomass fraction of a sample. Generators must ensure that they are using fuels that meet the conditions in the standard. For example, fuels must not contain substances for which the methods prescribed in the standards do not work, such as coal and charcoal. Also, the fuels should not be below 5 per cent or above 95 per cent biomass by weight.

6.13. CEN/TS 15440 includes two methods for determining the biomass percentage by weight - dissolution and manual sorting, both of which are described below. The standard explains the process the laboratory should follow and the conditions under which the methods should be used. As it is only the dissolution method that can be used to determine the GCV of the biomass in the sample, we suggest that generators use this as their main method. Both methods have drawbacks, so we suggest that generators use the manual sorting method regularly to verify the biomass percentage by weight calculated from the dissolution method.

Dissolution

6.14. The dissolution method relies on dissolving everything that is biomass and leaving everything that is not biomass. The problem is that certain materials may dissolve that are not biomass such as coal, oil, and bio-degradable plastic bags.

Manual sorting

6.15. The manual sorting method involves picking out materials by hand. Materials that have a biomass content are identified and the dissolution method is used to apply a percentage of the biomass fraction for each material. For example, card with plastic coating may be found to be 98 per cent biomass. This means that some estimation is used, which detracts from the accuracy of the technique. Manual sorting is also prone to human error.

[11] CHPQA accredited generators and generators using an ACT

Representative sampling

6.16. To ensure that the energy content reflects the biomass used to generate electricity, sampling must be representative. The CEN343 standard explains the processes for measuring the GCV and biomass fraction. It does not specify how many samples to take to ensure that the results are representative of the whole fuel.

Initial sampling requirements

6.17. Generators will almost certainly need to include an initial set of sampling from a single delivery of fuel from each fuel source. The samples taken from the delivery must be representative of what was burnt. As a guide, at least six samples will generally be necessary to demonstrate whether sampling can be representative. For more heterogeneous fuels, more than six samples may be necessary.

6.18. An initial set of samples from a single delivery will help us to assess whether it is possible for a generator to provide sampling information that is both representative of the fuel used and will provide a consistent measurement each month. To have confidence that sampling can be representative, the variance between the results of the sampling analysis from the same delivery of fuel must be relatively limited.

6.19. Generators will also almost certainly need to include an initial set of sampling across several deliveries of fuel from each fuel source. This set of sampling will be used to estimate the characteristics of the waste fuel that is used at the generator. From this, it will also be possible to work out a range in which the average (mean) percentage by weight and GCV of the fuel source are likely to lie. This information can then be used as a reference point by which to compare monthly figures. As a guide to numbers, the CEN standard for the classification of fuels suggests 40 samples are required to classify a fuel as SRF. This number of samples would appear reasonable as any less than this would make it difficult to calculate a narrow enough range in which the mean GCV and percentage by weight is likely to lie.

6.20. In our assessment of FMS procedures, if monthly figures closely match initial sampling, it will provide some comfort that the monthly figures are representative of the fuel. Here consistency may be an indication of reliability. However, a lack of consistency does not necessarily mean the sampling is unreliable. If this is the case, further evidence may be necessary to demonstrate that it is representative of what is being burnt. A smaller variance across fuel samples is also beneficial because it will give a smaller range as our reference point for the mean. This will make it easier for us to assess monthly samples against that reference point.

General sampling requirements

6.21. We will normally expect to see more frequent sampling in the early stages of a station's operation. Once we are more confident of the consistency of the fuel generators may reduce the frequency of sampling. As a minimum, we will expect sampling of every delivery and of any fuel carried over into the following month.

6.22. In our assessment of the FMS procedures, the type of fuel will also be taken into account as the variability of the sampling information is likely to be lower from more homogenous fuels such as SRF. This means generators using SRF or other processed fuels may find it easier to get their FMS procedures agreed than generators using unprocessed waste. The type of fuel may also affect the amount of evidence we need. For example, less evidence might be required for a fuel that has well-known and consistent characteristics.

Verifying results

6.23. Generators should consider how they might verify the results of their measurement and sampling techniques. Using the manual sorting method to validate the results of the dissolution method is one way to do this. They might also want to consider using a second method of sampling analysis at the stage of agreeing FMS procedures.

6.24. Measuring the GCV of the whole fuel could also be useful to verify the GCV of the biomass fraction, as a more consistent GCV of the whole fuel should indicate a more consistent GCV of the biomass fraction.

6.25. Having quality assurance systems in place may help generators to ensure that their fuels have a consistent make-up and to make it easier to provide consistent statistical data. It may also help to satisfy us of the accuracy of the results from their sampling and measurement techniques. It may help to confirm that there is no fossil fuel contamination.

6.26. If a generator is using an SRF then they may choose to follow CEN15358 – 'Solid recovered fuels – quality management systems – particular requirements for their application to the production of solid recovered fuels'. This standard provides a framework for monitoring the whole production process and should give generators a greater understanding of the properties of the fuel used at the generating station.

Using estimates

6.27. Only if a generator burning waste produces accurate and reliable information will we issue them with ROCs. We recognise that accurate measurement is difficult. We prefer generators to measure rather than estimate the weight or volume and GCV of their fuels but, where measurement is less accurate, we may be able to accept conservative estimates of the amount of biomass used for generation. The method used must not over-estimate the number of ROCs attributable to the biomass fraction of waste. Where there is doubt over the exact biomass content, we may accept conservative estimates as an alternative to not issuing ROCs at all. Conservative estimates will be based on measurement each month. Where it is not possible to find a reliable conservative estimate, then we have no option but to refuse to issue ROCs. Generators will therefore:

- receive ROCs on actual volumes, based on accurate data; or
- receive ROCs on a reliable conservative estimate; or
- not be issued ROCs (where data is unreliable and a conservative estimate cannot be established).

6.28. In our assessment of generators' FMS procedures we will consider how a generator proposes to deal with large variances in sampling data. Where there is a wide variance in sampling data we may be prepared to issue ROCs using a worst case scenario. For example, where a generator takes several samples in a month, ROCs could be issued on the sample analysis result with the lowest biomass fraction and GCV each month.

Appendices

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Appendix 1 - The Authority's powers and duties

1.1. Ofgem is the Office of Gas and Electricity Markets which supports the Gas and Electricity Markets Authority ("the Authority"), the regulator of the gas and electricity industries in Great Britain. This Appendix summarises the primary powers and duties of the Authority. It is not comprehensive and is not a substitute to reference to the relevant legal instruments (including, but not limited to, those referred to below).

1.2. The Authority's powers and duties are largely provided for in statute, principally the Gas Act 1986, the Electricity Act 1989, the Utilities Act 2000, the Competition Act 1998, the Enterprise Act 2002 and the Energy Act 2004, as well as arising from directly effective European Community legislation. References to the Gas Act and the Electricity Act in this Appendix are to Part 1 of each of those Acts.[12]

1.3. Duties and functions relating to gas are set out in the Gas Act and those relating to electricity are set out in the Electricity Act. This Appendix must be read accordingly[13].

1.4. The Authority's principal objective when carrying out certain of its functions under each of the Gas Act and the Electricity Act is to protect the interests of consumers, present and future, wherever appropriate by promoting effective competition between persons engaged in, or in commercial activities connected with, the shipping, transportation or supply of gas conveyed through pipes, and the generation, transmission, distribution or supply of electricity or the provision or use of electricity interconnectors.

1.5. The Authority must when carrying out those functions have regard to:

- The need to secure that, so far as it is economical to meet them, all reasonable demands in Great Britain for gas conveyed through pipes are met;
- The need to secure that all reasonable demands for electricity are met;
- The need to secure that licence holders are able to finance the activities which are the subject of obligations on them[14]; and
- The interests of individuals who are disabled or chronically sick, of pensionable age, with low incomes, or residing in rural areas.[15]

1.6. Subject to the above, the Authority is required to carry out the functions referred to in the manner which it considers is best calculated to:

[12] entitled "Gas Supply" and "Electricity Supply" respectively.
[13] However, in exercising a function under the Electricity Act the Authority may have regard to the interests of consumers in relation to gas conveyed through pipes and vice versa in the case of it exercising a function under the Gas Act.
[14] under the Gas Act and the Utilities Act, in the case of Gas Act functions, or the Electricity Act, the Utilities Act and certain parts of the Energy Act in the case of Electricity Act functions.
[15] The Authority may have regard to other descriptions of consumers.

- Promote efficiency and economy on the part of those licensed[16] under the relevant Act and the efficient use of gas conveyed through pipes and electricity conveyed by distribution systems or transmission systems;
- Protect the public from dangers arising from the conveyance of gas through pipes or the use of gas conveyed through pipes and from the generation, transmission, distribution or supply of electricity;
- Contribute to the achievement of sustainable development; and
- Secure a diverse and viable long-term energy supply.

1.7. In carrying out the functions referred to, the Authority must also have regard to:

- The effect on the environment of activities connected with the conveyance of gas through pipes or with the generation, transmission, distribution or supply of electricity;
- The principles under which regulatory activities should be transparent, accountable, proportionate, consistent and targeted only at cases in which action is needed and any other principles that appear to it to represent the best regulatory practice; and
- Certain statutory guidance on social and environmental matters issued by the Secretary of State.

1.8. The Authority has powers under the Competition Act to investigate suspected anti-competitive activity and take action for breaches of the prohibitions in the legislation in respect of the gas and electricity sectors in Great Britain and is a designated National Competition Authority under the EC Modernisation Regulation[17] and therefore part of the European Competition Network. The Authority also has concurrent powers with the Office of Fair Trading in respect of market investigation references to the Competition Commission.

[16] or persons authorised by exemptions to carry on any activity.
[17] Council Regulation (EC) 1/2003

Appendix 2 – A guide to appendices 3 and 4

1.1. The appendices include information relevant to both liquid and solid fuels. Because of differing requirements, in terms of storage, risk of contamination handling and general properties, their separate treatment is necessary.

Volume/weight and representative sampling

1.2. The appendices for liquid and solid fuels each start with a table summarising good practice for measuring weight/volume and for taking representative samples. These tables are intended to be a quick reference tool on good practice options available for measuring and sampling biomass fuels. They detail three or four methods, each of which contains a package of measures to satisfy us that fuel measurement and sampling procedures are sufficiently rigorous. The methods can be read down each column. Reading across, in each row is a possible response to each of the questions in the FMS questionnaire. In general, we would expect generators to give fuller answers when completing the questionnaire, incorporating some of the information in the explanations of each of the methods given below the table. We recommend that generators read through all the good practice methods and associated explanations, which give an overview of all the issues together with some of the options available.

Verification and sampling

1.3. It is good practice for generators to follow standards or use methods of verification as part of their procedures. This is not a requirement for agreement of FMS procedures, although where measurement is difficult it may be helpful in satisfying us that the measurement and sampling can be accurate. Some recognised standards for measuring and sampling fuels have been listed in the tables. Verification is done by measurement through two different methods and comparing the results to check that they are consistent. Where a generator chooses to verify results using another measurement, we will agree with the generator at the time of agreeing FMS procedures which measurement will be used each month for the issue of ROCs.

Contamination

1.4. This section contains a table which is broken down by fuel type. The first row under each fuel contains information likely to appear in a sampling analysis. As contamination and the type of contamination can depend on many different things this will not necessarily be the only information generators will need to produce. In working out exactly what contaminants generators should be testing, we recommend that generators use a method similar to that described in each fuel specific appendix, under ‘contamination’.

1.5. Subsequent rows in the contamination tables come in pairs. These take the questions given in the ‘contamination’ section of Measurement and Sampling Chapter 5, and give some answers based on our experience. The second row in the pair considers how the identified contaminant could be satisfactorily prevented. These answers are based on good practice at other stations.

Appendix 3 - General approach to measuring solid fuels

Table A1: Solid Biomass Fuels – good practice summary (weight measurement and sampling)

		Method 1	Method 2	Method 3
2.1/2.7 When is the weight measurement and sample taken?		Direct measurement immediately before combustion.	At station on delivery.	At station on delivery and stock calculation at beginning/end of month.
Mass measurement				
2.2	How?	Belt weigher.	Weighbridge.	Weighbridge for deliveries, stock calculation at beginning/end of month.
2.3	How often?	Throughout fuel burn.	Every delivery.	Every delivery. Stock calculation at the beginning/end of each month.
2.4	Measurement in month of burn?	n/a	Stocks run down at end of month.	Stock calculation at beginning/end of month.
2.5	Standards met?	None identified.	BS EN 30012-1 for weighbridge calibration.	BS EN 30012-1 for weighbridge calibration.
2.6	Verification?	Weighbridge and stock level calculation.	belt weigher if the station has one.	belt weigher if the station has one.
Taking a representative sample				
2.8	How?	Increments taken from the material flow close to the weigh point and immediately prior to combustion.	Manually from delivery vehicle, or as tipped or automatically depending on facilities available.	Manually from delivery vehicle, and from stockpile, or as tipped or automatically depending on facilities available.
2.9	How often?	Depends on the material being burned and the number of deliveries. At a minimum this will be once a month.	Every delivery.	Every delivery plus stockpile at the beginning of month.

2.10	Measurement in month of burn?	n/a	Stocks run down at end of month.	Stockpile sampled at beginning of month.
2.11	Standards met?	None at present but a solid biofuels standard is currently being developed by CEN/TC 335.	None at present but a solid biofuels standard is currently being developed by CEN/TC 335.	None at present but a solid biofuels standard is currently being developed by CEN/TC 335.
2.12	Verification?	Previous month's GCVs.	Previous month's GCVs.	Previous month's GCVs.

1.1. These methods require accurate weight measurement. This is only likely to be achieved in practice by the use of weighbridges and/or belt weighers.

Method 1: Direct measurement immediately before combustion

Measurement using belt weighers

1.2. In this method the flow of fuel to the generator is measured immediately prior to use. The flow is totalised for the month.

1.3. Sample increments should be taken from the moving stream to make up one or more composite samples that are representative of the fuel passing over the weighing point.

1.4. Belt weighers should be regarded as good practice for this method, although weighbridges could also be used where deliveries are used immediately without storage.

Accuracy

1.5. Inaccuracies from excessive tension or stiffness in the belt, irregular loading, or installation too close to non-weighing rollers should be kept to a minimum.

1.6. Belt weighing devices vary substantially in accuracy according to their principle of operation, construction and installation. The Organisation Internationale de Métrologie Légale (OIML) has classified those intended for commercial use into three classes see Table below.

Table A2

Class	Percentage of the mass of the totalized load for:	
	Initial verification	In-service
0.5	0.25	0.5
1	0.5	1.0
2	1.0	2.0

1.7. Good practice would be class 0.5.

1.8. There is an International Recommendation from OIML that specifies the metrological and technical requirements for continuous totalizing automatic weighing instruments of the belt conveyor type, that are subject to national metrological control. This is intended to provide standardised requirements and test procedures for evaluating in a uniform and traceable way. This is called

'International Recommendation - Continuous totalizing automatic weighing instruments (belt weighers). Part 1: Metrological and technical requirements – Tests. OIML R 50-1 Edition 1997 (E).'

and can be found at http://oiml.org/publications/R/R050-1-e97.pdf

1.9. Guidance for the calibration of stand-alone electronic weighing devices can be found at http://oiml.org/publications/R/R074-e93.pdf.

1.10. Weighbridges are described in Method 2 below.

1.11. Regular calibration is an integral part of the quality assurance of all weight measurements.

Method 2: At station on delivery

1.12. Fuel is weighed, and its calorific value determined, as it is delivered onto the generation site.

Measurement using weighbridges

1.13. The preferred method for material delivered by road is to weigh the fully loaded vehicle over a static weighbridge at the entrance to the generating station. After tipping into a storage area the empty vehicle is reweighed, the difference being the delivered weight of fuel.

1.14. Sampling of the load to determine GCV and contamination should be done during, or as soon as is practically possible after, the delivery. Good practice would be to sample during tipping or to use a sampling augur located over the weighbridge.

1.15. If biomass material is exported from the generating station during the accounting period it must be weighed and sampled.

Accuracy and calibration

1.16. Weighbridges will normally achieve an accuracy of +/- 0.5% of the load.

1.17. Operators of public weighing equipment have responsibilities to ensure that they can perform their duties competently and honestly. No one may operate public weighing equipment unless they hold a certificate from a Chief Trading Standards Officer. Although the weighbridge at a power station is unlikely to be a public weighing facility, good practice would be that the weighbridge is operated as if it were, and that the appropriate certificate is obtained.

Relevant standards

1.18. The British Standard BS EN 30012-1 presents in detail methods of calibration for static weighing devices and for determining periodic confirmation intervals. This is reviewed with further details in the following code of practice:

1.19. Code of Practice for the Calibration of Industrial Process Weighing Systems, Institute of Measurement and Control, October 2003. www.npl.co.uk/instmc_weighing_panel/wgc0496.pdf

1.20. Regular calibration is an integral part of the quality assurance of all weight measurements.

Method 3: At station on delivery and calculation of stocks

1.21. Weighbridge measurement as method 2.

Calculation of stocks

1.22. For this method, the biomass material held in stock at the station must be measured at the end/beginning of each month to determine accumulation or depletion. This could be done typically by transit over a weighbridge, survey of the stock pile, or level measurement of a bin.

1.23. Where volume calculation is used, then bulk densities must be determined that can be demonstrated to be representative of the material in stock at the time of measurement.

1.24. Accuracy could be improved by operating the stocking area so as to reduce the remaining quantity to a very low level at the period end. This could by achieved, for example, by separating each period's stock. In certain circumstances and by prior agreement we may accept reliable estimates of stock carried over from one month to the next.

Sampling

1.25. For a given accuracy, the required sample weight is directly proportional to the size of the largest particle in the mixture being sampled. This means that the weight of sample needed reduces as the particle size reduces, and thus the total size of a sample of sawdust will be smaller than that of a sample of woodchips.

1.26. The objective of any sample extraction procedure is to ensure that all particles have an equal chance of reporting to the sample. This is particularly important when the material being sampled contains a wide range of particle sizes (such as chipped wood), as the finer sized particles will tend to settle towards the bottom of the material in a delivery vehicle or in a stockpile, and towards the bottom of the flow of material on a conveyor. Generators should explain how sampling will be undertaken, which demonstrates that the sample taken is representative of the whole.

1.27. Samples can be extracted:

- mechanically from a drop flow
- mechanically from a moving conveyor
- manually from a stationary conveyor
- manually from a drop flow
- manually from a vehicle
- manually from a storage pile

Preparing a sample for chemical analysis

1.28. The overall size of the composite sample that is collected may be over 200kg, but the actual amount of material that is required for chemical analysis is usually less than 5 grams. Thus it is necessary to obtain a representative sample of the composite sample that is suitable for chemical analysis. This can be achieved by using a combination of sample size reduction (using a suitable shredder) and sample splitting procedures to produce a finely powdered sample that is suitable for chemical analysis.

Contamination

Identification and prevention

Table A3: Common contaminants of solid bio-fuels and methods of prevention

	Wood fuels	**Animal processing residues/ agricultural residues**	**Other plant fuels eg PKE, olive residues, shea nuts**	**Sewage sludge**
Analysis in addition to GCV	Chlorine, sulphur waste woods, heavy metals, nitrogen or advanced thermogravimetry with analysis of evolved gas to detect binder agents in a wood sample.	Chlorine, sulphur, heavy metals.	Chlorine, sulphur, hydrocarbon may be useful if fuel. not of animal feed quality.	Chlorine, sulphur.
Contaminants from production process to make fuel	MDF chipboard may contain preservatives, polishes, glues, tannalising fluids. Pellets may contain glues or binders.	None identified.	PKE/olive residues - addition of oil, residual solvent from extraction.	Contaminants present in influents into sewage works. Chemicals added during treatment.eg polymers for de-watering.
Prevention	Difficult to prevent. Supply contracts that guarantee quality management. Visual inspection. Heavy metal analysis will show some preservative contaminants. Nitrogen or thermogravimetry analysis to indicate no glues and resins.	None identified.	Strict quality control at production stage. Fuels for cattle feed unlikely to contain solvent. For other fuels, hydrocarbons test may indicate presence.	Hydrocarbons can indicatite fossil fuel contamination. These contaminants cannot be controlled and should be monitored.

	Wood fuels	**Animal processing residues / agricultural residues**	**Other plant fuels eg PKE, olive residues, shea nuts**	**Sewage sludge**
If not virgin biomass, previous use of fuel	Could be a variety of uses eg demolition wood, recycled pallets, paints and spillages.	n/a	n/a	n/a
Prevention	Difficult to prevent. Supply contracts that guarantee quality management. Visual inspection. Heavy metal analysis will show some preservative contaminants. Nitrogen analysis may indicate glues and resins.	n/a	n/a	n/a
Packaging of the fuel	Binder cord, ropes, bags, plastic packaging.	Plastic packaging.	n/a	n/a
Prevention	Visual inspection and manual removal.	Visual inspection and manual removal.	n/a	n/a
Contamination in transport	Contamination from previous transport use .	Contamination from previous transport use.	Contamination from previous transport use.	Contamination from previous transport use.
Prevention	Visual inspection and manual removal. Clean transport prior to use. Dedicated transport.	Visual inspection and manual removal. Clean transport prior to use. Dedicated transport.	Visual inspection and manual removal. Clean transport prior to use. Dedicated transport.	Visual inspection and manual removal. Clean transport prior to use. Dedicated transport.
Storage at power station	Storage with fossil fuels eg coal.	n/a	Storage with fossil fuels eg coal.	Storage with fossil fuels eg

	Wood fuels	**Animal processing residues/ agricultural residues**	**Other plant fuels eg PKE, olive residues, shea nuts**	**Sewage sludge**
				coal.
Prevention	Use separate stores. Measurement and sampling prior to mixing. No mixed fuel carried over.	Use separate stores. Measurement and sampling prior to mixing. No mixed fuel carried over.	Use separate stores. Measurement and sampling prior to mixing. No mixed fuel carried over.	Use separate stores. Measurement and sampling prior to mixing. No mixed fuel carried over.

1.29. Palm oil is extracted using an expeller or solvent and the expeller from this process can be contaminated with residual solvent. However, the CV of palm kernel expeller (PKE) comes mainly from its oil content and it is unlikely that residual solvent contributes significantly to its CV.

Storage

1.30. The following tables indicate best practice for the storage of different fuels and how long they can be stored without a material change in composition.

Table A4: Wood storage

	Forestry co-products	**Sawmill co-products**	**Pellets produced from forestry co-products and sawmill co-products**	**Waste wood**
How stored at station?	Barn/silo/ outside heap. Wood should be dried in loose piles. Dry wood must be stored under cover.	Barn/silo/ outside heap. Dry wood must be stored under cover.	Barn/silo. Stored under cover.	Store in barn/silo. Keep dry.
For how long?	Wood chip (50% moisture) – few days. 30% moisture - up to two months.	Wood chip - if high moisture (40-55%) - a few days Dry - up to three months.	Up to six months, providing it is kept dry. Minimise handling.	Up to two months.

1.31. Dry forestry co-products must be stored under cover to ensure the wood does not become wet and begin to degrade.

1.32. Pellets should be stored under cover on site of use, with minimal handling to prevent them breaking down.

Table A5: animal processing residues storage

	Dried sludge	**sludge cake**	**MBM**	**Blood and Meat slurry**	**Fish waste, soup and blood**
How stored at station?	Stored in sealed silo on site.	Stored in sealed silo on site.	Dry, enclosed storage facilities. May be stored in silos.	Dedicated storage.	Dedicated storage.
For how long?	Dried sludge may be stored for some time if kept dry.	Sludge cake may degrade on storage. Use rapidly.	Tendency to degrade rapidly. Depends on the quality of the fuel.	Tendency to degrade rapidly. Depends on the quality of the fuel.	High moisture waste has tendency to degrade rapidly and should be used immediately. Dry wastes may not deteriorate so rapidly, providing they are stored dry.

Table A6: agricultural residues storage

	Poultry litter	**Straw**	**Micanthus**	**Pellets from agricultural crops**
How stored at station?	Stored under cover e.g. in a barn/silo.	Store under cover at power station.	Store under cover at power station.	Barn/silo (under cover).
For how long?	Up to 10 days at plant.	Up to 12 months if kept dry.	Up to 12 months if kept dry.	Up to one month. Need minimal handling to prevent mechanical deterioration. Compaction in storage may cause some pellets to break up.

Table A7: Other plant fuels

	PKE/ Olive Cake and pellets	Shea Nuts	Cereal or maize pellets
How stored at station?	Store under cover. Need to control temperature, moisture/humidity and ventilation conditions in storage to prevent self heating.	Store under cover. Moisture content must be kept very low to prevent fungal growth.	Store under cover. Attracts moisture (hygroscopic). Store in covered store to prevent wetting and microbial degradation. Need to control temperature, moisture/humidity and ventilation conditions in storage to prevent self heating. Handle carefully to prevent mechanical break up and release of dust.
For how long?	2 months. May begin to degrade in store, depending on moisture and oil content and ventilation.	Providing temperature and moisture are kept low shea nut residues should store for 1-2 years.	Depends on properties. Modified feed pellets should be used rapidly.

Appendix 4 - General approach to measuring liquid fuels

Mass measurement and sampling

Table A8: Liquid Bio-fuels – good practice summary (mass measurement and sampling)

		Method 1	Method 2	Method 3	Method 4
2.1/2.7 When is the mass measurement and sample taken?		Direct measurement immediately before combustion	In storage from station tank(s)	At station on delivery	At station on delivery and from storage tank(s)
Mass measurement					
2.2	How?	Mass flow meter or calculated from flow meter reading and fluid density.	Tank level measurement – ultrasonic/tape dips.	Weighbridge.	Combination of tank level and weighbridge.
2.3	How often?	Throughout fuel burn.	Before and after every delivery and transfer to another storage tank.	Every delivery.	Weighbridge, every delivery, tank at month end/beginning.
2.4	Measurement in month of burn?	n/a	Measurement taken in addition to above at beginning/ end of month.	Stocks run down at end of month.	Tank measurement taken at month end/beginning.
2.5	Standards met?	None identified.	None identified.	None identified.	None identified.
2.6	Verification?	Weighbridge/ tank level measurement.	Flow meter/ Weighbridge.	Tank level/flow meter.	Flow meter.
Taking a representative sample					
2.8	How?	Increments taken from flow close to	Manual dip from top middle and bottom of tank	Manual tap on pipe	See 2 and 3

		flow measurement			
2.9	How often?	Dependant on number of deliveries, min. once a month, see below.	Dependant on number of deliveries, min. once a month, see below.	Every delivery.	Every delivery and at month beginning.
2.10	Measurement in month of burn?	n/a	Sample taken at month end/ beginning.	Stocks run down at end.	Tank re-sampled at month end/beginning.
2.11	Standards met?	ISO 3171, BS 2000, part 61, ASTM D 4177.	ISO 3170 BS 2000, part 61, ASTM D 4057.	ISO 3170 BS 2000, part 61, ASTM D 4057.	ISO 3170 BS 2000, part 61, ASTM D 4057.
2.12	Verification?	Previous month's GCVs.	Previous month's GCVs.	Previous month's GCVs.	Previous month's GCVs.

Method 1: Direct measurement immediately before combustion

Mass measurement – flow meter

1.1. Flow meters can be less accurate than weighbridges, but they are located at a point close to combustion. The advantage of this is that it obviates the need to re-measure stocks in the month of burn. Often weighbridge and/or tank level measurements are also taken. If this is a generator's chosen method, then the figure used for the calculation of ROCs should always come from the flow meter. The weighbridge and/or tank measurement will serve as a good check.

1.2. The most accurate meters are those that have an inaccuracy of less than one per cent of the measured value and it is this type of meter that is normally used for commercial and legal compliance purposes. These are positive displacement meters, coriolis meters, turbine meters and possibly vortex and electromagnetic meters. Regular calibration to accredited standard methods is necessary to ensure accuracy. Modifications to pipe-work may be necessary to accommodate this.

1.3. Inaccuracies due to differentiation in specific gravity, temperature and viscosity should be kept to a minimum. If a flow meter that does not measure mass flow directly (but some other effect caused by the velocity of the fluid in the pipe) is used then measurements of specific gravity, temperature and viscosity must be taken and corrected for.

Taking a representative sample

1.4. One of the standards listed (in the table) for automatic pipeline sampling is followed. ASTM D 4177 describes the automatic extraction of sample increments from a pipeline. It was designed for petroleum products but should be applicable to most biomass liquids.

1.5. The standard followed may or may not have been developed specifically for the fuel being used. Where the standard was not developed for the fuel being sampled, the fuel has similar properties to the fuel the standard was developed for. It may be difficult to sample fuel on the way to combustion. In such circumstances we may accept sampling of the fuel when in storage. For information on how often samples should be taken, see Chapter 5.

1.6. Sampling should be done next to the flow metering so that the energy flow can be determined at a fixed point. The flow meter should be located as close as practicable to the combustion.

Method 2: In storage from station tank(s)

Mass measurement – storage tank

1.7. An indirect method is usually employed, which involves measuring the level in the tank and calculating the volume geometrically. A correction must be applied for temperature (to allow for the expansion of the tank). The level can be measured by the traditional methods of inserting a graduated rod or weighted tape measure and noting the wetted length, or an automatic meter using an ultrasonic or radar echo ranging system.

1.8. If generators are calculating the mass in the tank, they will also need to know the density of the fluid. This can be determined in the laboratory by a standard method or in the tank by measuring the difference in hydrostatic head between two points at known depths.

1.9. The overall accuracy of this method depends critically on the homogeneity of the material in the tank. If the top is less dense than the bottom, then the mass will almost certainly be wrong. If there is a suspicion of segregation, densities should be measured at several points in the tank and a representative average determined.

Taking a representative sample

1.10. One of the standards listed in Table A8 for manual sampling is followed. Sample increments are drawn from tanks or a pipeline through a sampling valve specially constructed to prevent material accumulation. The procedure can be manual or automatic.

1.11. The standard followed may or may not have been developed specifically for the fuel being used. Where the standard was not developed for the fuel being sampled, the fuel has similar properties to the fuel for which the standard was developed. To further reduce the risk of an unrepresentative sample being sent to the laboratory, one of two processes is used. For either process three samples are taken at the same time one each from the top, middle and bottom of the tank. Then either all three samples are sent to the laboratory or the three samples are combined and a sample is taken from the combined samples. For consistency, samples should be taken at the same time that the tank volume is measured. Where fuel is carried over from one month to the next, samples are taken at the beginning of each month. For more information on how often samples should be taken, see Chapter 5.

Method 3: At station on delivery

Mass measurement - weighbridge

1.12. Weighbridges work best for stations that only have one storage tank and do not carry over fuel from one month to the next. This is because transfers from one tank to another and carryover are difficult to measure using a weighbridge. Our experience is that larger stations tend to use a weighbridge alongside another measurement, as in Method 4.

Taking a representative sample

1.13. One of the standards listed in Table A8 for manual sampling is followed.

1.14. Samples are usually taken by a probe through the top hatches of the tanker. Samples could also be taken from the discharge line.

1.15. The standard may or may not have been developed specifically for the fuel being used. Where the standard was not developed for the fuel being sampled, the fuel has similar properties to the fuel the standard was developed for. To ensure that sampling is representative of what is being burned a sample is taken from every delivery. Where a station has several deliveries in a month, samples may be combined and a sample of the combined sample sent to the laboratory to be tested. For more information on how often samples should be sent to the laboratory, see Chapter 5.

Method 4: At station on delivery and from storage tank(s)

Mass measurement – weighbridge and storage tank

1.16. Weighbridge readings measure most of fuel burned in the month and a tank measurement is taken at the beginning of the month. This measures the amount of carryover into the following month. Tank measurements may also be used to measure the transfer of fuel from one tank to another. The mass burned is calculated as follows:

Mass burned = Opening balance – closing balance + deliveries (+ transfers)

Opening balance = tank measurement at the beginning of the month of burn

Closing balance = the tank measurement the end of the month of burn

Deliveries = Weighbridge measurements within the month of burn

1.17. For more information on tank and weighbridge measurement, see Methods 2 and 3.

Taking a representative sample

1.18. See Methods 2 and 3.

Contamination

Identification and prevention

Table A9: Common contaminants of liquid bio-fuels and methods of prevention

	Biodiesel	**Tallow / tall oil / palm oil**	**Cooking oil / vegetable oil**
Analysis in addition to GCV	Constituents, sulphur.	Sulphur, tall oil, sometimes hydrocarbons.	Sulphur, sometimes hydrocarbons.
Contaminants from production process to make fuel	Methanol, glycerol and others.	None identified.	n/a
Prevention	Can not be prevented, must be measured. Purchase biodiesel to agreed quality standard EN 14214.	None identified.	n/a
If not virgin oil previous use of fuel	Could be a wide variety.	n/a	Could be a wide variety.

Prevention	Supply contracts which guarantee quality management.	n/a	Supply contracts which guarantee quality management.
Previous use of storage tank	Diesel or other fossil fuel previously used.	HFO or other fossil fuel previously used.	Diesel or other fossil fuel previously used.
Prevention	Storage tank purged before filled with biomass or other operating procedure to ensure pipes are clean.	Storage tank purged before filled with biomass or measured see fuel specific calculations below or other operating procedure to ensure pipes are clean.	Storage tank purged before filled with biomass or other operating procedure to ensure pipes are clean.
Previous fuel in pipes	Diesel or other fossil fuel previously used.	HFO or other fossil fuel previously used.	Diesel or other fossil fuel previously used.
Prevention	Pipes purged before filled with biomass or other operating procedure to ensure pipes are clean.	Pipes purged before filled with biomass. or other operating procedure to ensure pipes are clean.	Pipes purged before filled with biomass or other operating procedure to ensure pipes are clean.
Joint pipework with fossil fuel	Diesel or other fuel used.	HFO or other fuel used.	Diesel or other fuel used.
Prevention	Method 2, 3 or 4 used for sampling and measurement. Can only use method 1 if before joint pipework.	Method 2, 3 or 4 used for sampling and measurement or method 1 if before joint pipework or HFO measured as below.	Method 2, 3 or 4 used for sampling and measurement. Can only use method 1 if before joint pipework.

1.19. Further information on measurement is in the fuel specific calculations.

Mixing liquid bio-fuels with fossil fuel

1.20. This section relates to liquid biomass fuels that are mixed in the same tank as a fossil fuel such as Heavy Fuel Oil (HFO). This is usually done to make them easier to handle. It explains how generators may wish to measure stock that is carried over from one month to the next. Both the volume of the biomass fuel and the energy content of that biomass fuel need to be measured. Three methods generators could use are described below. These are the marker method, the mass balance method and the analytical method. It may be appropriate for generators to use the same method for measuring volumes and GCVs or it may be appropriate for generators to use one method for volume and a different method for GCV.

The marker method

How the marker method works

1.21. A marker is a property of the two fuels being mixed that differs significantly between the two fuels. For example, the percentage of sulphur in tallow may always be less than 0.01 and the percentage of sulphur in HFO may always be greater than 1.0. If the percentage of sulphur in the mix carried over is measured, this can be used to calculate the volume and GCV of biomass carried over into the following month. This calculation is explained in more detail below. The amount of the marker in the fuel will generally be given in sampling analysis as a percentage of the whole fuel.

When the marker method can be used

1.22. To use a marker there will need to be a clear difference in the amount of one of the properties of the two fuels. The bigger the difference, the more accurately the calculation can be carried out. We would generally expect the difference to be at least an order of magnitude (x10).

Examples of markers accepted so far:

- tallow mixed with HFO – Sulphur content; and
- tall oil mixed with HFO – Acidity level.

The marker calculation

The following information is needed for the marker calculation:

For the volume and GCV calculations:

- percentage marker in biomass – as determined by sampling analysis of the deliveries of biomass in the month of burn;
- percentage marker in fossil fuel– as determined by sampling analysis of the deliveries of fossil fuel in the month of burn; and
- percentage marker in mixed fuel– as determined by sampling analysis of the mixture of fuel at the end of the month of burn.

For the volume calculation only:

- opening balance of biomass;
- opening balance of fossil fuel;
- deliveries; and
- closing balance of mixed fuel at end of month.

1.23. In the first month, the opening balance should be straightforward. For example, the tank may have 3000 tonnes of fossil fuel and 0 tonnes of biomass fuel. In the following months the opening stock will generally be the closing stock as calculated for the previous month.

For the GCV calculation only:

- GCV of fossil fuel; and
- GCV of combined fuel.

Steps 1 and 2: percentage of biomass in mix

1.24. The calculations in the first two steps are performed to work out the percentage of biomass and fossil fuel in the mix. This is used when calculating both the volume and GCV of fuel carried over. Step 1 is the average of the percentages given in the analysis of samples taken from the fuel in the month. Step 2 calculates the percentage of biomass and percentage of fossil fuel in the mixture left in the tank. This is calculated by the working out the relative difference in the amounts of the marker present in the fuels. This is the difference between the amount of the marker in the mixed fuel and the amount of the marker in the fossil fuel as a percentage of the difference between the amount of the marker in the biomass fuel and the amount of the marker in the fossil fuel.

Step 3 and 4: volume calculation

1.25. Step 3 calculates the closing balance by multiplying the percentage of biomass in the mix by the closing balance of the mixed fuel. This can the be used in step 4 to calculate the amount of biomass and fossil fuel used in the usual way, opening balance minus closing balance plus deliveries.

Step 5 and 6**:** GCV calculation

1.26. The GCV of the mix of fuel is expressed per unit of energy, for example, MJ or GJ. The percentage of this GCV made up of fossil fuel and made up of biomass has been calculated in Step 2. Step 5 is used to calculate the GCV in the mix of fuel that is attributable to biomass. This is done by deducting the GCV attributable to fossil fuel from the GCV of the mix of fuel. The GCV attributable to the fossil fuel is the GCV of the fossil fuel multiplied by the percentage of fossil fuel in the mix.

1.27. Step 6 works out the GCV of biomass per unit of energy. This is done by dividing the GCV attributable to biomass for the percentage of biomass in the mix calculated in Step 5 by the percentage of biomass in the mixture of fuels.

Step 1: calculate average percentage of marker in fuels

Average marker in biomass = sum of marker in biomass samples ÷ number of biomass samples

Average marker in fossil fuel = sum of marker in fossil fuel samples ÷ number of fossil fuel samples

Step 2: work out the amount of biomass in tank at end of month

Percentage of biomass in mix = (marker in mixed fuel – average marker in fossil fuel) ÷ (average marker in biomass – average marker in fossil fuel)

Percentage of fossil fuel in mix = 1 – percentage of biomass in mix

Step 3: calculate the closing balance of biomass and fossil fuel

Closing balance of biomass = percentage of biomass in mix x closing balance of mixed fuel

Closing balance of fossil fuel = percentage of fossil fuel in mix x closing balance of mixed fuel

Step 4: calculate the amount of biomass and fossil fuel burned

Biomass burned = opening balance of biomass – closing balance of biomass + deliveries of biomass

Fossil fuel burned = opening balance of fossil fuel – closing balance of fossil fuel + deliveries of fossil fuel

Step 5: calculate the GCV of the biomass in the combined fuel

GCV of biomass in combined fuel = GCV of mix - (GCV of fossil fuel x percentage fossil fuel in mix)

Step 6: calculate the GCV of the biomass

GCV of biomass = GCV of biomass in combined fuel ÷ percentage biomass in mix

The mass balance method

How the mass balance method works

1.28. The mass balance method works on the principle that what enters the tank directly corresponds to what is burned. It assumes that the biomass and fossil fuel are perfectly mixed in the tank.

When the mass balance method can be used

1.29. This method is more appropriate in some circumstances than others. When considering whether this method is acceptable we will take account of the circumstances detailed below

For volume:

- whether any tests have been done to show the fuels mix well and there is a uniform mix of the fuels in the tank;
- whether the tank is expected to be rapidly converted to being fully biomass; and
- how frequently the proportions of biomass to fossil fuel are being recalculated.

1.30. As it assumes that the ratio of biomass and fossil fuel burned is the same as the ratio of biomass and fossil fuel that entered the tank the fuels need to be well mixed for this method to work. If generators want to use this method, they will be expected to provide evidence that the fuels in the tank are well mixed. In addition, as this calculation relies on an assumption, we may be more willing to accept it over a short period of time (for example, if the tank is converting to only holding biomass).

For GCV only:

- whether the fuel is likely to deteriorate under the conditions in the tank
- whether a verification method is used and how closely this matches the GCV

1.31. Normally fuels will need to be re-sampled in the month of burn. Some liquid biomass fuels have a very stable GCV. It is also difficult to re-sample for the GCV of the biomass in the mixture of fuels. For these two reasons, where liquid fuels are mixed in a tank with fossil fuels, we may accept estimates of the carried over GCV based on GCV samples taken in the previous month as described in this method. The fuel will need to be unlikely to deteriorate to provide an accurate estimate of the GCV of biomass in the tank. A method of verification could also be used to calculate the GCVs based on the marker method for comparison.

The mass balance calculation

1.32. This calculates the amount of biomass burned from the relative amount of biomass and fossil fuel that have entered the tank and the total amount of mixed fuel that have been burned. The calculation is explained further below.

Figures needed for this calculation:

For both volume and GCV calculation:

- the opening tank level
- the closing tank level
- the deliveries of each fuel

- the opening biomass stock from previous mix calculation (not necessary for first time calculation is performed)

- the opening fossil fuel stock from previous mix calculation(not necessary for first time calculation is performed)

For GCV calculation only:

- GCV of carried over fuel

- GCV of delivery of fuel

1.33. In the first month, the opening stock should be straightforward, for example, the tank may have 3000 tonnes of fossil fuel and 0 tonnes of biomass fuel. The carry over of the GCV should also be straightforward as it would either be 0 or the GCV of a pure biomass fuel in the tank. In the following month the opening stock will be the closing stock as calculated for the previous month for both volume and GCV.

Steps 1 to 5: the amount of fuel burned between deliveries

1.34. Steps 1 to 5 work out the amount of fossil fuel and biomass burned between two deliveries. They use the opening balance after a delivery and the closing balance before the next delivery and the proportion of biomass fuel to fossil fuel to work out how much biomass and how much fossil fuel was burned.

1.35. Step 1 works out the volumes of fossil fuel and biomass in the tank after a delivery. In the example below the delivery was biomass, but the calculation can similarly be done after a delivery of fossil fuel. The volumes are then used to work out the proportion of biomass to fossil fuel in the tank. Total fuel in the tank also needs to be calculated as in Step 2 to work out the proportion of biomass to fossil fuel in the tank. The proportions are then calculated in Step 3 by dividing the amount of each fuel in the tank after the delivery by the total amount of fuel in the tank. The closing balance of each fuel is calculated in Step 4 by multiplying the percentage of each fuel in the tank by the closing balance of the total fuel in the tank. Step 5 then calculates the amount of each fuel burned by deducting the closing balance of the fuel from the opening balance of the fuel.

1.36. To ensure the proportions used in the calculation are correct, the calculation is repeated just before any delivery of biomass or fossil fuel and at the end of the month. The only time it does not need to be repeated before a delivery is when no fuel has been burned between the last time the calculation was done and the delivery.

Steps 6 and 7: calculate total volume of fuel burned

1.37. As a delivery will alter the proportion of fossil fuel to biomass burned this calculation should be repeated each time there is a new delivery or transfer to the tank. The calculation will also need to be done. Step 7 then works out the total biomass burned in the month by totalling the outcomes of all the calculations.

Step 8: the GCV of the fuel carried over

1.38. Step 8 works out the GCV of the fuel carried over. This calculation is a weighted average of the GCV of the deliveries to the tank in the previous month and the fuel carried over to the previous month.

Steps 1 -3 use information from just after a delivery but before any fuel is burned.

Step 1: Calculate the total volume of each fuel in the tank

Total input of fossil fuel = fossil fuel opening balance

.

Total input of biomass = biomass opening balance + delivery of biomass

Step 2: Calculate the total volume of fuel in the tank

Total input of fuel = total input of fossil fuel + total input of biomass

Step 3: Calculate the proportion in the tank of each fuel

Proportion of fossil fuel in tank = total input of fossil fuel ÷ total input of fuel

Proportion of biomass in tank = total input of biomass ÷ total input of fuel

Step 4: Calculate the amount of fuel carried over

Fossil fuel closing balance = percentage fossil fuel in tank x closing balance

Biomass closing balance = percentage biomass in tank x closing balance

Step 5: Calculate the amount burned of each fuel

Amount of fossil fuel burned = total input of fossil fuel – fossil fuel closing balance

Amount biomass burned = total input of biomass – biomass closing balance

Step 6: repeat this calculation

Steps 1 - 5 are repeated each time there is a delivery and at the end of the month.

Step 7: calculate the amount of biomass burned in the month

Amount of biomass burned in month is the total of the amounts of biomass burned from each repetition of the calculation.

Step 8: Calculate the GCV of the fuel carried over

Weighted average GCV = ∑ (quantity from which sample was taken x sample GCV)j + quantity carried over x sample GCV fuel carried over ÷ quantity

The analytical method

1.39. Another way in which generators could satisfy us that they can accurately measure the amount of biomass and fossil fuel carried over each month is directly to analyse samples to find out what percentage of biomass and what percentage of fossil fuel is mixed in the tank. This is the simplest method in terms of the calculation involved, but it may not be practical to do. Because of this, at present, there are no stations using such a method.

Verification

1.40. Generators may wish to consider using a second method of measurement to back-up their chosen method of measurement. It is not a requirement of agreeing FMS procedures and it may not always be easy to measure using two methods. Where it is relatively easy, it will provide additional evidence that measurement and sampling can be done that accurately reflects the fuel burned. This useful where two or more fuels are mixed because accurate measurement and sampling of a mixture of fuels is more difficult than of a single fuel.

Storage

Table A10: Liquid Bio-fuels – good practice summary (storage)

	Biodiesel	**Tallow**	**Tall oil**	**Palm oil**	**Cooking oil / vegetable oil**
How stored?	Water/air tight tank.	Water/air tight tank.	Water/air tight tank.	Water/air tight tank.	Water/air tight tank.
For how long?	up to six months.	up to six months.	up to six months.	up to six months.	up to six months.

1.41. Generally these fuels can be stored for long periods of time without too much deterioration. When transported and stored as recommended, these fuels could be stored without loss of quality for up to 6 months.

Appendix 5 - FMS Questionnaire

Completing the FMS Questionnaire

Please complete this questionnaire and return it to:

Susan Pelmore
Manager, Biomass and Co-firing Issues
Renewables & CHP Team
Ofgem
9 Millbank
London SW1P 3GE

Email: susan.pelmore@ofgem .gov.uk

A separate copy of this is to be completed for each generating station you wish to have accredited as biomass or co-firing under the Orders.

There are two sections to this questionnaire:

1. Fuels/General information

2. Fuel Measurement & Sampling Arrangements

Section 1 should be completed for the generating station as a whole.

Section 2 should be completed for each biomass fuel used at the generating station. The answers to questions should clearly show which fuel(s) they relate to.

Any additional supporting information that you wish to submit with your response would be most welcome.

FUEL MEASUREMENT AND SAMPLING QUESTIONNAIRE

Company name (operator):

Generating station name:

Accreditation ID:

Section 1: Fuels/General Information

1.1. Different fuels display different characteristics and so it is important that sampling and measurement procedures take these characteristics into account.

1. 1 Please list each biomass fuel you intend burning and which you wish to consider for ROC qualification.

1.2. Please note: Section 2 should be completed for group of these fuels used eg solid and liquid.

1.2 Please give details of the supplier(s) of the fuel - including name(s) and address(es). This information should be supported by evidence described in paragraph 3.3. Copies of relevant extracts from fuel supply contracts should include details of the fuel content and the duration of the contract clearly marked.

1.3 Please list any additional biomass fuels you have permission to burn or are seeking Environment Agency permission to burn.

1.4 How will you make sure that your monthly ROC claim does not include any biomass burned which does not result in the generation of electricity? For example, if the generating station is on hot standby, being tested or there is a cancelled start it is likely that electricity has not been generated.

PLEASE COMPLETE THE FOLLOWING SECTIONS SEPARATELY FOR EACH BIOMASS FUEL LISTED IN YOUR ANSWER TO QUESTION 1.1

Section 2: Fuel Measurement & Sampling Arrangements

1.3. This section will help us to consider the accuracy of your fuel measurement proposal. The accurate measurement of biomass is important because Article 16(3)[18] of the Orders requires us to have been provided with all information we need to assess whether ROCs should be issued and that we are satisfied that this information is accurate and reliable. This includes measurement of the volume and Gross Calorific Value (GCV) of the fuels burned which are used to calculate the biomass energy content of the total fuel used to generate electricity. Measurement is also important for other eligibility considerations. These include the classification of ROCs as biomass or co-fired, which depends on the amount of fossil fuel being used. It might also suggest that ROCs could not be issued at all, for example, if contamination of the total biomass used is above 10%.

1.4. As the definition of biomass in the Orders (Article 2(1)) requires that at least 90% of the energy content of the fuel in question must be derived from plant or animal matter to be biomass, we need to be sure that any biomass fuel carried over has been accurately measured in the month that it has been burned. This includes both the weight or volume and GCV of the fuel carried over.

1.5. There are also a number of questions about whether your measurement procedures meet relevant UK or European standards. Please note that whilst these standards may need to be met for other purposes they are not a requirement under the Orders.

a) Weight or volume

2.1 When is the weight or volume measurement taken? eg at station on delivery

2.2 How is the weight or volume measured?

2.3 How often is the weight or volume measured?

2.4 How do you manage the requirement to measure accurately fuel in the month it is burned? This is a particular issue if any of the biomass fuel delivered in a particular month is being carried over to be burned in a different month.

2.5 If the volume measurement(s) meets any UK, European or other standard(s) (e.g. BS, ISO, CEN), please give details.

2.6 Is any method of verification of the measurement used?

[18] Article 15(3) to the Northern Ireland Order

b) Gross Calorific Value

2.7 When are representative samples taken? eg at the station on delivery

2.8 How is the representative sample taken?

1.6. Sampling needs to be representative for it to reflect accurately what has been burned.

2.9 How often is a sample taken?

2.10 How do you ensure that the GCV is representative of what is being burned?

2.11 If the sampling analysis of the GCV or the sampling methods meet any UK, European or other standard(s) (e.g. BS, ISO, CEN), please give details.

2.12 Is any method of verification of the sampling used?

2.13 Apart from GCV, what other (if any) analysis (e.g. under Environment Agency requirements) do you perform on your biomass?

c) Contamination

1.7. We would like some information on what contamination of the fuel is possible and how this can be prevented and/or measured. The definition of biomass in the Orders (Article 2(1)) includes that "….90 per cent of the energy content is derived from plant or animal matter or substances derived directly or indirectly therefrom…". The contamination of each of the biomass fuels used therefore must not be more than 10% of the energy content of each of those fuels for the generating station to be eligible for ROCs in the month of generation.

2.14 What is the origin of the fuel? For example, if the fuel is a type of wood it may be virgin wood from the forestry commission, pallets from commercial activity.

2.15 How do propose to manage contamination? Please include how and where you will measure contamination levels, on a monthly basis, in your answer.

2.16 Have you found any contaminants so far? If so, what were these?

2.17 Have you identified any potential contaminants that you do not intend measuring (please list)? If so, what preventative measures will you put in place?

2.18 Do your measurement techniques for contamination meet any UK, European or other standard(s) (e.g. BS, ISO, CEN)? Please give details.

d) Storage

2.19 How will the biomass fuel be stored at the generating station, including any temporary storage facilities eg in a covered hanger or shed, sealed tank etc.? Please make clear whether the biomass fuel will be stored separately from other fuel sources (incl. from other biomass fuels).

2.20 On average, for how long will the biomass fuel stored between delivery and burning?

e) Off-site measurement only

2.21 Please explain the practicalities of auditing your off-site measurement facilities.

f) Waste only

2.22 How many samples have you included an initial set of samples for a single delivery?

2.23 How many samples have you included in an initial set of samples across deliveries?

2.24 Please explain any calculations or statistical analysis has that done and how it shows that sampling can be representative

2.25 Are you proposing a method of conservative estimation? If so please explain the method you are proposing.

g) Additional information

2.26 Is there any other information that you consider to be relevant?

Appendix 6 - The biomass calculations

The calculations explained

How is the number of ROCs calculated?

1.1. ROCs are issued using the following calculation:

ROCs issued = net eligible output x qualifying percentage

Where net eligible output = total eligible output - total input.

1.2. The total eligible output and total input reflect the terminology in the 'all stations (1)' worksheet of the monthly data template. Eligible output refers to the gross electricity output which has been supplied by licensed suppliers. Total input refers to all electricity that is used for purposes directly relating to the operation of the generating station.

1.3. Eligible output and input are explained in the generator guidance (see Associated Documents). This Appendix explains how to quantify the qualifying percentage. For most generating stations, the qualifying percentage will be the energy content of the biomass fuels used to generate electricity divided by the energy content of total fuel used to generate electricity. For CHPQA accredited generators, this is also multiplied by the percentage of qualifying power output of the station.

1.4. The effect of this calculation is to deduct from the net eligible output any generation that is not eligible for ROCs, because it is generated from fossil fuels. In the case of CHP generating stations burning waste, it also adjusts for the efficiency of the station as explained further below.

1.5. The calculation reflects the requirements in Article 9 of the Orders to issue ROCs using the calculation *renewable output x (net output divided by gross output).* All three terms are defined in the Orders. In addition, it reflects the requirements set out in Articles 16[19] and 18 of the Orders.

1.6. The calculations in this guidance are split into eight steps which allow a generator to ascertain the qualifying percentage to be used in the ROC issue calculation set out above. The steps start with the information generators will have from measuring and sampling their fuels. For more information on measuring and sampling fuels, see Chapter 5.

1.7. The eight steps are explained below and the calculations they refer to are listed together at the end of this chapter. This is followed by three worked examples of the calculations.

[19] Article 15 in the Northern Ireland Order

Can ROCs be issued for electricity generated from fossil fuel?

1.8. No. All electricity generated from fossil fuel, including waste fossil fuel, must be deducted for before ROCs are issued. Any substance that is derived directly or indirectly from fossil fuel eg coal, RFO or natural gas is considered to be fossil fuel. In addition, any component of biomass which is derived from fossil fuel, eg alcohol in biodiesel or plastic packaging is fossil fuel. In this Appendix, fossil fuel that is a component of biomass is referred to as contamination. Calculation b of Step 5 is used to deduct fossil fuel contamination of biomass fuels used for generation.

1.9. For the purpose of calculating what ROCs are to be issued, the percentage energy content of fossil fuels (does not qualify for ROCs) to biomass fuels (does qualify for ROCs) are used.

How do the calculations fit with the monthly data template?

1.10. Most of the information for the calculations and the calculations themselves should be input into the monthly data template. The template along with completion instructions is available on our website using the following link:

http://www.ofgem.gov.uk/ofgem/work/index.jsp?section=/areasofwork/renewobligation

1.11. The worksheet in this template for calculating the qualifying percentage is 'fuelled stations (4)'. The worked examples in Appendix 7 use a copy of this worksheet. A blank copy is included in Appendix 8. It may be helpful to refer to this when reading the rest of this appendix.

- Some calculations are done automatically in the monthly template, others generators will need to do themselves. The calculation summary at the end of the appendix indicates which calculations are done automatically.

- The calculations are given in words with letters in brackets next to some of the words. Where letters are given they correspond directly with the letters in the monthly data template. Where a letter has i or j next to it, it indicates the calculation needs to be performed for each applicable fuel.

Steps 1 -3: Calculating the energy content of each fuel

1.12. The energy content for each fuel must be calculated before it is possible to work out the relative energy contents of the fuels. The energy content is calculated by multiplying the quantity of the fuel by its GCV. This calculation should be done for each fuel used for generation.

1.13. The quantity of each fuel burned should be entered into column (a) of Table 4.1.1 or 4.1.2 of the monthly data template. The GCV of each fuel should be entered into column (b) of the monthly data template. When doing this, generators should also ensure that:

- the quantity of fuel is a weight or volume
- the measurement unit of the weight or volume is the same for all fuels, for example, all in litres or all in tonnes.
- the energy unit of the GCV is the same for all fuels, for example, all in MJ or all in GJ.
- The units of the weight or volume match the units of the GCV, for example, if the weight or volume is in tonnes the GCV should be per tonne.

Step 1: Calculate the quantity of each fuel

1.14. The weight or volume of biomass burned should only include biomass burned resulting in the generation of electricity. Any biomass not used for the generation of electricity should either be deducted or not included. For more information see Chapter 5.

Quantity (ai) = quantity measured – quantity not resulting in generation

Step 2: Calculate the GCV of each fuel

1.15. The GCV calculation in Step 2 is a weighted average. It is calculated by multiplying the quantity of the fuel used in the month from which each sample was taken by the GCV of the sample. This calculation should be done for each sample taken. This is indicated by the letter j in the formula. The average is then the sum of these figures divided by the total quantity of that fuel burned in the month. This calculation should be repeated for each fuel burned. This is indicated by the letter i in the formula.

1.16. Taking a weighted average helps ensure that the GCV used in step 3 is representative of what is burned. So, if a sample has an exceptionally high or low GCV but is taken from only a small amount of the fuel used for generation the GCV used for the fuel as a whole is not biased upwards or downwards.

1.17. There may be circumstances in which it is difficult to calculate a weighted average. In such instances we may accept other calculations such as an unweighted average. These will be judged on a case by case basis, we will be looking to ensure that any alternative method will not result in more ROCs being issued than otherwise would be the case.

Weighted average GCV (bi) = ∑ (quantity from which sample was taken x sampled GCV) j ÷ Quantity (ai)

Step 3: Calculate the energy content of each fuel

1.18. This step calculates the energy content of each fuel used. This is done by multiplying the quantity of the fuel with the (weighted average) GCV of the fuel used.

Energy content (ci) = quantity (ai) x GCV (bi)

Steps 4 and 5: Calculating the percentage biomass contribution of each fuel

1.19. Steps 4 and 5 use the energy content calculated in steps 1 to 3 to work out the percentage of the overall energy content attributable to the biomass fraction of the biomass fuels used for generation. This is done by dividing the biomass energy content of each biomass fuel by the total energy content of all fuel used for generation.

Step 4: Sum the energy content contributions of all fuels

1.20. This calculates the total energy content of all fuels used by adding together the energy content of each of the fuels.

Total energy content of fuels (d) = Sum of energy contents (∑ci)

Step 5: Calculate the percentage biomass energy content of each fuel

1.21. Step 5 sets out two calculations. One of the two calculations should be done for each biomass fuel used. Calculation (a) should be used where there is no contamination and calculation (b) where the biomass fuel is contaminated with fossil fuel. Generators should read the 'contamination' section in Chapter 5 before deciding whether or not their fuel is contaminated. Calculations (a) and (b) are essentially the same calculation, with calculation (a) assuming a biomass fraction of 100 per cent.

1.22. Calculation (a) is the energy content of the fuel divided by the total energy content of all fuels multiplied by 100

Percentage biomass energy content (ei) = energy content (ci) ÷ total energy content of fuels (d) x 100

1.23. Any fossil fuel use including contamination of a biomass fuel must be deducted for the ROC issue. Because calculation (a) is used where the fuel is 100% biomass, this calculation is exactly as described in the first paragraph.

1.24. Calculation (b) is used to deduct fossil fuel contamination of a biomass fuel from the ROC issue. This could be alcohol used to produce biodiesel or plastic contamination from packaging. Calculation (b) works out the biomass fraction of the biomass fuel by energy content. It deducts the fossil fuel by not including the energy content attributable to fossil fuel in the percentage of electrical output that qualifies for ROCs.

1.25. Calculation (b) is split into three steps. It requires the generator to have the following information:

- the quantity of the whole fuel used for generation
- the percentage of biomass in the fuel by weight or volume
- the GCV of the biomass in the fuel

Step (I) Calculating the weight or volume of the fuel

1.26. It may be almost impossible to measure the weight or volume of the biomass fraction of the fuel in the usual way e.g. using a weighbridge or belt weigher. So the quantity is often calculated as in step I, by multiplying the weight or volume of the whole fuel burned by the percentage by weight or volume of the biomass in the fuel. The percentage is generally determined by representative sampling.

1.27. The GCV of the biomass fraction may also be difficult to determine. Various methods can be used to derive the GCV of the biomass fraction of a fuel.

Quantity of biomass fraction = quantity (ai) x percentage biomass by weight in fuel

Step (II) Calculating the energy content of the biomass fraction

1.28. Step II is to work out the energy content of biomass that resulted in generation. It is the quantity of the biomass fraction as calculated in step I, multiplied by the GCV of the biomass fraction.

Biomass energy content = quantity of biomass fraction x GCV of biomass fraction

Step (III) Calculating the percentage energy content of the biomass fraction

1.29. Step III calculates the percentage biomass energy content contribution to generation made by the fuel. This is done by dividing the energy content of the biomass fraction by the total energy content of all fuel used for generation.

Percentage biomass energy content (ei) = biomass energy content ÷ total energy content of fuels (d) x 100

1.30. Generators may not always wish to use this method of calculation to deduct fossil fuel contamination. For example, they may find that the information they have lends itself better to the opposite calculation. This would be to work out the energy content attributable to fossil fuel and to deduct this from the energy content of the whole fuel. Whilst calculations may vary, they will all achieve the same result - deducting the energy content of the fossil fuel contamination from the biomass fuel.

Step 6: Has the biomass definition been met?

1.31. To qualify as biomass under the Orders the biomass fraction of each fuel must be at least 90 per cent by energy content. If the biomass fraction is less than 90 per cent then the biomass definition has not been met. If the biomass definition is not met, ROCs can only be issued to generating stations burning waste which are an Advanced Conversion Technology or that are CHPQA accredited. See the section on waste for more information.

1.32. For each contaminated biomass fuel, generators will need to work out whether the energy content of the fuel is at least 90 per cent biomass. This is done by dividing the energy content of biomass in the fuel by the energy content of the whole fuel. The biomass energy content will be the figure resulting from step III, calculation (b), Step 5. The total energy content will be the figure from Step 4.

Percentage biomass energy content of fuel = biomass energy content of fuel ÷ total energy content of fuel x 100

Step 7: Calculating the biomass qualifying percentage

1.33. The qualifying percentage to be used in the calculation for the issue of ROCs is a total of the biomass percentages calculated for each fuel in Step 5. The qualifying percentage from this calculation should be entered into the 'fuel stations (4)' worksheet of the monthly data template and 1.5 in the 'all stations (1)' worksheet of the monthly data template.

Qualifying percentage (E) = sum of percentage biomass energy contents (∑ei)

Step 8: Are biomass or co-fired ROCs to be issued?

1.34. Chapter 2 explains when a generating station is eligible for co-fired ROCs and when it is eligible for biomass ROCs. This can depend on whether fossil fuel or waste used in the station come under Article 8(3). The calculation in Step 8 works out whether the fossil fuel and/or waste used for Article 8(3) purposes exceeds ten per cent of the energy content of all the fuel used. Energy content is calculated in the same way as described in the calculations above. If the energy content of the fossil fuel and/or waste does not exceed ten per cent then biomass ROCs will be issued, otherwise co-fired or waste ROCs will be issued.

Percentage energy content of fossil fuel or waste used for Article 8(3) purposes = energy content of fossil fuel or waste used for Article 8(3) purposes ÷ total energy content of fuel used at the station x 100

CHPQA accredited waste generating stations

1.35. The approach to the issue of ROCs for CHP stations using waste under the RO is similar to the approach to the Climate Change Levy, which uses the CHP Quality

Assurance scheme. Generators that are fully compliant with the Good Quality benchmark (that is they have a high efficiency of electricity generation and heat use) will receive ROCs on all of their biomass-generated electricity. Generators that are partially compliant (typically with a lower or intermittent heat use), will receive ROCs on a lower fraction of their electricity generation. This will be determined by the relationship between their qualifying power output (QPO) and total power output (TPO) in the same manner as for the CCL exemption.

1.36. For example, a CHP generator burning waste that is fully exempt from the CCL and uses a waste stream that is 50% biomass will receive ROCs on 50% of their electricity generation, whereas a plant using the same waste stream but which is only 70% CCL compliant (that is, QPO is 70% of TPO) will receive ROCs on 35% (70% of 50%) of their electricity generation.

1.37. ROCs will be issued for the qualifying power output using the following calculation.

ROCs issued = (total eligible output – total input) x biomass qualifying percentage x qualifying power output/total power output

1.38. The QPO and TPO will be based on the most recent certificate held by the generator, but, unlike the CCL, there will not be an end-of-year reconciliation process.

1.39. When generators submit claims for ROCs they will need to submit the figure calculated before the ratio of QPO to TPO is applied. The monthly data template should be completed as if the generator were claiming ROCs for all its output, not just its QPO. Ofgem will do the QPO/TPO calculation automatically in its database.

Alternative ways of calculating the qualifying percentage

1.40. Under Article 2(1) each biomass fuel stream must have a plant or animal matter derived energy content of at least 90 per cent. If a generator can satisfy us that each biomass they are using is over 90 per cent pure, the default position is that 10 per cent of the electricity generated from biomass will be treated as having been generated from fossil fuel. We will issue ROCs using a greater percentage if we can be satisfied that the biomass fuel is over 90 per cent pure. Most generating stations choose to do this by providing accurate measurement and sampling information and there are examples throughout this document of how this can be done. Where it is not possible to provide accurate figures, an estimate may be agreed in advance. For estimates to be agreed they should reflect reality and not be biased resulting in the award of more ROCs than would have been the case if the ROC issue had been based on figures from accurate measurement. For this reason, where estimates are agreed, they will generally be conservative. There should also be a logical process for an estimated calculation rather than reliance on an arbitrary figure or figures.

Summary of calculation

Step 1: Calculate the quantity of each fuel

Quantity (ai) = quantity measured – quantity not resulting in generation

This calculation is not done in the monthly data template

Step 2: Calculate the GCV of each fuel

Weighted average GCV (bi) = ∑ (quantity from which sample was taken x sampled GCV) j ÷ Quantity (ai)

This calculation is not done in the monthly data template

Step 3: Calculate the energy content of each fuel

Energy content (ci) = quantity (ai) x GCV (bi)

This calculation is done automatically in the monthly data template.

Step 4: Sum the energy content contributions of all fuels

Total energy content of fuels (d) = Sum of energy contents (∑ci)

This calculation is done automatically in the monthly data template.

Step 5: Calculate the percentage biomass energy content of each fuel

(a) Calculate the percentage energy content for a non contaminated fuel

Percentage biomass energy content (ei) = energy content (ci) ÷ total energy content of fuels (d) x 100

This calculation is done automatically in the monthly data template.

(b) Calculate the percentage energy content for a contaminated fuel

Step (I) Calculating the weight or volume of the fuel

Quantity of biomass fraction = quantity (ai) x percentage biomass by weight in fuel

Step (II) Calculating the energy content of the biomass fraction

Biomass energy content = quantity of biomass fraction x GCV of biomass fraction

Step (III) Calculating the percentage energy content of the biomass fraction

Percentage biomass energy content (ei) = biomass energy content ÷ total energy content of fuels (d) x 100

This calculation is not done in the template.

Step 6: Has the biomass definition met?

Percentage biomass energy content of fuel = biomass energy content of fuel ÷ total energy content of fuel x 100

This calculation should be done separately for each contaminated biomass fuel.

This calculation is not done automatically in the monthly data template.

Step 7: Calculating the biomass qualifying percentage

Qualifying percentage (E) = sum of percentage biomass energy contents (∑ei)

Step 8: Are biomass or co-fired ROCs to be issued?

Percentage energy content of fossil fuel or waste used for Article 8(3) purposes = energy content of fossil fuel or waste used for Article 8(3) purposes ÷ total energy content of fuel used at the station x 100

This calculation is not done automatically in the monthly data template.

Appendix 7 - Example ROC calculations

Example 1 – Biomass only, no contamination

1.1. Generators must perform the calculations for each fuel used. We have used straw as an example.

1.2. The 'Stations using fuel (4)' sheet of the monthly template is completed as below:

4.1.1 Renewable fuels resulting in electricity generation

Renewable fuel	Quantity (a)	Unit of measurement eg tonnes, kg	Gross CV (b)	Unit of measurement eg MJ/kg, GJ/tonne	Energy content contribution to total generation (c) = (a*b)	% Energy content contribution to total generation (e) = (c/d *100)
Short Rotation Coppice	900	tonnes	10	GJ/tonne	9000	46.997389034%
Waste wood	550	tonnes	15	GJ/tonne	8250	43.080939948%
Straw	60	tonnes	15	GJ/tonne	900	4.6997389034%
Qualifying percentage (E) = sum of (e) then rounded to 2 decimal places						94.78%

4.1.2 Fossil fuel resulting in electricity generation

Renewable fuel	Quantity (a)	Unit of measurement eg tonnes, kg	Gross CV (b)	Unit of measurement eg MJ/kg, GJ/tonne	Energy content contribution to total generation (c) = (a*b)	% Energy content contribution to total generation (e) = (c/d *100)
Coal	25	tonnes	40	GJ/tonne	1000	5.2219321149%
Total energy content of fuels used for the generation of electricity (d)					19150	5.22%

4.2 Fuels/waste used for Article 8(3) purposes

Fuel type	Fuel eg Gas oil, HFO	Quantity	Unit of measurement eg tonnes	Gross calorific value	Unit of measurement eg GJ/tonne	What quantity of this fuel resulted in electricity generation?
Fossil fuel	Coal	50	tonnes	40	GJ/tonne	25

Step 1: Calculate the quantity of each fuel

60 tonnes of straw were burned and no straw was used that did not result in generation.

Quantity (a) = 60 – 0 = 60 tonnes

Step 2: Calculate the GCV of each fuel

Three samples were taken of the straw, one from a 10 tonne delivery, one from a 20 tonne delivery and one from a 30 tonne delivery. The sampling analysis came back with GCVs of 13, 16 and 15 respectively.

GCV of the samples = 13 x 10 + 16 x 20 + 15 x 30 = 900

The weighted GCV of the samples = 900/60 = 15

Step 3: Calculate the energy content contribution of each fuel

Energy content of straw = 60 x 15 = 900

Step 4: Sum the energy content contributions of all fuels

Total energy content of all fuels (d) = 9000 + 8250 + 900 + 1000 = 19150

Step 5: Calculate the percentage energy content contribution of each fuel

As there is no contamination of the straw calculation (a) is used.

% Biomass energy content of straw = 900/19150 x 100 = 4.6997389034%

Step 6: Has the biomass definition met?

As none of the fuels are contaminated this is not applicable.

Step 7: Calculating the biomass qualifying percentage

biomass qualifying percentage = 46.997389034% + 43.080939948% + 4.6997389034% = 94.778067885118%

Rounded to 2 decimal places this is 94.78%

Assuming the gross output of the station is 1,000,000 kWh and the input is 0 kWh, 948 ROCs would be issued.

The number of ROCs issued = 1,000,000 * 0.9478 = 947,800 kWh = 948

Step 8: Are biomass or co-fired ROCs to be issued?

Percentage energy content of fossil fuel or waste used for Article 8(3) purposes = (50 x 40) ÷ (19150 + (25 x 40)) x 100 = 2000/20150 =9.93%

50 x 25 is the energy content of the coal used that was not used for generation.

As this does not exceed 10% biomass ROCs will be issued.

Example 2 - Co-fired with no contamination

1.3. The 'stations using fuel (4)' sheet of the monthly template is completed below:

4.1.1 Renewable fuels resulting in electricity generation

Renewable fuel	Quantity (a)	Unit of measurement eg tonnes, kg	Gross CV (b)	Unit of measurement eg MJ/kg, GJ/tonne	Energy content contribution to total generation (c) = (a*b)	% Energy content contribution to total generation (e) = (c/d *100)
Short Rotation Coppice	900	tonnes	10	GJ/tonne	9000	4.0881217%
Waste wood	550	tonnes	15	GJ/tonne	8250	3.747449%
Straw	60	tonnes	15	GJ/tonne	900	0.4088121%
Qualifying percentage (E) = sum of (e) then rounded to 2 decimal places						8.24%

4.1.2 Fossil fuel resulting in electricity generation

Renewable fuel	Quantity (a)	Unit of measurement eg tonnes, kg	Gross CV (b)	Unit of measurement eg MJ/kg, GJ/tonne	Energy content contribution to total generation (c) = (a*b)	% Energy content contribution to total generation (e) = (c/d *100)
Coal	5000	Tonne	40	GJ/tonne	200000	90.8471496 %
HFO	50	Tonne	40	GJ/tonne	2000	0.9084714%
Total energy content of fuels used for the generation of electricity (d)					220150	91.76%

4.2 Fuels/waste used for Article 8(3) purposes

Fuel type	Fuel eg Gas oil, HFO	Quantity	Unit of measurement eg tonnes	Gross calorific value	Unit of measurement eg GJ/tonne	What quantity of this fuel resulted in electricity generation?
Fossil fuel	HFO	100	Tonne	40	GJ/Tonne	50

Steps 1 – 5 are the same as example 1.

Step 6: Has the biomass definition met?

As none of the fuels are contaminated this is not applicable

Step 7: Calculating the biomass qualifying percentage

Biomass qualifying % = 4.0881217 + 3.747449 + 0.4088121 = 8.2443828%

Biomass qualifying % rounded to 2 decimal places = 8.24%

Assuming a gross output of 10,000,000 kWh and input of 0, 824 ROCs would be issued.

ROCs issued = 10,000,000 * 0.0824 = 824,000 kWh = 824

Step 8: Are biomass or co-fired ROCs to be issued?

In this circumstance the station is using fossil fuel that is not used for Article 8(3) purposes. It is therefore considered to be partly fuelled by fossil fuel. As Article 8(3) is already not met the calculation for Article 8(3) does not need to be performed. Co-fired ROCs will be issued.

Example 3 – Co-fired with contamination

1.4. The 'stations using fuel (4)' sheet of the monthly template is completed a below:

4.1.1 Renewable fuels resulting in electricity generation

Renewable fuel	Quantity (a)	Unit of measurement eg tonnes, kg	Gross CV (b)	Unit of measurement eg MJ/kg, GJ/tonne	Energy content contribution to total generation (c) = (a*b)	% Energy content contribution to total generation (e) = (c/d *100)
Short Rotation Coppice	900	tonnes	10	GJ/tonne	9000	4.0881217%
Waste wood	550	tonnes	15	GJ/tonne	8250	3.747449%
Straw	60	tonnes	15	GJ/tonne	900	0.4088121%
Qualifying percentage (E) = sum of (e) then rounded to 2 dp						8.24%

4.1.2 Fossil fuel resulting in electricity generation

Renewable fuel	Quantity (a)	Unit of measurement eg tonnes, kg	Gross CV (b)	Unit of measurement eg MJ/kg, GJ/tonne	Energy content contribution to total generation (c) = (a*b)	% Energy content contribution to total generation (e) = (c/d *100)
Coal	5000	Tonne	40	GJ/tonne	200000	90.8471496
HFO	50	Tonne	40	GJ/tonne	2000	0.9084714
Total energy content of fuels used for the generation of electricity (d)					220150	91.76%

4.2 Fuels/waste used for Article 8(3) purposes

Fuel type	Fuel eg Gas oil, HFO	Quantity	Unit of measurement eg tonnes	Gross calorific value	Unit of measurement eg GJ/tonne	What quantity of this fuel resulted in electricity generation ?

Fossil fuel	HFO	100	Tonne	40	GJ/Tonne	50

Steps 1 – 4 are the same as example 1.

Step 5: Calculate the percentage biomass energy content of each fuel

We have assumed there is plastic contamination of the straw, because of this calculation (b) is used.

Step (I) Calculating the weight or volume of the fuel

Percentage biomass by weight in straw (%) = 97%

We have assumed only one sample was taken in the month so a weighted average of the percentage by weight from sampling analysis has not been calculated.

Quantity of biomass fraction burned = 0.97 x 60 = 58.2 tonnes

Step (II) Calculating the energy content of the biomass fraction

We have assumed that the GCV of the biomass fraction = 14

Biomass energy content = 58.2 x 14 = 814.8

Step (III) Calculating the percentage energy content of the biomass fraction

Percentage biomass energy content = 814.8/220150 x 100 = 0.3701112%

Step 6: Has the biomass definition been met?

Percentage biomass energy content = 814.8/900 x 100 = 90.5333333%

As this is above 90% ROCs can be issued this month provided all other information is satisfactory.

Step 7: Calculating the biomass qualifying percentage

Biomass qualifying % = 4.0881217 + 3.747449 + 0.3701112 = 8.2056819

Biomass qualifying % rounded to 2 d.p. = 8.21%

Assuming a gross output of 10,000,000 and input of 0, 821 ROCs would be issued.

ROCs issued = 10,000,000 * 0.0821 = 82,100 = 821

Step 8: Are biomass or co-fired ROCs to be issued?

In this circumstance the station is using fossil fuel that is not used for Article 8(3) purposes. It is therefore considered to be partly fuelled by fossil fuel. As Article 8(3) is already not met the calculation for Article 8(3) does not need to be performed. Co-fired ROCs will be issued.

Appendix 8 - Monthly fuel template

Fuel use - to be completed by generating stations using fuel

Version No: 2

Month and year of generation

4.1.1 Renewable fuels resulting in electricity generation

	Renewable fuel	Quantity (a)	Unit of measurement eg tonnes, kg	Gross calorific value (b)	Unit of measurement eg MJ/kg, GJ/tonne	Heat contribution (c) = (a*b)	Percentage contribution to total generation (e) = (c/d*100)	Does Ofgem have copies of representative samples taken at generating station?	Does Ofgem have a copy of the purchase contract for the fuel?	What date does the purchase contract expire?	Was there any visible contamination of the fuel?	What was the contamination percentage of the biomass used for generation?
1						0	0.000000000000%	Please answer	Please answer	Please answer	Please answer	Please answer
2						0	0.000000000000%	Please answer	Please answer	Please answer	Please answer	Please answer
3						0	0.000000000000%	Please answer	Please answer	Please answer	Please answer	Please answer
4						0	0.000000000000%	Please answer	Please answer	Please answer	Please answer	Please answer
5						0	0.000000000000%	Please answer	Please answer	Please answer	Please answer	Please answer
6						0	0.000000000000%	Please answer	Please answer	Please answer	Please answer	Please answer
7						0	0.000000000000%	Please answer	Please answer	Please answer	Please answer	Please answer
8						0	0.000000000000%	Please answer	Please answer	Please answer	Please answer	Please answer
9						0	0.000000000000%	Please answer	Please answer	Please answer	Please answer	Please answer
10						0	0.000000000000%	Please answer	Please answer	Please answer	Please answer	Please answer
11						0	0.000000000000%	Please answer	Please answer	Please answer	Please answer	Please answer
12						0	0.000000000000%	Please answer	Please answer	Please answer	Please answer	Please answer
Qualifying percentage (E) = sum of (e) then rounded to 2 dp												

4.1.2 Fossil fuel resulting in electricity generation

	Fossil fuel	Quantity (a)	Unit of measurement eg tonnes, kg	Gross calorific value (b)	Unit of measurement eg MJ/kg, GJ/tonne	Heat contribution (c) = (a*b)	Percentage contribution to total generation (c/d*100)
1						0	0.000000000000%
2						0	0.000000000000%
3						0	0.000000000000%
4						0	0.000000000000%
Total heat contribution of fuels used for the generation of electricity (d)						0	0.00%

Relevant comments:

4.2 Fuels/waste used for Article 8(3) purposes

	Fuel type	Fuel eg Gas oil, HFO	Quantity	Unit of measure-ment eg tonnes	Gross calorific value	Unit of measurement eg GJ/tonne	What quantity of this fuel resulted in electricity generation?
1	Please answer						
2	Please answer						
3	Please answer						

Appendix 9 - Glossary

A

ACT

Advanced Conversion Technology

ASTM

American Society for Testing and Materials

B

BWG

DTI/Ofgem Biomass Working Group

BS

British Standard

C

CHP

Combined Heat and Power

CHPQA

Combined Heat and Power Quality Assurance

CEN

European Committee for Standardisation

CCL

Climate Change Levy

D

DTI

Department of Trade and Industry

Defra

Department for the Environment, Food and Rural Affairs

E

EU

European Union

EN

European Norm (Standard)

F

FMS

Fuel Measurement and Sampling

FES

Future Energy Solutions

G

GCV

Gross Calorific Value

GJ

Gigajoule

H

HFO

Heavy Fuel Oil

I

ISO

International Organisation for Standardisation

K

Kg

Kilogram

M

MSW

Municipal Solid Waste

MJ

Megajoule

O

Ofgem

Office of Gas and Electricity Markets

OIML

Organisation Internationale de Metrologie Legale

P

PKE

Pine Kernal Extract

Q

QPO

Qualifying Power Output

R

RO

Renewables Obligation

ROC

Renewables Obligation Certificate

RFO

Recycled Fuel Oil

S

SoS

Secretary of State

SRF

Solid Recovered Fuel

T

TPO

Total Power Output

Appendix 10 - Industry standards

CEN 343 - This set of European drafts standards which covers many aspects of the measurement, sampling and management of solid recovered fuels.

The most relevant are:

CEN/TS 15440 - solid recovered fuels - method for the determination of biomass content

CEN/TS 15358 - solid recovered fuels - quality management systems - particular requirements for their application to the production of solid recovered fuels.

ISO 3170 - Petroleum liquids: manual sampling – this specifies the manual methods for sampling from fixed tanks, railcars, road vehicles, ships and barges, drums, cans or from liquids being pumped in pipelines.

ISO 3171 - Petroleum liquids: automatic pipeline sampling – this specifies procedures for crude oil and liquid petroleum products being conveyed by pipeline.

BS 2000 Pt 61 - Methods of test for petroleum and its products – this specifies methods for sampling and analysis of liquid fuels.

BS EN 30012-1 - This British Standard BS EN 30012-1 presents in detail methods of calibration for static weighing devices and for determining periodic confirmation intervals

EN 14214 - European biodiesel standard, which specifies the minimum standard that biodiesel must meet.

ASTM D 4057-95(2000) – American standard for manual sampling of petroleum and petroleum products. Covers procedures for representative sampling of petroleum products. The procedures described may also be applicable in sampling most non-corrosive liquid industrial chemicals, provided safety precautions are strictly followed.

ASTM D 4177 - This American standard describes the automatic extraction of sample increments from a pipeline. It was designed for petroleum products but should be applicable to most biomass liquids.

BS 1016 Methods for analysis and testing of coal and coke (for example for moisture content, ash, volatile matter, gross calorific value, sulphur, chlorine, carbon, hydrogen and nitrogen).

BS 1017 (Part 1) Methods for the automatic or manual sampling pf coal. The mechanical sampling aspects of BS 1017 - 1:1989 (coal) and BS1017 - 2:1994 (coke) have been superseded by BS ISO 13909 parts 1 to 8. The manual sampling aspects of BS1017 will be replaced by BS ISO 18383, currently in preparation. BS 1017-1 and BS1017-2 will be withdrawn on publication of BS ISO 18383.