RISCAuthority

administered by FPA Fire Protection Association

RC64: Recommendations for fire safety with small biomass installations

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Contents

Summary of Key Points

This document has been developed through the RISCAuthority and published by the Fire Protection Association (FPA). RISCAuthority membership comprises a group of UK insurers that actively support a number of expert working groups developing and promulgating best practice for the protection of people, property, business and the environment from loss due to fire and other risks. The table below summarises the key points of the document.

Comply with fire safety legislation	• Because of the danger of carbon monoxide and carbon dioxide being produced an assessment should be undertaken in accordance with the Dangerous Substances and Explosive Atmospheres Regulations 2002 (as amended in 2015), (DSEAR). (5.1.3) • All fire risk assessments should consider the possibility of deliberate fire setting. (5.1.2)
Fire safety management	• Where a significant biomass installation is being planned consideration should be given to liaising with the local fire and rescue service at the initial stages to allow the service to visit the site to establish the location and extent of water supplies available in the locality. (5.3.1) • Staff training should address the potential risk to staff of entering a pellet or wood chip store where there may be a hazardous atmosphere. (5.3.3)
The selection of fuel	• The biomass fuel selected should be easy to source to ensure a regular supply and in a form that can be delivered readily into the store or storage container. (5.4.1)
Storage of biomass fuel	• Purpose built fuel stores should be provided for fuel, preferably independent buildings linked to the heating installation by the biomass feed system. Where this is not possible, the store should be separated from the remainder of the building by a form of construction that provides at least 60 minutes fire resistance with entry only from the outside. • At the planning stage the volume and hence the storage requirements for the chosen fuel should be calculated to allow suitable provisions to be provided.
Biomass heating systems	• When considering installing a biomass boiler system, the form of fuel to be used should be identified prior to the purchase of equipment. (5.6.1)
Maintenance	• All biomass boilers and associated equipment should be installed, commissioned and maintained by a HETAS approved and qualified engineer working to their current standard MIS 3004 or an engineer who holds a valid training certificate or qualification for installation and servicing from the manufacture of the boiler or associated equipment. (5.7.1)
Reducing the dangers of self heating of fuel	• Flow from the biomass store that results in a first in, first out regime should be established as it minimises spoilage and self heating. (5.8.2)
Fire protection	• Fires in large stocks of biomass fuels develop very slowly thus there is time to take a measured approach to the problems associated with firefighting. (5.9.1 and 5.9.7)

Symbols used in this guide


Good practice


Bad practice


Discussion topic

Frequently asked question

1 Introduction

Biomass fuelled heating systems burn wood pellets, chips, logs, dried seaweed or even some forms of crops to provide hot water for heating purposes. These forms of feedstock make excellent biomass fuels and provided they are not contaminated can be used in a wide variety of biomass technologies. These recommendations focus on wood chip and wood pellet systems, currently the most commonly encountered form of biomass installations.

Biomass fuels have low energy densities compared to fossil fuels. Nevertheless, different types of woody fuels should not be mixed together,as differing moisture content and chemical makeup can have an effect on the overall mass to energy conversion rate and the efficiency of a biomass process. Despite the technology involved in the combustion process being relatively straightforward, there are significant hazards associated with the storage of the wood pellets and chips. Storage conditions may result in the production and accumulation of carbon monoxide and carbon dioxide in biomass stores with a resulting depletion in the level of oxygen. Several instances are recorded of fatalities associated with this behaviour, especially where pellets, which are associated with higher levels of carbon monoxide production than wood chips, are stored. This hazard is most prevalent within six weeks of pellet manufacture.

In addition, conditions during delivery or moving the product, for example to load hoppers, may distribute hazardous quantities of dust in the atmosphere. Under some conditions self-heating may also occur. Further background information is set out in HSE Research Report RR1077 (ref. 1) and is therefore not repeated here. A great deal of additional information may also be found in the Carbon Trust/Combustion Engineering Association's publication: *Health and Safety in Biomass Systems – Design and Operation Guide* (ref. 2).

2 Scope

Wood pellet and wood chip boilers are now in use in a wide range of premises including homes, community centres, schools, colleges, warehouses and industrial buildings. These recommendations are concerned with the production of energy from biomass as an alternative to oil or gas fired boilers in domestic and commercial environments. Wood chip or wood pellet systems of this scale are normally associated with providing a hot water supply of 70-80°C operating temperature with the boiler typically rated between 50kW and 3MW. Hot water systems greater than 3MW (with either single or multiple boilers) are outside the scope of these Recommendations. Also outside the scope of this document are stoves: space heating appliances often featuring opening doors at the front.

3 Synopsis

These recommendations provide advice regarding the selection, storage, handling and use of biomass fuels. The nature of the hazards and forms of fire protection measures that should be considered for biomass installations are discussed together with measures that may be taken to reduce the hazards associated with the self heating of fuel. These Recommendations refer to small commercial systems rather than large industrial plant.

4 Definitions

Auger feed

An auger feed consists of a shaft with a broad helical flange resembling a corkscrew rotating to force bulk materials from one end to the other. In biomass installations the auger is often enclosed within a cylindrical casing.

Biomass fuel

Biomass fuels are organic materials produced from virgin wood, energy crops and industrial waste such as dust. (Although wood based fuels are most commonly encountered as they present a reliable product of known composition, animal wastes and municipal solid waste may also be employed.)

Slumber

Slumber mode is when a wood burning or solid fuel appliance is purposely set at a low or minimum output normally for overnight burning to be revived in the morning without the need for relighting.

5 Recommendations

5.1 Compliance with fire safety legislation

5.1.1 In premises to which the Regulatory Reform (Fire Safety) Order 2005 (or equivalent legislation in Scotland and Northern Ireland) apply (refs. 3, 4, 5, 6, 7), a fire risk assessment should be carried out and recorded by a competent person. The assessment should be reviewed whenever there is a significant change in the process. This will include the introduction of a biomass boiler onto the site and any changes in the type and quantities of biomass that are stored and the manner in which they are handled and used thereafter.

5.1.2 All fire risk assessments should consider the possibility of deliberate fire setting, especially where the premises are not occupied 24 hours a day.

5.1.3 Where significant quantities of wood chips and pellets are stored, there is a danger of carbon monoxide being produced, as well as carbon dioxide, with a resulting depletion of oxygen levels. This is a particular hazard where pellets are stored. An assessment should therefore be undertaken in accordance with the Dangerous Substances and Explosive Atmospheres Regulations 2002 (as amended in 2015), (DSEAR) (ref. 8). In common with the fire risk assessment, this should be undertaken by a competent person.

5.1.4 The DSEAR assessment should also address the potential build up of dust and creation of explosive mixtures of dust from biomass products in the atmosphere.

5.1.5 Although not directly related to fire safety, where the storage of biomass is introduced onto premises there should be a safe system of work. Fuel stores should thus be considered to be confined spaces as defined by the Confined Space Regulations 1997 (ref. 9).

5.1.6 An assessment should also be undertaken in compliance with the Control of Substances Hazardous to Health (COSHH) Regulations 2002 (ref. 10).

5.1.7 Further guidance regarding fire safety risk assessments and choosing a competent fire risk assessor are available in a National Fire Chiefs Council guidance document (ref. 11) and in RISCAuthority Recommendation RC66 (ref. 12).

5.2 Business continuity

5.2.1 Fire hazards and thus the threats to a business are increased by the need for some processes to continue during the night or over weekends when no, or few, staff may be present. It is therefore paramount that careful consideration be given to fire safety implications of a process working unattended when equipment is being specified and the fire risk assessment is undertaken. Further advice is set out in RISCAuthority Recommendations for fire safety of unattended processes RC42 (ref. 13).

5.2.2 All organisations should take steps to ensure the continued smooth running of their business by making a suitable emergency plan. Guidance for this is set out in Business Resilience: A Guide to protecting Your Business and its People (ref. 14). The emergency plan should address the implications of a fire, flood and other

perceived disasters on all facets of the business model. It should indicate the lines of communication that should be followed and the contact details for specialist assistance, providers of alternative accommodation and alternative sources of biomass fuels.

5.2.3 When complete, the emergency plan should be rehearsed by means of an annual table top exercise, with the results being assessed and amendments made to the plan as necessary.

5.2.4 Consideration may be given to applying commercially available computer programmes, such as the ROBUST software (Resilient Business Software Toolkit) that is available to download from the internet (ref. 15), or other appropriate product, to develop and check the adequacy of the plan.

5.3 Fire safety management (general)

5.3.1 Where a significant biomass installation is being planned, consideration should be given to liaising with the local fire and rescue service at the initial stages to allow the service to visit the site to establish the location and extent of water supplies available in the locality.

5.3.2 The benefits of a carefully planned and comprehensive fire safety management regime coupled with appropriate fire safety routines and adequate staff training which is observed and embraced by all staff cannot be over-emphasised.

5.3.3 Staff training should address the potential risk to staff of entering a pellet or wood chip store where there may be a hazardous atmosphere.

5.3.4 Access to such stores should be restricted to designated, suitably trained and competent staff. Certain activities may require a hot work permit to be generated and complied with. Biomass storage areas should normally be kept locked shut.

5.3.5 Pellet and wood chip stores to which entry may be made should have prominent warning signs displayed at the entrance and be fitted with carbon monoxide detectors which provide a local alarm and signal to a permanently attended location in the event of a rapid rise in the concentration of the gas (see 5.8.6).

- Ventilation conditions and the mechanism for feeding fuel into the boiler should be designed to deny a route for exhaust fumes (including carbon monoxide) to be able to permeate back to the fuel store. (5.3.6)

5.3.6 Ventilation conditions and the mechanism for feeding fuel into the boiler should be designed to deny a route for exhaust fumes (including carbon monoxide) to be able to permeate back to the fuel store. A continuous path of fuel should also be avoided in the design as this may lead to burn back. To assist in the prevention of burn back a chip lock valve (rotary valve or similar) should be fitted to prevent air from entering the feed tube from the storage bin so producing a chimney effect.

5.3.7 Unless unavoidable, no hot work such as welding, flame cutting and similar activities should take place within or adjacent to biomass fuel stores. If for justified reasons hot work is necessary, all such activities should be conducted under an effective Permit to Work system and in strict accordance with the RISCAuthority Recommendations for hot work RC7 (ref 16).

- Care should be taken during delivery and movement of the fuel (including during maintenance or repair operations) to minimise the distribution of dust in the atmosphere. (5.3.8)

5.3.8 Care should be taken during delivery and movement of the fuel (for example during maintenance or repair operations) to minimise the distribution of dust in the atmosphere. For example, the lower explosive limit (LEL) for wood dust varies with composition, particle size and moisture content but is generally regarded to be 40g/m^{-3} although quantities as low as 15g/m^{-3} have been reported to cause explosions (ref. 1).

5.3.9 Where there are long transport mechanisms consideration should be given to installing spark and linear heat detection along the conveyor. Should the transport mechanisms pass between different fire compartments it may be necessary for such automatic fire detection to initiate additional fire protection measures e.g. localised fire suppression systems around the conveyor and/or conveyor drop outs to prevent combustible materials continuing to pass between compartments. Consideration also should be given to providing anti-slip measures on long inclined belts (more commonly found on larger installations).

5.3.10 The use of damp pellets or wood must be avoided and the fire must not be left to slumber for long periods (such as overnight) as in this situation the boiler may fail to reach its design operating temperature, resulting in incomplete combustion and the production of tars, creosotes and high levels of carbon monoxide in the flue gases.

5.3.11 Over a period of time fines will concentrate on the bottom of the biomass store. In order to ensure smooth operation of the installation the store should be emptied and cleaned on a risk assessed basis but at least once every two years. In practice this is best done during the summer when checks on the condition of the conveyor belts and bearings of the transport mechanism should also be inspected and any necessary measures taken to prevent overheating. The use of thermographic surveying should be considered.

5.3.12 During the cleaning and inspection process the store should be vacuumed with an industrial vacuum cleaner rated for use in an ATEX Zone 22 (ref. 17); sweeping should not be undertaken to avoid the production of a combustible/explosive atmosphere.

5.3.13 Where a biomass boiler is to be installed in a building that is located in a National Park or enjoys for example National Heritage or Scotland listing, the local authority or Historic England/Historic Environment Scotland may need to be consulted regarding the visual impact of a chimney flue, fuel store or boiler house.

5.3.14 In some circumstances grants may be available towards the installation of a biomass boiler system but in some cases, conditions may require a number of associated energy efficiency measures to be undertaken in the property. These may include:

- Insulating the whole loft of the property to meet current building regulations
- Installing cavity wall insulation (if the property has cavity walls)
- Fitting low energy light bulbs in all appropriate light fittings
- Installing specified controls for the heating system (including thermostats and programmers/ timers)

5.3.15 If a biomass boiler is not being used in the winter months it should be drained down in accordance with the manufacturer's instructions to protect the installation from the effects of frost.

5.4 The selection of fuel

5.4.1 There is a wide range of biomass fuel sources available; the properties of the most common are set out in Table 1 with samples of conventional fuels included for comparison. The biomass fuel selected should be easy to source to ensure a regular supply and in a form that can be delivered readily into the store or storage container.

5.4.2 The moisture content of the fuel should be consistent and matched to the type of boiler. The fuel should neither be too dry nor too wet and thus the manufacturer's instructions should be followed when selecting the fuel to be used. Changes should not be made to the type of fuel employed without advice from the supplier of the boiler.

- Avoid the purchase of cheap or poor quality fuel as it may not be of consistent size or moisture content and may not be free of foreign objects. (5.4.3)

5.4.3 It is important, especially for small installations, that the fuel is of a good quality, of consistent size so as not to jam the feed mechanism and free of foreign objects. The fuel should meet a recognised standard; any problems encountered with the day to day operation of the installation will more likely be associated with the fuel than the boiler and associated equipment. BS EN ISO 17225 (ref. 18) is the recognised standard for solid biofuels.

5.4.4 Other than on farms and agricultural establishments where there may be a plentiful supply of wood chips of a consistent quality, a biomass pellet boiler is the most common selection for domestic or small commercial applications as the source of fuel of a consistent quality can be guaranteed.

Fuel	Energy density by mass (GJ/tonne)	Energy density by mass (kWh/kg)	Bulk density (kg/m^3)	Energy density by volume (MJ/m^3)	Energy density by volume (kWh/m^3)
Wood chips (very dependent on MC)	7-1	2-4	175-350	2,000-3,600	600-1,000
Log wood (stacked – air dry: 20% MC)	15	4.2	300-550	4,500-8,300	1,300-2,300
Wood (solid – oven dry)	18-21	5-5.8	450-800	8,100-16,800	2,300-4,600
Wood pellets	18	5	600-700	10,800-12,600	3,000-3,500
Miscanthus (bale)	17	4.7	120-160	2,000-2,700	560-750
Coal (lignite to anthracite)	20-30	5.6-8.3	800-1,000	36,500	4,500-9,100
Oil	42	11.7	36,500	39	10,200
Natural gas (NTP)	54	15	39		10.8

Table 1: Energy density and bulk density of fuels (1MJ = 0.27kWh and 227.8kWh). MC refers to Moisture Content as a %. Source: Forestry Commission

5.5 Storage of biomass fuel

5.5.1 Purpose built stores should be provided for fuel. Biomass stores should preferably be independent buildings linked to the heating installation by the biomass feed system. Where this is not possible, the store should be separated from the remainder of the building by a form of construction that provides at least 60 minutes fire resistance. Entry and fuel delivery provisions should be from the outside of the building only. Where necessary doors should be protected by bunker boards.

5.5.2 Biomass fuel stores should be built on impervious solid bases. The structure should be of non-combustible construction, weatherproof and lined internally to minimise the introduction of moisture and the escape of combustible dust.

5.5.3 The floor of the store should form a smooth, sloping and angled surface. In the case of wood pellets that flow freely the floor may be of a 'V' shape to allow pellets to flow to the auger feed at the base of the 'V' section.

5.5.4 Provisions should be available to ease delivery of the fuel. In the case of wood pellets, these may be blown from the delivery truck directly into the fuel store. When planning a new installation, it is therefore critical that access is available for a fuel delivery vehicle to park adjacent to the biomass store. Adequate access should also be allowed for fire and rescue service vehicles.

- When planning a new installation, it is critical that access is available for a fuel delivery vehicle to park adjacent to the biomass store. (5.5.4)

5.5.5 At the planning stage the volume and hence the storage requirements for the chosen fuel should be calculated to allow suitable provisions to be provided. When considering the volume of the store it should be noted that wood chips typically occupy some three times the volume of wood pellets for the same weight of wood.

5.5.6 The volume of the stored biomass will reflect the energy output of the boiler. In order to minimise the hazards it is desirable to provide a store that is as small as reasonably practicable; a 5m^3 storage space may be regarded to be the maximum for a small commercial building.

5.5.7 While the storage of biomass should be minimised, the quantities will need to be considered in the light of financial implications and the frequency of deliveries.

5.5.8 Checks should be made at the time of delivery to ensure that the fuel, especially wood chips, is not being delivered in an overheated condition. Where necessary the moisture content should be specified to the supplier and also be monitored periodically thereafter. A number of proprietary devices are available commercially to undertake these measurements.

5.5.9 Most biomass boilers have automatic auger feed mechanisms from bulk fuel stores. Only very small installations, mostly for domestic application, have a hopper instead that has to be filled manually. Hoppers can hold up to two days fuel supply. Where a

- A potentially dangerous atmosphere may be generated in a wood pellet or wood chip store. What operating procedures should be set in place to allow a safe system of working when entry to a biomass fuel store is necessary? (5.5.10 and 5.5.11)

FAQ

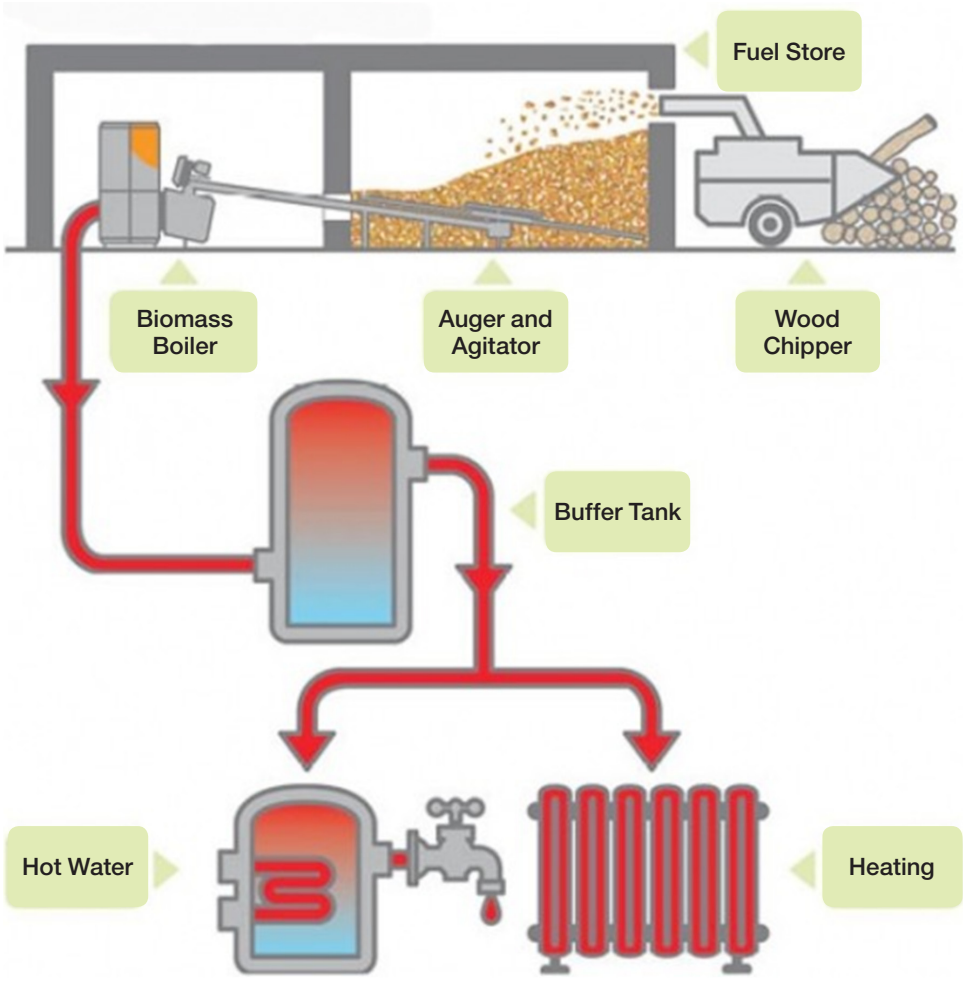
- How can providing adequate ventilation to reduce the build-up of a dangerous atmosphere be balanced in practice against the potential for excessive ventilation which may allow the ingress of moisture and lead to deterioration of the fuel? (5.5.11)

hopper feed system is installed it is most practical to purchase biomass in bags but such bags should still be stored as indicated in paragraph 5.5.1 above.

5.5.10 All relevant staff should be aware that potentially dangerous atmospheres may be generated in both wood pellet and wood chip stores. The hazards involve the production of carbon monoxide and carbon dioxide and hence the depletion of oxygen in the atmosphere. Dangerous atmospheres in fuel stores may also arise from poorly vented boiler combustion gases which may also contain carbon monoxide.

5.5.11 When considering the ventilation of wood chip and pellet stores providing adequate ventilation to reduce the build-up of a dangerous atmosphere should be balanced against the potential for excessive ventilation which may allow the ingress of moisture and lead to deterioration of the fuel.

5.5.12 The advice regarding the storage of biomass fuels provided by the suppliers and distributors should include relevant material safety data sheets (MSDS) and be read and observed.



5.5.13 As the ambient temperature and relative humidity in biomass stores can affect the build-up of toxic gases the environment in large stores should be controlled and monitored. (See 5.8.6)

5.5.14 Large installations require correspondingly large volumes of biomass pellets which may be stored in a silo. Silo storage introduces a number of serious fire and life safety hazards and should only be implemented having taken specialist advice and following consultation with the insurer of the property, the local authority and the fire and rescue service. Where small silos are provided there should be no opening in the walls or the base of the silo other than inspection ports that are opened periodically in accordance with an operating procedure to allow cleaning and inspection of the interior as otherwise air could be admitted. Silo storage of industrial quantities of biomass is outside the scope of these Recommendations and is not considered further in this document.

5.5.15 Silos should be painted a light colour to reflect heat from the sun so as to reduce the likelihood of self-heating of the stored fuel.

5.5.16 The designated storage area should be free of electrical installation, air ducts and water installations. Where electrical equipment is unavoidable equipment should be selected so as to be suitable for use in an ATEX Zone 22 (ref. 17) (i.e. an area in which an explosive atmosphere in the form of a cloud of combustible dust in air is not likely to occur but, if it does, will be present for a short period only). Switches for lights should be located outside the store.

5.5.17 To prevent caking of the fuel a form of mechanical agitation may be necessary when feeding fuel such as pellets into the boiler. Various proprietary solutions are available which may be linked to the auger drive.

5.5.18 Lightning protection should be provided on silos in accordance with BS EN 62305 (ref. 19). Elements of biomass storage systems, including silos, other storage containers, auger transport systems and other items of plant, including plastic pipe work, should be bonded and earthed to prevent the accumulation of electrostatic charges igniting accumulations of dust in the atmosphere. Further information is set out in RISCAuthority Recommendations RC 12 (ref. 20). Additional information regarding silos is provided in RC 10 (ref. 21)

5.6 Biomass heating systems

5.6.1 When considering installing a biomass boiler system, the form of fuel to be used should be identified prior to the purchase of equipment. Modern biomass boiler systems use proven technology and are reliable, clean and efficient. (Biomass boilers can operate at 92% efficiency levels, comparable with modern gas condensing boilers).

5.6.2 Boilers for domestic or small commercial applications burn fuel with the resulting hot gases being fed to a heat exchanger to provide hot water or heating. In larger systems the boiler is coupled to a heat/energy buffer store (in the form of well insulated hot water or accumulator tanks) which allows the boiler to work at maximum efficiency and hence more economically for a shorter period of time while the store is being charged. If this heat store is effectively designed, it can provide for peak loads experienced and hot water for sinks and showers. Specialist advice should be sought to ensure that a suitable form and capacity of heat store is installed.

5.6.3 Boiler controls are very similar to those of common gas condensing systems and consideration can be given to installing links to allow the equipment to be controlled remotely from a laptop, computer or other smart device where necessary.

5.6.4 Biomass boilers should be operated in accordance with the manufacturer's instructions, paying particular compliance with instructions concerning emissions of particulate matter and nitrogen oxides.

- Avoid purchasing biomass heating systems that are not of a recognised quality or do not meet the requirements of recognised European and International standards. (5.6.5)

5.6.5 Only biomass heating systems of a recognised quality should be purchased as these are manufactured to satisfy established European and International standards by companies that support quality production practices to demonstrate that all items that leave their production line meet the same standards as samples that have been tested to set relevant benchmarks. In the UK MCS 008: Product certification scheme – biomass (ref. 22) is the recognised standard providing ongoing independent, third party assessment and approval for small boilers (normally with a domestic application) with a nominal heat output up to 45kW.

5.6.6 Due to their efficient design, biomass boilers typically produce ash with a volume of 0.5-2.0% of the original volume of the fuel. Ash should be removed regularly in accordance with the manufacturers instructions and deposited in a metal bin with a metal lid designated for the disposal of ash only prior to damping down and removing to a location outside and at least 10m away from buildings and structures to await removal from the site.

5.6.7 Chimneys for biomass boilers should be constructed in accordance with Approved Document J to the Building Regulations (ref. 23). Flue liners must be installed within a chimney. Where a chimney is not available one may be constructed of non-combustible material capable of withstanding the temperatures to which they may be

subjected. (Construction of a new chimney is notifiable to the local authority Building Control Department.)

- Brick chimneys should not be used for biomass boilers (5.6.8)

5.6.8 Brick chimneys should not be used for biomass boilers because the flue gases of these installations produce a more concentrated smoke with higher moisture content. In such cases condensation can occur when flue gases come into contact with a cold chimney surface, resulting in residual tars and creosotes condensing in the chimney. These can then soak into the brickwork, damaging the chimney, and, more seriously, run back down to the boiler causing a fire hazard. Where a biomass boiler is to be introduced into an existing building any existing chimney must therefore be lined.

5.6.9 Several methods of lining a chimney are available, for example inserting a flexible stainless steel flue liner manufactured specifically for solid fuel use (i.e. not of a spiral design where apertures may be created by cycles of heating and cooling). Alternatively, a refractory concrete lining or clay or concrete liner may be introduced to protect the existing brickwork.

5.6.10 The chimney must be sealed against gas escape along its whole length, and against rain water ingress between flue liner and chimney at the top.

- Flue pipes should have the same diameter or equivalent cross-sectional area as the flue outlet from the appliance. (5.6.11)

5.6.11 Flue pipes should have the same diameter or equivalent cross-sectional area as the flue outlet from the appliance.

5.6.12 Flues from biomass boilers should not be connected to the same chimney as those from oil burning equipment.

5.6.13 Ducts and flues should be fitted with sufficient access doors to enable effective cleaning throughout the entire length of the extraction system.

5.6.14 The height of a flue for a small installation rated at less than 50kW is regulated by the Building Regulations and thus liaison should be established with the local authority Building Control Department at the planning stage.

5.6.15 Building Regulations also require and specify minimum flue heights; a flue which is too short will not produce sufficient negative pressure to draw the flue gases from the burning chamber which may allow these gases, including carbon monoxide, to escape from the boiler if sufficient combustion air is not available. Conversely, a flue which is too tall will result in excess air flow through the burning chamber which can cause combustion to occur too quickly causing the boiler to overheat. Excess air flow in the flue will also reduce the efficiency of the installation by carrying more heat than necessary up the flue.

5.6.16 Bends or dips in the design of flues and ductwork where residues might collect are to be avoided. Flues leading from the biomass boiler room should be routed directly to the outside without passing through fire compartment walls or being routed within floor or ceiling voids or other spaces where exposed combustible materials may be present. Where this is not practicable, proprietary sleeves or penetration seals should be fitted where ducts pass through fire compartment walls or floors (ref. 24).

- Combustible materials should not be located in the vicinity of ducts and flues. (5.6.17)

5.6.17 Combustible materials should not be located in the vicinity of ducts and flues. Combustible linings and roofing should be cut back to at least 150mm from the duct and a non-combustible collar fitted.

5.6.18 An adequate external air supply is essential for the safe operation of the boiler. If the air supply in the room in which the appliance is installed is insufficient the flue could produce enough suction to place the room under significant negative pressure (European guidelines suggest that negative pressure should not exceed –4 pascals). This may lead to the boiler being partially deprived of oxygen, resulting in the production of carbon monoxide and inefficient combustion. The lack of air combined with negative pressure may also allow products of combustion, including carbon monoxide, to be drawn back into the boiler room. This can create an extremely dangerous hazard for the occupants or anyone later visiting the area.

5.6.19 To avoid creating a negative pressure in the boiler room in excess of -4 pascals, effective ventilation should be provided by means of the provision of permanently open ventilation. Open louvres or vents to allow natural air circulation is recommended and should be provided in accordance with Approved Document J to the Building Regulations (ref. 23).The use of extract fans in boiler rooms should be avoided.

5.6.20 Although negative pressure in the boiler room should be avoided, the combustion chamber in the boiler should always remain under negative pressure to prevent the escape of smoke and gases. This is a design feature that will result from the correct use of the equipment.

5.6.21 Where a boiler is fitted with an access door, great care must be taken when opening it as burning gases can flare out into the room.

5.6.22 A clear space of at least 1m should be maintained around the boiler. The provision of a metal guard is recommended to maintain the clear space and protect the heater from impact damage.

5.6.23 Where there is insufficient space in the premises for a fully automatic installation, batch fed, pellet boilers may be suitable. These can be installed in a boiler room, basement or other suitable area and loaded with pellets from bags into an internal hopper. However, the limited burn time offered by a relatively small internal hopper means that batch fed pellet boilers are only available in relatively small power ratings.

5.6.24 Waste materials associated with biomass boilers should be stored separately from other combustible waste from the building or processes and be deposited within an external lidded metal bin at least 10m from any buildings and structures.

5.7 Maintenance

5.7.1 As with gas and oil fired boilers, biomass boilers will need an annual safety and maintenance check in accordance with the manufacturer's instructions to ensure good continuing function of their mechanical components. All biomass boilers and associated equipment should be installed, commissioned and maintained by a HETAS approved and qualified engineer working to their current standard MIS 3004 (ref. 30) or an engineer who holds a valid training certificate or qualification for installation and servicing from the manufacture of the boiler or associated equipment. (Note: HETAS is the UK national organisation working for consumer safety and the wider public interest in safe, efficient and environmentally responsible use of biomass and other solid fuels.)

- Biomass installations should be checked daily and will require regular cleaning together with the periodic removal of ash. (5.7.2)

5.7.2 Biomass installations should be checked daily and will also require regular cleaning together with the periodic removal of ash. These are functions that may be undertaken by suitably trained staff.

5.7.3 Biomass boilers require ash to be removed regularly in accordance with the manufacturer's instructions,but a bed of embers should be left in position. During the ash removal process care should be taken not to push ash into the burner as this could lead to blockages.

5.7.4 Providing the equipment has been installed, maintained and operated within the manufacturer's guidelines, and the fuel is within the specification provided by the manufacturer, the only other regular maintenance required will be thorough cleaning of the ducts and flues. This should be undertaken by a competent contractor on a risk assessment approach (normally once or twice a year), taking into account the size of the installation, combustion efficiency and the nature of the fuel employed.

5.7.5 Periodic cleaning should include the auger screw feed to ensure that no foreign bodies have been introduced and removal of any particles trapped in the screw thread. Even slow moving parts can cause a rise in temperature, lead to a fire or present a source of ignition for a dust explosion. The removal of dust from the auger conveying system is also important in that if dust becomes trapped, it may ignite at the point of frictional contact at a lower temperature than that required to ignite a dust cloud.

5.8 Reducing the dangers of self heating of fuel

5.8.1 Under suitable conditions of temperature and moisture, wood based fuels can provide the nutrients for micro-organisms to grow and proliferate in a similar manner to haystacks. The heat from the microbiological reactions may raise the temperature sufficiently to start thermal oxidation. Although killing the micro-organisms, the further heat generated by chemical degradation such as oxidation can also lead to combustion of the stored product. The elements necessary for a fire to occur are thus sufficient moisture, oxygen and time.

When new deliveries of fuel are made, it should be checked that the moisture content is at an acceptable level and that no overheated biomass fuel is introduced to the premises (see section 5.5.9).

5.8.2 In some forms of automatic pellet supply mechanisms the flow to the boiler is made from the top of the new delivery, rather than the base and this 'first in, last out, regime may lead to some pellets remaining in the store for a considerable time. In these circumstances it is not good practice to replenish the wood pellet store before it is empty – adding new stock onto old pellets should be avoided.

Flow from the biomass store that results in a first in, first out regime is preferable as it results in stock being in regular motion during discharge and minimises spoilage and self heating.

5.8.3 An excessively large biomass store should be avoided as should purchasing excessive volumes of fuel when financial incentives may be available. Similarly, there are advantages in keeping fuel in several small piles rather than one large one.

5.8.4 It should be ensured that the fuel store remains weather tight and that any leaks or damage are repaired without delay.

5.8.5 In addition to the automatic fire detection and alarm installation (see section 5.9.3), where there are large stocks of biomass materials, temperature sensing cables or thermal imaging should be considered as a practical method of monitoring the temperature within the bulk of the stored material. Practicalities of retaining the cables in place and the positioning of them within the stack can, however, lead to incipient localised self-heating being missed. Where the temperature of biomass stores is measured, the actual temperature and the rate of rise of the temperature should be monitored so as to be able to properly assess the severity of a hazard.

- Carbon monoxide detectors should be installed in the biomass store. (5.8.6)

5.8.6 Carbon monoxide detectors should be installed in the biomass store. They should measure the concentration of the carbon monoxide over a period of time to allow a trend analysis to raise the alarm promptly in the event of a sudden rise of the concentration of the gas.

5.9 Fire protection

5.9.1 Fires in large stocks of biomass fuels develop very slowly, often over weeks and can go unnoticed during this time. By the time a fire is detected or discovered it may be well established and difficult to fight. Measures should therefore be taken to monitor the temperature of the fuel as well as the environment of the fuel store (see section 5.8.5).

5.9.2 Fire protection measures relating to the fuel storage and boiler system should be proportionate to the risk. Where there is uncertainty the measures should be determined in consultation with the insurer according to the findings of a fire risk assessment.

5.9.3 The fuel store and boiler room, together with the remainder of the property, should be protected by an automatic fire detection and alarm (AFD) system complying with a category of installation as defined in BS 5839-1 (ref. 25).

5.9.4 The AFD system should be designed, installed, commissioned and maintained in accordance with BS 5839-1 (ref. 25) by an engineer with certification from an independent UKAS accredited third party certification body.

5.9.5 The automatic fire detection and alarm system should be monitored either on-site (where staff are present 24 hours a day, seven days a week) or by an off-site alarm receiving centre certified by an independent UKAS accredited third party certification body and operating in accordance with BS EN 50518 (ref. 26).

5.9.6 High temperature alarms should be provided in ductwork and exhaust flues.

5.9.7 Where it has been determined that there is a fire in a biomass store extreme care must be taken and the various firefighting options considered. As this will most likely be a smouldering fire there is time to take a measured approach to the problem. An emergency response plan which considers the various potential incidents and firefighting options should be prepared and tested.

5.9.8 Caution should be exercised when making plans for firefighting, simply opening the door or hatch to the fuel store to introduce a water spray could, in extreme cases, lead to oxygen from the air mixing with hot gases and pyrolysed materials leading to a backdraft.

5.9.9 Plans for fighting fires in biomass fuel stores should include measures that can be taken without gaining access to the storage area. Most common among these methods are inert gas injection and water spray. Most modern boilers have sprinkler systems fitted in the augers before the boiler and in the auger screws used in transferring the fuel from the stores with independent operation. These should be designed so that in the event of failure of the mains electrical supply the system will still operate rotary valves or large gate valves to ensure that burning fuel is not transferred to another area.

5.9.10 Suitable interlocks should be fitted to shut down the supply of fuel to the burner in the event of a fire being detected in the fuel store or burner building.

- What choices are available for effective firefighting in silos? (5.9.11, 5.9.12, 5.9.14 and 5.9.15)

5.9.11 Suitable inert gases for injection into biomass systems include nitrogen, and carbon dioxide. To be effective the gas must be injected from the bottom of the fuel stack and reduce the oxygen content within the store to less than 2%. A secondary benefit of this action will be that the oxygen content will also inert the head space against dust explosion. Blanketing (by injection above the fuel) will not be effective as smouldering can continue within the stack. Prior to gas injection the outlets from the store should be sealed to retain the gas. The store should then be left, possibly for several days or even weeks, with the temperature inside being monitored. Great care should be taken when assessing the time before unsealing the store as the products of an oxygen starved fire can have the potential for a backdraft. Care should also be taken to minimise the asphyxiation hazard when entry to the store is determined to be viable.

5.9.12 While an internal water spray system may quench flames on the surface of the fuel stack the water is unlikely to penetrate the biomass due to absorption by the upper layers. This can cause swelling of the fuel sealing the lower layers to the effects of the water and allowing smouldering there to continue. In large stacks and in silos this can lead to cavities forming in the lower layers of the fuel which can have a serious threat to life safety if the stack collapses when entry to the store or silo is gained.

5.9.13 Suitable access should be provided to silos for firefighting personnel, their vehicles and equipment. Liaison should be established with the fire and rescue service in relation to the width, headroom, turning circles and provision of hard standing for their vehicles. The fire and rescue service will be aware of the hazards of firefighting water causing stored biomass to swell and threaten the integrity of the silo.

- Why is high expansion foam not effective in fighting a fire involving biomass fuel in a silo? (5.9.14)

5.9.14 Although the introduction of high expansion foam may quench a surface fire it will not cool the bulk of the fuel.

5.9.15 The installation of automatic fixed fire suppression systems is a further option. Where the risk assessment determines that an automatic water sprinkler system should be installed in a fuel store, the installation should be designed, installed, commissioned and maintained in accordance with the LPC Sprinkler Rules incorporating BS EN 12845 (ref. 27) by engineers having certification by an independent UKAS accredited third party certification body. In this case there is again the likelihood with the introduction of water that the biomass will swell with similar implications as set out in section 5.9.11. Emptying a store of the remaining wet fuel when the fire is extinguished will also be problematic.

5.9.16 In some designs of fuel store the weight of firefighting water, the swelling biomass and pressure on the container may put the fuel store under excessive structural load. This can also be a serious hazard in the case of silos.

5.9.17 A suitable number of appropriate portable fire extinguishers should be provided in the boiler room and in the immediate vicinity of the biomass store. Such portable extinguishers should be approved and certified by an independent, third party certification body and be installed in accordance with BS 5306-8 (ref. 28).

5.9.18 Portable fire extinguishers should be inspected and maintained by a competent engineer in compliance with BS 5306-3 (ref. 29).

6 Checklist

This checklist is based on the guidance and certain recommendations made in RC64: Recommendations for fire safety with small biomass installations and designed for use by premises operators and in particular members of the maintenance or facilities team as an audit tool for use on site. It is recommended an audit using this checklist be undertaken at least every 6 months.

The Checklist can be printed and a hard copy used, or completed electronically and printed off (if needed); checklists created electronically will be saved with the document on closing as a digital record. The references with each question below and shown in brackets relate to the relevant sections of RC64.

Additional blank copies of the checklist may be created as required for printing or electronic completion.

		Yes	No	N/A	Action required	Due date	Sign on completion
6.1	**Compliance with fire safety legislation (section 5.1)**						
6.1.1	Is access to the fuel store restricted to competent designated staff? (5.3.4)						
6.1.2	Do pellet and wood chip stores to which entry may be made have prominent warning signs displayed at the entrance? (5.3.5)						
6.1.3	Are pellet and wood chip stores fitted with carbon monoxide detectors? (5.3.5 & 5.8.6)						
6.1.4	Are ventilation conditions and the mechanism for feeding fuel into the boiler designed to deny a route for exhaust fumes (including carbon monoxide) to be able to permeate back to the fuel store (eg providing blow back protection through the use of a rotary valve)? (5.3.6)						
6.1.5	Is there a prohibition on hot work such as welding, flame cutting and similar activities taking place within or adjacent to biomass fuel stores (or a management system to manage the risks)? (5.3.7)						
6.1.6	Is care taken during delivery and movement of the fuel to minimise the distribution of dust in the atmosphere? (5.3.8)						
6.1.7	Has additional fire detection and/or suppression been installed where there are long transport mechanisms passing through differing fire compartments? (5.3.9)						
6.1.8	Is the use of damp pellets or wood avoided? (5.3.10)						
6.1.9	Is care taken not to allow the fire to slumber for long periods such as overnight? (5.3.10)						
6.1.10	Is the store emptied and cleaned at least once every two years and the conveyor belts and bearings of the transport mechanism inspected at this time (through, for example, the use of thermographic surveying)? (5.3.11)						
6.1.11	During the cleaning and inspection process is the store vacuumed with an industrial vacuum cleaner rated for use in an ATEX Zone 22? (5.3.12)						
6.1.12	If a biomass boiler is not being used in the winter months is it drained down in accordance with the manufacturer's instructions to protect the installation from the effects of frost?						
6.2	**Selection of fuels (section 5.4)**						
6.2.1	Is the moisture content of the fuel consistent and matched to the type of boiler? (5.4.2)						
6.2.2	Is the fuel of a good quality, of consistent size and free of foreign objects so as not to jam the feed mechanism? (5.4.3)						
6.3	**Storage of biomass fuel (section 5.5)**						
6.3.1	Is the biomass fuel store a purpose built independent building linked to the heating installation by the biomass feed system? (5.5.1)						

		Yes	No	N/A	Action required	Due date	Sign on completion
6.3.2	Is the biomass fuel store of non-combustible construction, weatherproof and lined internally to minimise the introduction of moisture and the escape of combustible dust? (5.5.2)						
6.3.3	Does the floor of the store form a smooth, sloping and angled surface to allow pellets to flow to the auger feed? (5.5.3)						
6.3.4	Are provisions available to ease delivery of the fuel? (5.5.4)						
6.3.5	Is the store as small as reasonably practicable? (5.5.6)						
6.3.6	Are checks made at the time of delivery to ensure that the fuel, especially wood chips, is not being delivered in an overheated condition? (5.5.8)						
6.3.7	Where a hopper feed system is installed, and fuel is purchased in bags are the bags stored as indicated in paragraph 5.5.1? (5.5.9)						
6.3.8	Are all relevant staff made aware that potentially dangerous atmospheres may be generated in both wood pellet and wood chip stores? (5.5.10)						
6.3.9	Is the need for providing adequate ventilation to reduce the build-up of a dangerous atmosphere in the biomass fuel store balanced against the potential for excessive ventilation which may allow the ingress of moisture and lead to deterioration of the fuel? (5.5.11)						
6.3.10	Is the temperature and humidity of the environment in large stores controlled and monitored? (5.5.13)						
6.3.11	Are silos painted a light colour to reflect heat from the sun so as to reduce the likelihood of self-heating of the stored fuel? (5.5.15)						
6.3.12	Is the designated storage area free of electrical installations, air ducts and water installations? (5.5.16)						
6.3.13	Is a form of mechanical agitation necessary when feeding fuel such as pellets into the boiler to prevent caking of the fuel? (5.5.17)						
6.3.14	Is lightning protection provided on silos in accordance with BS EN 62305? (5.5.17)						
6.4	**Biomass heating systems (section 5.6)**						
6.4.1	Is the heating system effectively designed to incorporate a heat store for current expected peak loads to allow the boiler to work at maximum efficiency for shorter duration? (5.6.2)						
6.4.2	Are links installed to allow the equipment to be controlled remotely from a laptop, computer or other smart device where necessary? (5.6.3)						
6.4.3	Is the biomass boiler operated strictly in accordance with the manufacturer's instructions? (5.6.4)						
6.4.4	Is ash removed regularly and deposited in a metal bin with a metal lid located outside and at least 10m away from buildings and structures to await removal from the site? (5.6.6)						
6.4.5	Are brick chimneys for biomass boilers avoided to prevent residual tars and creosotes condensing in the chimney? (5.6.8)						
6.4.6	Where necessary has a flexible stainless steel flue liner manufactured specifically for solid fuel boilers or a refractory concrete liner been introduced to protect an existing brick chimney? (5.6.9)						
6.4.7	Has the chimney been sealed against gas escape along its whole length and against rain water ingress between flue liner and chimney at the top? (5.6.10)						
6.4.8	Do flue pipes have the same diameter or equivalent cross-sectional area as the flue outlet from the appliance? (5.6.11)						

		Yes	No	N/A	Action required	Due date	Sign on completion
6.4.9	Are flues from biomass boilers routed independently from chimneys from oil burning equipment? (5.6.12)						
6.4.10	Are ducts and flues fitted with sufficient access doors to enable effective cleaning throughout the entire length of the extraction system? (5.6.13)						
6.4.11	Have bends or dips in the design of flues and ductwork where residues might collect been avoided and are flues routed directly to the outside without passing through fire compartment walls or being routed within floor or ceiling voids or other spaces where exposed combustible materials may be present? (5.6.16)						
6.4.12	Have combustible linings and roofing been cut back to at least 150mm from the duct and a non-combustible collar been fitted? (5.6.17)						
6.4.13	Is there an adequate external air supply available for the efficient operation of the boiler and safety of personnel? (5.6.18)						
6.4.14	Are open louvres or vents to allow natural air circulation provided and is the use of extract fans avoided? (5.6.19)						
6.4.15	Is negative pressure in the boiler room avoided? (5.5.20)						
6.4.16	Where a boiler is fitted with an access door is great care taken when opening it to avoid burning gases flaring out into the room? (5.6.21)						
6.4.17	Is a clear space of at least 1m maintained around the boiler? (5.6.22)						
6.4.18	Are waste materials associated with biomass boilers stored separately from other combustible waste from the building and deposited within an external lidded metal bin at least 10m from any buildings and structures? (5.6.24)						
6.5	**Maintenance (section 5.7)**						
6.5.1	Are biomass boilers subject to an annual safety and maintenance check by a HETAS approved and qualified engineer in accordance with the manufacturer's instructions to ensure good continuing function of their mechanical components? (5.7.1)						
6.5.2	Are biomass installations checked daily and regularly cleaned by suitably trained staff with the periodic removal of ash? (5.7.2)						
6.5.3	When the ash is removed regularly in accordance with the manufacturer's instructions is a bed of embers left in position? (5.7.3)						
6.5.4	Is the cleaning of the ducts and flues undertaken by a competent contractor on a risk assessment approach? (5.7.4)						
6.5.5	Does the periodic cleaning include the auger screw feed to ensure that no foreign bodies have been introduced and removal of any particles trapped in the screw thread? (5.7.5)						
6.6	**Reducing the incidence of self heating of fuel (section 5.8)**						
6.6.1	When new deliveries of fuel are made, are checks made to ensure that the moisture content is at an acceptable level and that no overheated biomass fuel is introduced to the premises? (5.8.1)						
6.6.2	Is the biomass fuel flow managed so as to result in a first in, first out regime to minimise spoilage and self heating? (5.8.2)						
6.6.3	Are regular checks made to ensure the fuel store remains weather tight with any leaks or damage being repaired without delay? (5.8.4)						

		Yes	No	N/A	Action required	Due date	Sign on completion
6.6.4	Are temperature sensing cables or thermal imaging methods used to monitor the temperature within the bulk of the stored material? (5.8.5)						
6.7	**Fire protection (section 5.9)**						
6.7.1	Have measures been taken to monitor the temperature of the fuel as well as the environment of the fuel store? (5.9.1)						
6.7.2	Are the fuel store and boiler room, together with the remainder of the property, protected by an automatic fire detection and alarm system complying with a category of installation as defined in BS 5839-1? (5.9.3)						
6.7.3	Is the fire detection and alarm system maintained in accordance with BS 5839-1 by an engineer with certification from an independent UKAS accredited third party certification body? (5.9.4)						
6.7.4	Is the automatic fire detection and alarm system monitored either on-site (where staff are present 24 hours a day, seven days a week) or by an off-site alarm receiving centre? (5.9.5)						
6.7.5	Are high temperature alarms provided in ductwork and exhaust flues? (5.9.6)						
6.7.6	In the event of a fire in a biomass store is extreme care taken to ensure the most appropriate firefighting method is used through reference to the Emergency Response Plan? (5.9.7)						
6.7.7	Do plans for fighting fires in biomass fuel stores include measures that can be taken without gaining access to the storage area? (For example are the auger screws protected by a sprinkler installation) (5.9.9)						
6.7.8	Are suitable interlocks fitted to shut down the supply of fuel to the burner in the event of a fire being detected in the fuel store or burner building? (5.9.10)						
6.7.9	If inert gas injection is provided as a firefighting measure is the gas injected from the bottom of the fuel stack and is it designed to reduce the oxygen content within the store to less than 2%? (5.9.11)						
6.7.10	Is suitable access provided to silos for firefighting personnel, their vehicles and equipment in relation to the width, headroom, turning circles and provision of hard standing for the vehicles? (5.9.13)						
6.7.11	Where an automatic water sprinkler system is installed in a fuel store, is the installation maintained in accordance with the LPC Sprinkler Rules incorporating BS EN 12845 by engineers having certification by an independent UKAS accredited third party certification body? (5.9.15)						
6.7.12	Has consideration been given to the weight of firefighting water, the swelling biomass and the resulting structural loads to which the fuel store may be subject? (5.9.16)						
6.7.13	Are a suitable number of appropriate portable fire extinguishers provided in the boiler room and in the immediate vicinity of the biomass store? (5.9.17)						
6.7.14	Are portable fire extinguishers inspected and maintained by a competent engineer in compliance with BS 5306-3? (5.9.18)						

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