



A User Guide to the U.S. Wood Chip Heating Fuel Quality Standard

A Summary of ANSI/ASABE AD17225-4:2014 FEB2018 Solid Biofuels -- Fuel Specifications and Classes -- Part 4: Graded Wood Chips and its Application in the U.S. Market.

Acknowledgements

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Introduction

In the United States, there are widely adopted technical standards for nearly every heating fuel – natural gas, oil, propane, wood pellets – but, until recently, not wood chips.

A wood chip heating fuel quality standard is essential to improve the performance, efficiency, and reliability of wood chip heating systems and enhance the technical credibility and market confidence that will help expand the wood chip heating market.

In 2016, the Biomass Energy Resource Center, American Society of Agricultural and Biological Engineers, Biomass Thermal Energy Council, and Innovative Natural Resource Solutions, LLC spearheaded an initiative to develop a national wood chip heating fuel quality standard following the American National Standard Institute (ANSI) protocol. After in-depth review and discussion, it was decided to nationally adopt an existing international standard and modify it to be applicable to the U.S. market. This standard is entitled: **ANSI/ASABE AD17225-4:2014 FEB2018 Solid biofuels -- Fuel specifications and classes -- Part 4: Graded wood chips**. The modifications to the existing international standard were developed over 18 months and involved several rounds of official voting, revisions, and rigorous stakeholder review and input.

Purpose of this Companion Document

This document is a companion to the technical standard, which can be obtained through ASABE[1]. Its purpose is to serve as a user-friendly summary of the Standard, assist in understanding and properly interpreting the Standard, and provide information on producing and purchasing graded wood chips as specified in AD17225-4. It is not intended to provide the same level of detail as the Standard or replace the Standard document, but rather to provide a general overview of its most important parameters.

Scope

The AD17225-4 wood chip Standard covers wood chips used for boiler fuel in residential, commercial, and light industrial thermal applications. For more details and to avoid any ambiguity definitions and abbreviations used in this companion document can be found in Appendix I.

Purpose of Standard

The purpose of the Standard and of this companion document is to provide unambiguous and clear classification for wood chips and guidance to determine wood chip heating fuel quality. The standard defines what physical and chemical parameters affect fuel characteristics and quality.

While wood chips have been used for decades for heat and energy production,

[1] www.asabe.org

prior to the adoption of this Standard wood chips used in modern wood heating in the U.S. were not governed by a common technical standard, nor were standardized chip specifications widely used or accepted in the U.S. marketplace. Consequently, manufacturers of wood combustion equipment and systems are rarely able to guarantee reliable, consistent, high performance of the heating system without an established fuel quality standard.

Adoption of a national fuel standard for wood chips directly addresses concerns some energy policy makers, air quality regulators, public health advocates, and environmental activists have about pollutants associated with wood combustion. Clean, efficient wood combustion is a product of advanced combustion engineering of boilers and furnaces, and a known, consistent fuel standard around which systems are tightly engineered to achieve high performance.

For modern wood heating to be broadly accepted, it must be safe, clean, efficient, and convenient. Issues of reliability and performance are exacerbated by the common use of subjective terms such as "dirty chips", "clean chips", "bole chips", "semi-dry chips", and "hog fuel" to describe wood chip fuel quality. Adoption of a national technical standard for wood chips allows boiler vendors, policy makers, regulators, engineers, fuel suppliers, loggers, and foresters to all speak a common language – thus contributing towards the common goal of clean, efficient wood combustion in a modern wood heating appliance.

Architects, building specifiers, and mechanical engineers will often consider such fuel standards a prerequisite for their specifying of the respective heating technology (e.g. gas, oil, and various wood fuels). Without a clear and trusted wood chip fuel specification to reference, these building professionals may not recommend modern wood heating systems.

In summary, the wood chip heating fuel Standard is a tool for good communication and understanding among producer, seller, buyer, and equipment manufacturer.

About ASABE and How to Acquire the Standard

This document is only a summary of the Standard. The full technical standard can be obtained through ASABE [2]. ASABE (www.asabe.org) is a professional and technical organization of members

[2] www.asabe.org

worldwide who are dedicated to the advancement of engineering applicable to agricultural, food, and biological systems. ASABE Standards are consensus documents developed and adopted by the American Society of Agricultural and Biological Engineers to meet standardization needs within the scope of the Society; principally agricultural field equipment, farmstead equipment, structures, soil and water resource management, turf and landscape equipment, forest engineering, food and process engineering, electric power applications, plant and animal environment, and waste management. ASABE Standards, Engineering Practices, and Data Standards are informational and advisory only. Their use by anyone engaged in industry or trade is entirely voluntary.

Section 1. Summary of Standard

Overview

The AD17225-4 Standard was adapted from a standard published by the International Organization for Standardization (ISO).[3] The ISO 17225-4 Standard was adopted with deviations, to make it more relevant to the US market. The overall structure and parameter definitions were retained from the ISO standard in an effort to maintain consistency between the U.S. and International standards.

The AD17225-4 standard classifies wood chips into three grade levels:

- Grade A are wood chips with a low ash content and, in some cases, lower moisture content:
    - Grade A1 have lower ash content
    - Grade A2 have comparatively higher ash content.
- Grade B have higher ash content than Grade A and, in some cases, a comparatively higher moisture content.

For each of the grades, the particle size, moisture content, and ash content is then reported in more specific sub-classifications.

The Standard defines the degree to which important quality parameters are allowed to vary and still qualify under the Standard. Parameters that must be met for wood chips to qualify under the Standard are called "normative". Other parameters that can be reported voluntarily, for effective communications between the seller and buyer, are called "informative" and are not required for qualification under the Standard. All parameters are independent of each other except for bulk density, which is influenced by moisture content and particle size.

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[3] An independent, international organization that develops and publishes international standards, https://www.iso.org/home.html

Normative Properties

Normative properties considered in the Standard are:

- Source of the wood
- Particle size, further defined by particle width and length, proportion of fines (undersized material), and oversized material (stringers etc.)
- Moisture content
- Ash content
- Bulk density
- Elemental properties (Grade B only): N, S, Cl, As, Cd, Cr, Cu, Pb, Hg, Ni, Zn.

Source of the Wood

Source of the wood is a normative parameter. The standard allows any wood sourced from forestry activities (including urban wood), plantations, short-rotation or coppice wood, and residues from wood product manufacturing industries. Any chemically-treated wood is excluded from this Standard. If there are reasons to suspect chemical contamination of the land on which the source trees have grown (i.e. if planting has been used for the sequestration of chemicals or growing trees have been fertilized by sewage sludge) then the wood should be excluded based on origin.

Wood chips are typically produced by grinding or chipping operations (Figure 1), followed in some cases by further screening and passive or active drying. Many terms are commonly used to define wood chips ("whole-tree chips", "bole chips", "paper chips", "hog fuel", etc.). These terms are not used in the Standard. If the wood chips meet the particle size requirement, they are included in the Standard, regardless of the method used to produce the chips (e.g. using a chipper, grinder, etc.), or the type of wood used to produce the chips (e.g. bole, whole-tree, slash, pulpwood, mill residue, etc.), as long as the wood was not chemically treated.

Figure 1: Typical origins of wood chips used as heating fuel.

Particle size (P)

Particle size is one of the normative parameters of the Standard and is categorized into five size classes, based on the size of the main fraction (the portion of wood chips of a similar size that form the majority of the chips in a batch). The size requirements and percentages of each fraction (main, fines, and coarse) must be met for the chips to qualify under the Standard (Table 1).

The main fraction must make up at least 60% of the weight of the fuel (Figure 4). The designation of each particle size class is based on the main fraction size in millimeters, based on the ISO standard, but units were converted to inches in the AD17225-4 Standard for the U.S. market.

Maximum cross-sectional area is also a specification for the coarse fraction, but not presented in Table 1 for simplicity's sake (please refer to standard document for details).

Any given wood chip batch must meet all the particle size classifications to meet the overall particle size requirements for that grade. For example, if the main fraction is less than 5/8 inches, the wood chips can be classified as P16S only if the proportion of the fines and coarse fractions, as well as the coarse fraction's maximum length and maximum cross section meet the Standard's requirements for PS16S. If there is a deviation from those requirements for any of the fractions, the batch may need to be screened or re-screened to meet the requirements of the given particle size class or re-graded to another class. It is the responsibility of the seller and buyer to ensure that all agreed upon requirements are met.

Table 1: Particle size parameters

Particle Size Class	Chip "Width"[4] main fraction >1/8 in, (minimum 60% by weight),	Fines Fraction: ≤1/8 in (% by weight)	Chip Length (% by weight)	Maximum Chip Length in the Coarse Section (in)
P9.5S	P ≤ 3/8 in	≤ 15 %	≤ 6 % greater than 3/4 in	≤ 1-1/4 in
P16S	P ≤ 5/8 in		≤ 6 % greater than 1-1/4 in	≤ 1-3/4 in
P25S	P ≤ 1 in			
P38S	P ≤ 1-1/2 in	≤ 10 %	≤ 6 % greater than 1-3/4 in	≤ 6.0 in
P50S	P ≤ 2 in		≤ 10 % greater than 2-1/2 in	≤ 8.0 in

[4] Defined by the sieve size that the main fraction will pass through

Scale Diagrams of Chip Sizes

The following diagram can be used to approximate the size class of a given wood chip (maximum "width" of main fraction and maximum length) for the majority of the main fraction. A single woodchip from the main fraction must fit within the shaded area to meet the particle size class.

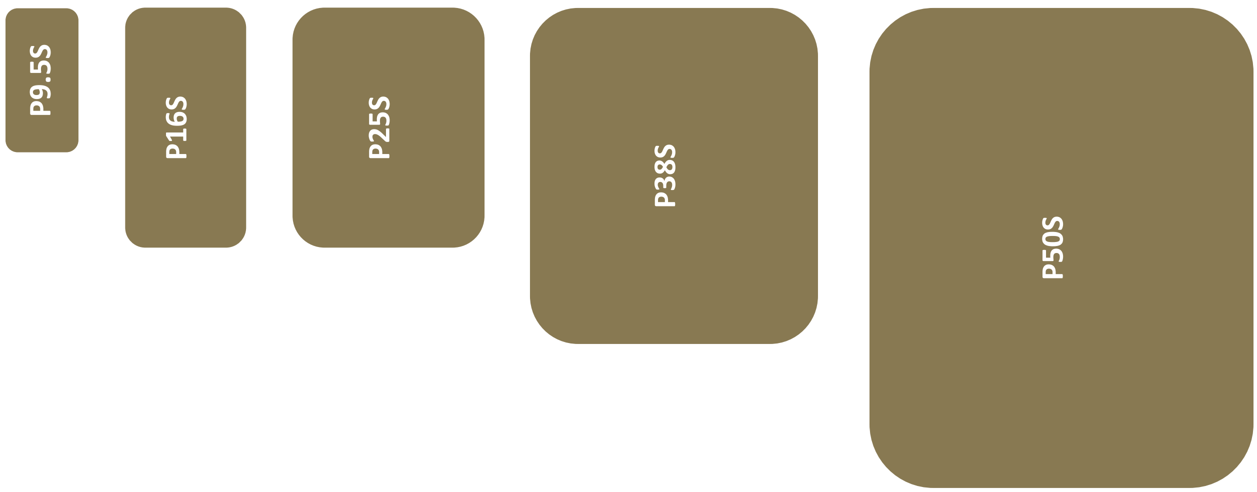


Figure 3: Two dimensional chip size diagram (to scale) of the five size grades in the Standard

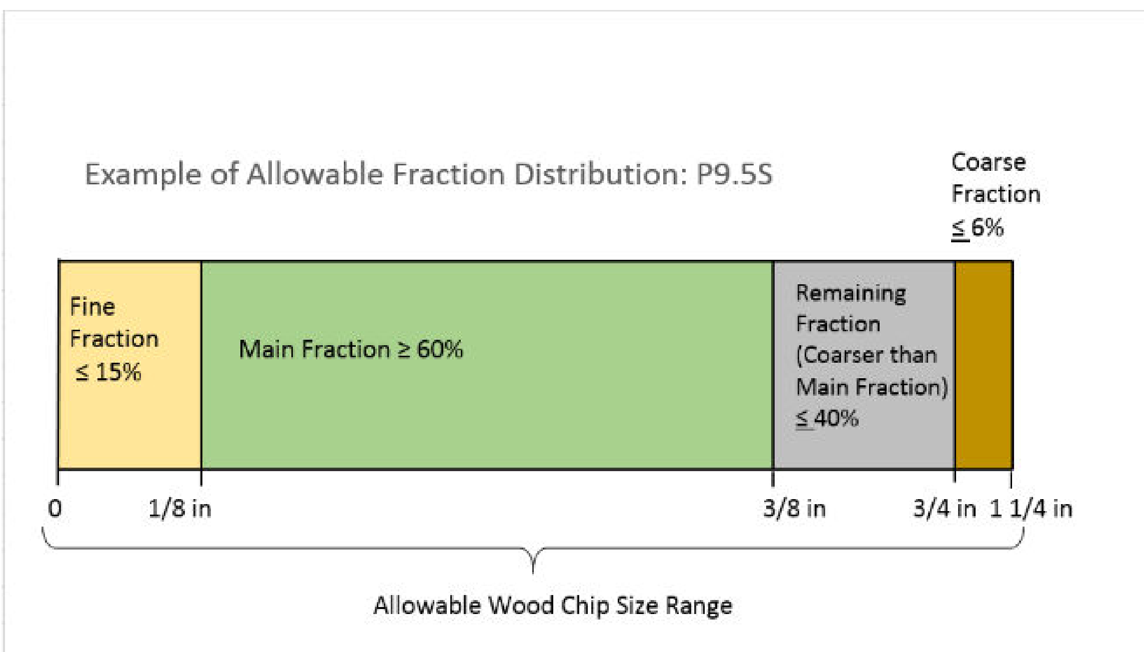


Figure 2: Allowable distribution of the wood chip fractions

Moisture Content (M)

Moisture content is an important factor in wood chip fuel quality. It affects transportation costs, storage and fuel-handling logistics, heat output, and management of combustion and emissions.

Moisture content may vary from load to load and seasonally. When considering moisture content, seasonal variations in the moisture content of deliveries should be taken into account.

Moisture content in the Standard is classified based on the percentage of water content (relative to the wet weight, which is the weight as received). If moisture content is greater than 50%, the grade is automatically Grade B. Moisture content classes are defined as follows:

Table 2: Moisture content parameter

All Grades (A1, A2, and B)	
M13 ≤ 13 %	
M25 ≤ 25 %	
M30 ≤ 30 %	
M35 ≤ 35 %	
If moisture content is >35%:	
Grade A1 and A2:	**Grade B:**
M50 ≤ 50%	M35 + > 35%

It is important to note that while Grade A provides a moisture content class between 35% and 50%, Grade B does not – it groups all fuel with greater than 35% moisture content into a single class of >35% (with no maximum).

Ash Content (A)

Ash content and ash melting behavior are important to achieve the intended combustion efficiency and ensure the equipment maintenance, durability, and the level of effort required for maintenance aligns with the equipment operator's expectations.

There are three ash content classes:

- A1.0 is less than or equal to 1.0% ash content,
- A1.5 is between 1.0% and 1.5% ash content
- A3.0 is between 1.5% and 3.0% ash content

If ash content is greater than 3%, the wood chips do not qualify under this Standard.

Bulk Density (BD)

Bulk density (the weight per given unit of volume,) is influenced by particle size, wood species (softwood vs. hardwood), and moisture. This quality parameter remains from the original ISO standard, but is more applicable to European markets where wood chips are often purchased by volume, not weight as is typical in the U.S. Bulk density is highly influenced by moisture content.

Elemental Properties

For Grade B chips, when ash content is greater than 1.5%, the elemental properties of the chips should be tested to demonstrate compliance with the Standard.

For lower ash content chips (Grade A), these values can be reported on an informative basis, based on individual agreements between the seller and purchaser.

The chlorine (Cl), sodium (Na) and potassium (K) contents of the wood influence the ash melting behavior and may increase the fouling and corrosion risk of the boiler. Therefore, the elemental composition of the wood chips should be determined if the ash content is high. The agglomeration of ash into clinkers (or slag) has been found to be caused by potassium (K), calcium (Ca), and silicon (Si) in the ash. These minerals melt at temperatures found in the boiler forming a glass like material that may cause operational and maintenance issues.

The elemental composition and heavy metal concentrations (N, S, Cl, As, Cd, Cr, Cu, Pb, Hg, Ni, Zn) of the wood chips must be tested and reported if the ash content of the wood chips is greater than 1.5% and must meet set concentration levels (see Standard document for details on the limits for each element).

Informative Properties

Informative properties are:

- Elemental properties (for Grade A1 and A2): N, S, Cl, As, Cd, Cr, Cu, Pb, Hg, Ni, Zn
- Net calorific value.

Elemental Properties

Elemental properties are Informative rather than normative for Grade A1 and A2. For details, see above under normative properties (for Grade B chips).

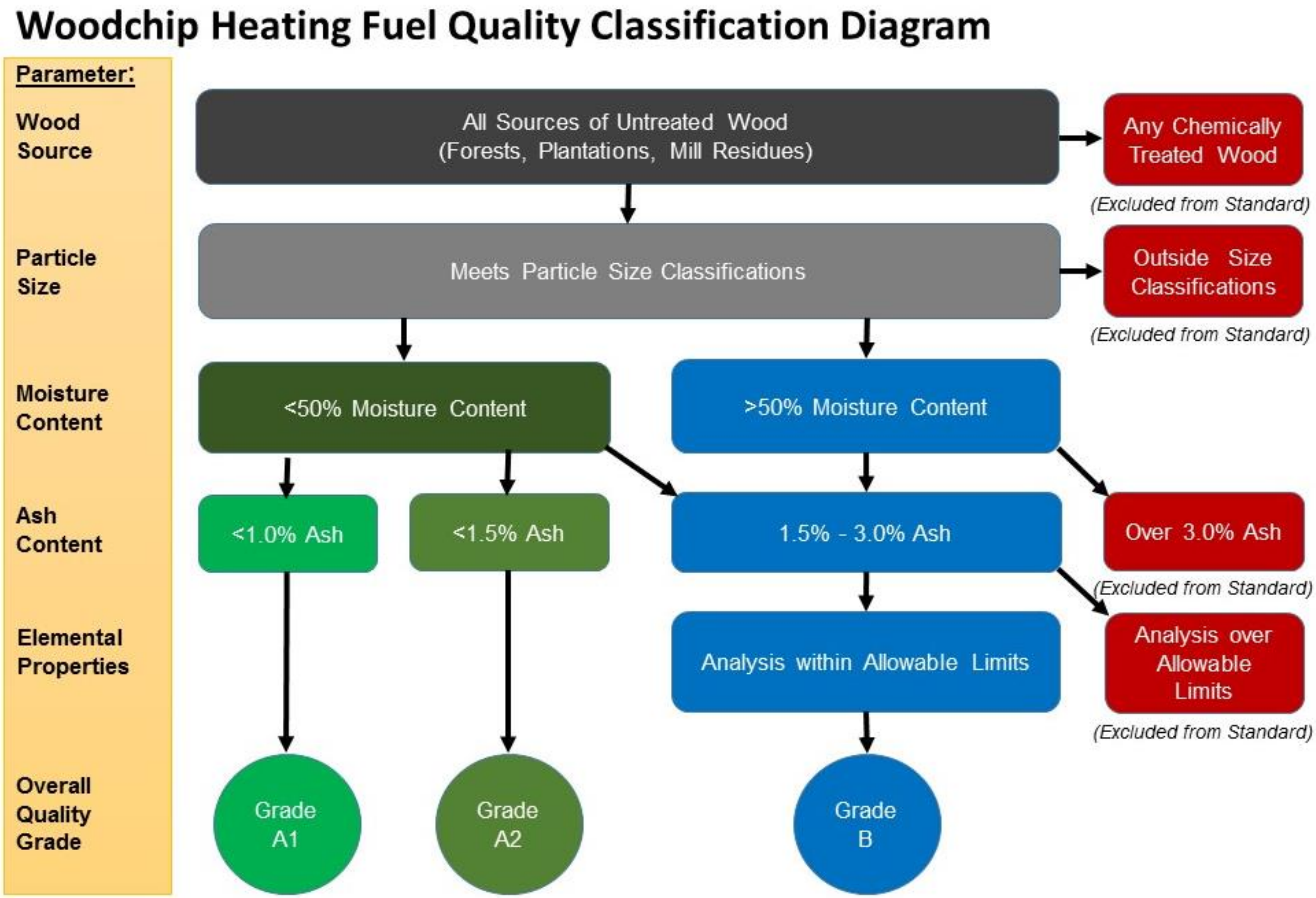
Calorific Value

Calorific value is not a parameter that is used as a requirement for the Standard. It is only informative (not required), and will range from 7,000-10,000 Btu per bone dry pound of wood on a Higher Heating Value (HHV) basis[5] and will depend on tree species, ash content, and inclusion of bark and leaves/needles in the chips.

[5] https://www.fpl.fs.fed.us/documnts/techline/fuel-value-calculator.pdf

Summary Flow Diagram

The following diagram summarizes the parameters that are evaluated in the Standard and how the overall wood chip grade is determined. Note that all parameters have sub-classifications in addition to grade that should be reported under the Standard.



Section 2. User Guide for Producers

Quality Assurance

Wood chip heating systems are finely tuned to operate on fuel of known and reliably consistent physical and chemical properties. For this reason, it is important for both the wood chip fuel producer and end user/buyer to be confident that they are consistently producing and consuming fuel that meets understood and agreed-upon standards. Quality assurance is essential to build trust and ensure that the wood chips meet the buyer/end user's requirements, as detailed in a fuel procurement agreement.

Quality of fuel should regularly monitored during production, interim storage, and transportation, as well as during storage at the customer's facility. The overall goal of quality assurance is to ensure that the fuel quality is as expected, does not degrade, and that impurities do not find their way into the wood chips.

The essential components of a quality assurance program that should be in place throughout the supply chain include:

- Defining responsibilities, processes, equipment, required documentation (including third party verification if needed), and procedures if a batch does not meet the expected grade;
- Training of appropriate employees on production, storage, and transportation requirements as well as applicable standards and specifications;
- Verifying desired properties in an agreement between the supplier and buyer/end user.

Sampling techniques and analysis of samples are described and defined in the ISO standards listed in Appendix IV. See section below on Testing to Standard Specifications for more details on sampling and testing.

To the extent that the ANSI/ASABE AD17225-4 Standard becomes widely adopted in the marketplace, producers of wood chip fuel should familiarize themselves with the specifications of the Standard to ensure that their processes are capable of producing fuel that can consistently meet one or more grades of the Standard. Producers of wood chip fuel should be prepared to provide end users/buyers with test data to verify their fuel meets known standard specifications and should consider having third-party independent lab test results available in order to respond to fuel procurement Request for Proposals (RFP) when they are issued. As fuel procurement contracts may have damage clauses for failure to produce fuel that meets a stated standard, producers should clearly understand the Standard and periodically conduct tests to ensure they are delivering fuel within the desired specifications.

Using the Standard in Real World Applications

For example, Jane Doe Forestry Products has been selling wood chips as heating fuel for years, and they are wondering if their chips would qualify under the Standard. So let's look at how their chips would be graded:

1. They routinely produce bole chips from pulp-grade roundwood at a chipping yard using a disk-style chipper. Roundwood is chipped with bark and the chips are screened before being directly blown into a delivery truck.
   ➔ The wood origin qualifies under the Standard as it hasn't been chemically treated.
2. Particle size for this batch of chips is as follows:
   - Chips are less than 1 inch width for 80% of sample,
   - Fine fraction is 5%
   - 5% of chips are greater than 1-¾ inch
   - Maximum length of chips is 4 in.

   ➔ Batch qualifies under the Standard for particle size class: 38SP.

3. Moisture content of batch is 30%:
   ➔ Batch qualifies for the Standard, moisture content class: M35.
4. Ash content is 1.2%:
   ➔ Batch qualifies for the Standard, ash content class A1.5.
5. Elemental analysis does not need to be reported because ash content is less than 3%.
6. ⇨ Wood chips qualify for **Grade A2 (Bole chips - forest management), P38S, M35, A1.5**

Production, Storage, and Transport Considerations for Producer

Quality Assurance by the Wood Chip Heating Fuel Producer

Quality assurance begins with production of the fuel in the field, processing yard, or at the mill. Principles of wood chip fuel quality assurance include:

- **Keep it clean** – no non-wood contaminants of any kind should be introduced during the manufacture of the wood chip fuel, including soil, rocks, plastics, metals, chemically treated wood, or other contaminants such as oils or paint. Ensure that bolts are tightened on all the equipment, so that nothing comes lose and contaminates the wood chips. Care should be taken to ensure that minimal soil is picked up by tree stems during the skidding and yarding process, as soil – even a small amount – can impact inorganic ash content of the finished wood chip fuel. Harvesting over frozen ground or snow can limit the introduction of soil in the chips. If possible, blow woodchips directly into a delivery truck and avoid the extra step of using a front-loader to scoop and load the chips, which could introduce dirt and other unwanted material. If fuel is stored after processing, ideally it should be stored on a concrete or asphalt surface to minimize the potential for contamination at the time of truck loading.

- **Keep it dry** – ideally no rain, snow or ice should be allowed to contact the fuel. Precipitation can cause variability in fuel moisture content and can create problems in transport and storage. If the producer has the capability, great care should be taken to remove snow and ice from tree stems before chipping, as snow and ice can cause chips to aggregate and freeze, creating significant problems once fuel is received by end user/buyer. Whenever and wherever possible, if fuel is stored by the producer after it is produced to meet a specification, it should be kept covered on a clean durable surface. Keep in mind that chipped fuel kept under roofed area is still exposed to the wind for extended periods (even in winter) and can result in wood chip fuel drying below the expected moisture content. Fuel stored in piles should be turned and mixed periodically to ensure consistent moisture content when fuel is loaded for delivery.

• **Keep it consistent in size** – ensure that processing equipment (debarkers, chippers, grinders, screens, etc.) are all properly maintained to ensure that fuel is produced to the chip size specifications required by the end user/buyer. Meeting consistent chip size requirements of the AD17225-4 Standard requires careful attention to the source material used, maintenance of equipment, including sharp chipping knives, chipper settings, proper screen sizing etc. Manufacturers of this equipment should be consulted to ensure that equipment is properly tuned to meet the specific chip size specifications.

A note about wood chip production: many states now regulate the processing and movement of wood chips in an attempt to slow the spread of invasive forest insect pests such as the emerald ash borer and asian long-horned beetle. Regulations can limit the time of year of chip processing, chip size restrictions, species that can be chipped, and other factors that processors of wood chip heating fuel need to be aware of. Contact your state Department of Agriculture or Natural Resources to learn more about invasive insect regulations in your area.

Some end users/buyers will require that producers conduct periodic quality tests, often by an independent third party.

Quality Assurance in Wood Chip Fuel Transport

The key considerations in fuel transport are:

• Make sure wood chip fuel stays dry during transport. This may require the use of live-floor trailers that have fixed or retractable covers. Loading on days with no rain or snow (plan ahead!) helps limit unwanted excess moisture. Closed-top chip vans are preferred to minimize the potential for road salts used in winter from contaminating wood chip fuel with chlorides – a very important consideration.

• Make sure chip trailers are clean and free of any non-wood contaminants, as well as the loader buckets used to load the wood chip delivery vehicle. Make sure all residues are removed from the truck after delivery so the next load is not contaminated with wood chips which may be to a different standard.

Summary of Quality Assurance during Production and Transportation

Table 3 summarizes the strategies aimed at producing wood chips that meet and maintain the requirements of a desired grade class, or to produce a higher quality grade. Strategies targeting each individual parameter are provided as bullet points and are discussed in the previous sections.

Table 3: Summary of strategies for obtaining wood chips of a desired quality.

Quality Parameter	Production and Transportation
Particle Size	**Keep it consistent in size:** • Limit introduction of fines and dirt • Maintain equipment and outlet screens • Feed chipper with uniform diameter material to have more uniform chips and fewer stringers • Invest in screening equipment.
Moisture Content	**Keep it dry:** • Use rigid top trailers rather than open top trailers that collect snow and rain • Keep rain and snow off the log and chip piles.
Ash Content	**Keep it clean:** • Exclude stump and roots • Keep trailers clean • Avoid dragging wood over muddy ground, harvest in winter over frozen ground or snow • At roadside or log landing, avoid pushing snow or dirt into the chip pile.
Elemental Properties	• Use only untreated wood of traceable origin • There is more nitrogen in green leaves than wood, exclude leaves and needles to keep N concentration low.
Calorific Value	• Chip sound wood - rotten wood has lower calorific value • Species influences the calorific value but moisture content has a much greater influence.
Exclusion of Foreign Objects	**Keep it clean:** • Make sure bolts are tightened to the disk on the chipper • When chipping, blow it directly into delivery truck, avoid using a front-loader as it is an extra step that could introduce foreign objects.

Section 3. User Guide for Buyers

Storage, Safe Handling and Use by Consumer

Wood chip systems fueled with consistent, uniformly sized chips experience fewer mechanical jams of the fuel feeding equipment. Systems fed cleaner wood chips produce less ash. Matching the right fuel source and quality to the right equipment is important to achieve the expected performance of a wood chip fueled system.

The fuel consumer should take precautions to ensure that fuel quality does not degrade between the fuel delivery and combustion in the boiler. Best practice recommendations to maintain chip quality include the following:

- Store chips indoors, preferably in a bunker structure. Silos can be used for lower moisture content chips, but freezing issues will arise in outdoor silos with chips of higher moisture content and/or very low outdoor temperatures.
- Limit the duration of on-site fuel storage to two to three months at most. At the end of the heating season, burn off all remaining fuel if it will not be used for half the year. Avoid storing chips for 6 months in-between heating seasons as the fuel is more likely to degrade during extended periods of storage.
- Use first-in, first-out procedures to ensure that the oldest fuel is used first. However, when the chip pile is regularly turned over, make sure not to alter the first in order.
- Protect the wood chip storage pile from rain and snow to avoid any increased moisture content and keep out blown dust or sand to avoid any increased ash content.
- If chips are stored outdoors or for long periods of time, monitor the temperature of stored wood chips and try to keep temperatures low and prevent the pile from self-heating.
- If chips are not directly unloaded into a fuel bin, keep the loading and unloading systems and storage conditions clean and dry, by storing chips on a paved or concrete pad storage area and ensuring proper drainage of storage area.
- Configure fuel conveyance systems to include mechanisms that help removed oversized material. For example, screens or even a simple roller attached over the metering bin can help remove oversized stringers that can cause mechanical jams.
- Train staff to understand the importance of chip quality and quality assurance protocols.

Generally, if the chips are protected from rain and snow (for example by being kept indoors) if the storage area and conveyance equipment remains clean and are appropriate to handle the grade of wood chips, and if the wood chips are stored for no more than a few months, then the quality of the wood chips should not degrade significantly between the time of delivery and combustion.

Summary of Quality Assurance for Buyers/ End-Users

Table 4 summarizes the strategies to maintain wood chip quality during storage and conveyance from storage to the boiler.

Table 4: Summary of strategies for storing and conveying wood chips of a desired quality.

Quality Parameter	Storage and Conveyance
Particle Size	• Install simple in-line equipment to screen oversized and undersized material out.
Moisture Content	• Protect pile from wind, snow, or flooding • Ensure proper drainage of the storage area • Encourage passive drying during storage and as the fuel is being conveyed between the storage bin and boiler.
Ash Content	• Protect pile from contamination and foreign objects, such as blowing sand or dust.
Elemental Properties	• Protect pile from chemical contamination.
Calorific Value	• Avoid high pile temperatures • Limit storage duration • Utilize first-in, first-out utilization techniques rather than first-in, last-out.
Exclusion of Foreign Objects	• Avoid the introduction of foreign objects (e.g. unpaved storage area, unclean front loader bucket), use magnets to remove any metal that may have been introduced in the chips (e.g. bolts, etc.).

Testing to Standard Specifications

Producers of wood chip fuels, and end users/buyers, will need to test wood chip fuel periodically to ensure they meet the specifications of the Standard.

Testing methodologies for wood chip physical and chemical parameters of the AD17225-4 Standard follow prescribed and internationally certified protocols. These are summarized in the Appendix IV.

Most end users/buyers will not have the equipment necessary to do proper testing of these physical and chemical parameters. Parameters such as moisture content can be tested with certain types of moisture meters (e.g. Figure 4). However probes do not generally work well and should not be used.

Figure 4: Example of a moisture meter to measure moisture content of wood chips.[6]

The most reliable means of testing with consistent methodologies is to submit samples to qualified independent third-party laboratories which routinely provide this service. There are many such laboratories throughout the United States that have invested in the equipment necessary to perform these tests. Several organizations maintain lists of accredited laboratories that specialize in testing wood chip heating fuels, including the Pellet Fuels Institute[7] and ENplus.[8]

[6] Photo credit: https://www.checkline.com/biomass_moisture_meters/bm

[7] http://www.pelletheat.org/accredited-auditing-agencies

[8] http://www.enplus-pellets.eu/about-enplus/testing-bodies/

Testing Procedures and Methods

When collecting samples for testing, care should be taken to ensure that the sample is truly representative of the fuel. The testing laboratory will provide instructions on proper sampling, handling and packaging of the sample to be sent to the lab. For example, if sampling from a truckload of wood chip fuel, the sample should be derived from multiple locations in the truckload. The sample should be pulled from multiple locations within the pile or after the pile has been turned and mixed. Samples should be placed in closeable (e.g. Zip-lock) plastic bags and labeled. Samples should be tested promptly after sampling, and not left in a manner that can compromise the sample, such as exposing the sample bag to temperature swings that can cause condensation of moisture, and eventually mold to form.

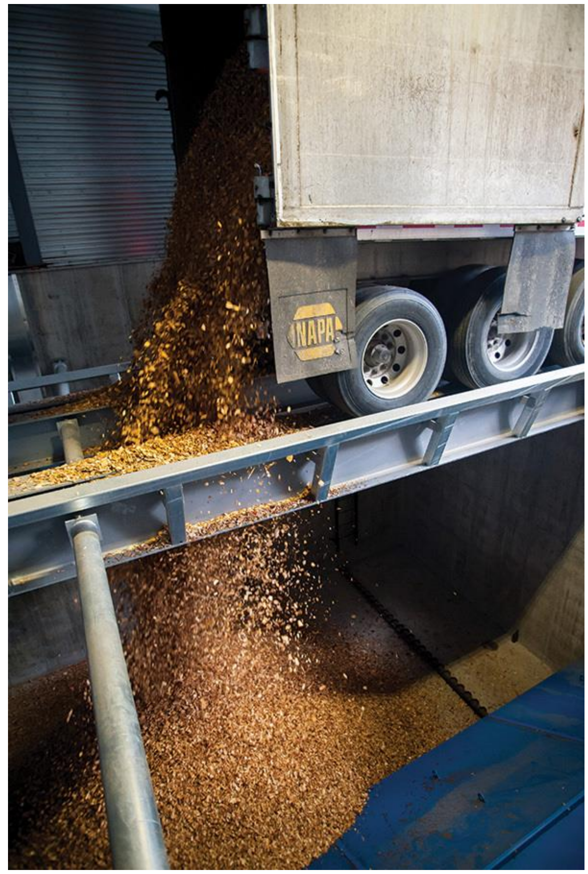
End users/buyers should require independent test lab data as a condition of their initial fuel procurement decision, and periodically thereafter to ensure that fuel is consistently meeting the Standard.

Using the Standard in Fuel Procurement

End users/buyers of wood chip fuel are encouraged to seek pricing from multiple suppliers when and where options exist in the marketplace. This may be a requirement of public institutions such as school districts that have policies regarding competitive bidding requirements and is a good practice for any end user. A well-managed competitive process will result in the best possible pricing and allow the end user/buyer to evaluate other considerations that distinguish producers, such as reliability of supply, and adherence to delivery policies and procedures (e.g. time of day restrictions). Most importantly, it will also ensure that the producers of wood chip fuel become familiar with the fuel quality specifications expected by the consumer, especially if the consumer specifies fuel to a known standard such as ANSI/ASABE AD17225-4.

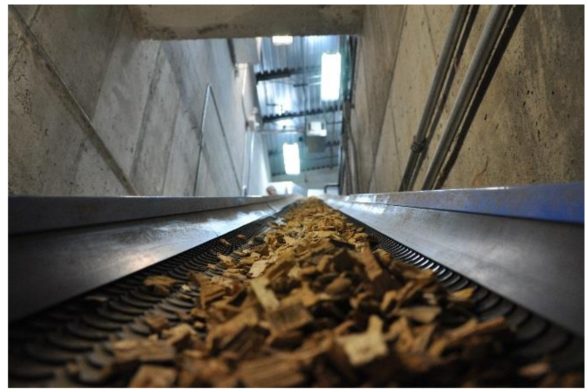
Considerations of End User/Buyer in Fuel Procurement

End users/buyers who are procuring fuel through a competitive process are encouraged to use a request for proposals (RFP) that sets forth clear expectations regarding fuel quality, anticipated volume, logistical considerations around delivery, and other factors. A model wood chip fuel procurement RFP has been developed to provide guidance in how to incorporate the woodchip standard into the procurement process (available online at https://www.woodchipstandard.org/links-resources/). The details of an RFP are beneficial to the producer in that they allow the producer to take all important



considerations and expectations into account when submitting a price proposal. End users/consumers are strongly encouraged to specify fuel to a specific grade of the ANSI/ASABE AD17225-4 wood chip standard. If prospective bidders are unfamiliar with the Standard, the end user/buyer can provide a copy of this guidance document and information on how to obtain a copy of the Standard. The end user/buyer is strongly encouraged to require independent third-party laboratory test data from the producer to verify that they are capable of producing fuel that meets the requirements of the Standard. The RFP should always require references of other customers, and reserve the right to reject any and all bids.

A typical competitive fuel RFP process requires up to 6-8 weeks from circulation of the RFP to completion of a contract, and is often commenced at the end of a heating season to ensure that fuel supply is under contract and ready for delivery for the next heating season. The end user/buyer should circulate the RFP to as many qualified fuel producers as possible. Public institutions may be required to advertise issuance of the RFP in a newspaper of local circulation. If up-to-date testing is required of the producer, they should be given at least 4 weeks to respond to the RFP as the turnaround time on test results can be up to two weeks from receipt of a test sample. A visit to the delivery site for prospective bidders is strongly advised in order to fully understand delivery logistical considerations. Fuel supply contracts can be for one or more years, but multi-year contracts usually include some consideration for unknown future price factors such as sharp increases in diesel fuel cost, and dramatic changes in local/regional wood markets.



Section 4. Appendices

I. Definitions

Ash content: Amount of ash produced during combustion relative to the amount of fuel fed into the system.

Bark: Bark residue derived from commercial timber and milling operations by various removal techniques.

Bole chips: Wood chips produced from the main tree stem (bole), exclusive of branches and leaves, typically without prior debarking.

Calorific value –energy contained in a fuel, determined by measuring the heat produced by the complete combustion of a specified quantity of it. Usually expressed in Btu per pound or Joules per kilogram.

Chemically-treated wood: Any wood that has been treated with chemicals other than air, water or heat whether intentional or inadvertent (excl. trace amounts of grease or other lubricants).

Chipper: Machinery that reduces roundwood, whole trees, slab wood, and branches and brush to chips of more or less uniform size.

Coarse fraction: Portion of wood chips that do not pass through the sieves used to determine the main fraction.

Contamination: Exposure of a fuel to impurity such as chemical substance, or inclusion of foreign objects such as nails, chipper knives, bolts, stones, gravel, or dirt.

Fines: Undersize material, composed of sawdust and non-combustible material such as mineral soil or sand.

Grinder: Machinery that processes wood by grinding it into smaller pieces with a hammermill, a rotating drum with rapidly spinning hammer that pound the material into small particles.

Higher Heating Value (HHV): A measure of the energy content of perfectly dry wood (zero percent moisture content).

Hog fuel: Wood fuel that has pieces of varying size and shape and produced by crushing with blunt tools such as rollers, hammers, or flails.

Informative: Parameters that can be reported voluntarily and do not have to be met for qualification under the Standard.

Main fraction: Portion of woodchips of a similar size that form the majority of the chips in a batch (at least 60 w-%), excluding the coarse fraction and the fines.

Moisture content: The total amount of water in a biomass fuel given as a percentage of the total weight of the fuel.

Normative: Parameters that must be met for wood chips to qualify under the Standard.

Paper-grade: Barked or debarked wood chips generated as a by-product of the sawmill industry -also called sawmill chips

Pulpwood: lower grade of log that is suitable to be processed for paper manufacturing.

Sawlog: grade of log that will be processed for lumber for products such as construction or furniture. Sawlogs are wider, straighter and have fewer knots than pulpwood.

Screening: process of sifting to remove both under- and over-sized particles from a batch of wood chips.

Short-rotation or coppice wood: Small, fast-growing trees (e.g. willow) grown for raw material for heat or energy production in short-rotation plantations.

Stringers: longer pieces of wood that pass through a chipper or grinder without significant size reduction and that can be found in a batch of wood chips. Stringers may cause mechanical jam of the wood chip conveyors.

Plantation: trees that have been planted rather than have re-grown naturally from seeds. Plantations typically include a low diversity of tree species.

Urban wood chips: chips produced from sources like urban tree trimmings and removal, land and right-of-way clearing, ground pallets, Christmas trees. Should not include any construction and demolition waste, or any wood that has been chemically treated.

Whole-tree chips: Wood chips produced by chipping or grinding felled tree with its limbs, bark, and leaves needles, but excluding its roots system.

Wood chips: Woody biomass in the form of particles with a defined particle size and shape, produced by mechanical size reduction.

II. Abbreviations

w-% Percentage based on weight

A Designation for ash content on dry basis, A_d [w-%]

BD Designation for bulk density as received [kg/m^3]

Btu British thermal unit, a unit used to measure the quantity of heat, defined as the quantity of energy required to heat 1 lb. of water 1° F. It takes about 1,200 Btu to boil 1 gallon of water.

E Designation for energy density, [MWh/m^3 loose or stacked volume]

In Inches

M Designation for moisture content as received on wet basis [w-%]

P Designation for particle size distribution

Q Designation for net calorific value as received [MJ/kg or kWh/kg or MWh/t] at constant pressure

III. Unit conversions

1 millimeter (mm) equals 0.039 inches

1 square centimeter (cm^2) equals 0.155 square inches (in^2)

1 megawatt hour (MWh) equals 3.412 Million British Thermal Unit (MMBtu)

1 kilowatt hour (kWh) equals 3,412 British Thermal Units (Btu)

1 Megajoule (MJ) equals 9,478 British Thermal Unit (Btu)

1 metric ton equals 1.1 U.S. ton

1 kilogram (kg) equals 2.2 pounds (lbs.)

1 cubic meter (m^3) equals 35.3 cubic feet (cu.ft.)

IV. Referenced Documents

ISO standards describing methods for analysis of fuel properties are listed below. ISO standards may be purchased from https://webstore.ansi.org/.

- ISO 14780, Solid biofuels — Sample preparation
- ISO 16948, Solid biofuels — Determination of total content of carbon, hydrogen and nitrogen
- ISO 16968, Solid biofuels — Determination of minor elements
- ISO 16994, Solid biofuels — Determination of total content of sulfur and chlorine
- ISO 17225-1, Solid biofuels — Fuel specifications and classes — Part 1: General requirements
- ISO 17827-1, Solid biofuels — Determination of particle size distribution for uncompressed fuels — Part 1: Horizontally oscillating screen using sieve for classification of samples with top aperture of 3,15 mm and above
- ISO 17828, Solid biofuels — Determination of bulk density
- ISO 18122, Solid biofuels — Determination of ash content
- ISO 18125, Solid Biofuels — Determination of calorific value ISO 18134-1, Solid biofuels — Determination of moisture content — Oven dry method — Part 1: Total moisture — Reference method
- ISO 18134-2, Solid biofuels — Determination of moisture content — Oven dry method — Part 2: Total moisture - Simplified method
- ISO 18135, Solid Biofuels — Sampling
- ISO 16559, Solid biofuels — Terminology, definitions and descriptions