Woodchip Heating Fuel Specifications

in the Northeastern United States

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Biomass Energy Resource Center

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Wood energy systems will function and perform better with a high-quality fuel.

Woodchip systems that are fueled with consistent, uniformly sized chips experience fewer mechanical jams of the fuel feeding equipment. Systems that are fed low moisture-content wood fuel typically require less fuel to produce the same amount of energy. Systems that are fed cleaner woodchips (bark, foliage, dirt, and debris free) produce less ash and can burn longer without maintenance and removal of ash. Matching the right fuel source and quality to the right system and application—while still making economical choices—is important.

SOURCES. There are many sources of wood that can be processed into woodchip fuel and there are equally as many ways in which the wood can be harvested, processed, loaded, transported, and received—all of which can impact the overall quality of the woodchip as a fuel. Important characteristics of wood fuel are energy content; moisture content; chip shape, size, and uniformity; ash content; and the presence of dirt and other debris. (For definitions of each of these terms, please see the glossary at the end of this document.)

TYPES. There are four main types of woodchip fuel: paper chips, bole chips, whole-tree chips, and urban-derived wood fuel, in order from highest to lowest quality. Each differs on important characteristics like ash content, uniformity, and the absence of dirt and debris.

QUALITY. Before choosing one of these woodchip fuels for an energy system, careful consideration must be given to the best quality of chip required for the application as well as sourcing, availability, and pricing of each grade. There are currently no regulatory or voluntary industry standards to gauge the quality of woodchip fuel in the United States, but in the past have been described and categorized with vaguely defined and highly subjective terms such as “clean” and “dirty.”

This document attempts to present clear descriptions of chipped fuel sources and their corresponding specifications for use as boiler fuel. It is intended to assist wood fuel purchasers with selecting the best fuel for their application. Wood fuel suppliers may also find this useful as a guide for providing quality woodchips to customers. Outlined here are the technical specifics for four main woodchip heating fuel sources labeled Grades A through D in order of quality:

- **GRADE A.** Paper-grade chip (high quality)
- **GRADE B.** Bole chip (medium quality)
- **GRADE C.** Whole-tree chips (low quality)
- **GRADE D.** Urban-derived wood fuel (lowest quality)

GRADE A

Clean, Mill, or Paper-Grade Chips

Sources: Sawmills and Chip Mills

Clean, mill, or paper-grade woodchips are those meeting paper-making specifications that are produced as a by-product of lumber production by sawmills or as a primary product produced by chip mills that debark and chip roundwood and screen the chips.

Clean woodchips are the highest-quality woodchip for heating systems due to their low ash content, consistent moisture content, and uniform shape and size. High-quality logs are brought to sawmills to be made into lumber. The business of sawing rounds logs into square boards generates wastes such as slabs and off-cuts, which can be chipped at the sawmill. These logs are de-barked prior to chipping and the resulting chips are screened to remove fines and over-sized pieces. The result is a clean chip with consistent shape and size. These chips are blown directly into trailers for delivery.

PARAMETER	MAXIMUM	TYPICAL	MINIMUM
Particle Size			
Dimensions (length x width x thickness)	3" x 3" x 0.5"	1.5" x 1.5" x 0.25"	1" x 0.75" x 0.12"
Coarse materials (% retained by 3" mesh screen)	10%	5%	N/A
Main materials (% retained by ½" mesh screen)	100%	95%	90%
Fines materials (% passed through ½" mesh screen)	10%	4%	N/A
Ash Content			
Ash content by weight	3%	1.0%	No minimum
Alkali content (lbs/MMBtu)	0.4	0.2	N/A
Moisture Content			
Moisture content by weight	50%	42%	25%
Energy Content			
At given moisture content	50%	42%	20%
Btu/green pound	4,125	4,785	6,600
Contaminants (rocks, ice, dirt & debris)	None	None	No minimum

GRADE B

Bole Chips

Sources: Chip Yards

Bole woodchips are produced by chipping the main stem or bole of a harvested tree without debarking beforehand and are usually made from chipped pulpwood.

Bole chips are typically unscreened but can be improved by screening to remove excess over-sized or fine material. They are a medium-quality heating fuel due to their coarser chip size and higher bark and ash content. The bark content of bole chips causes slightly higher ash content than clean chips. Logs that cannot be made into lumber can be chipped at the harvest site or at a chipyard. They are fed to a mobile or stationary chipper.

At chipyards, a screener can be installed to separate fines and over-sized pieces. Fines can be sold to farmers as animal bedding and over-sized pieces can be used to make mulch. The remaining chips make a medium-quality fuel since they are even in shape and size, yet include bark and therefore produce more ash during combustion than higher-quality chips. These chips are blown directly into trailers for transport to customers.

PARAMETER	MAXIMUM	TYPICAL	MINIMUM
Particle Size			
Dimensions (length x width x thickness)	3.5" x 3.5" x 0.75"	2" x 2" x 0.25"	1" x 0.75" x 0.12"
Coarse materials (% retained by 3" mesh screen)	15%	10%	No minimum
Main materials (% retained by ½" mesh screen)	100%	90%	80%
Fines materials (% passed through ½" mesh screen)	20%	10%	No minimum
Ash Content			
Ash content by weight	3%	1.5%	No minimum
Alkali content (lbs/MMBtu)	0.5	0.3	No minimum
Moisture Content			
Moisture content by weight	50%	42%	25%
Energy Content			
At given moisture content	50%	42%	25%
Btu/green pound	4,125	4,785	6,600
Contaminants (rocks, ice, dirt & debris)	None	None	No minimum

GRADE C

Whole-Tree Chips

Sources: In-Woods Chipping of Tops and Limbs

Whole-tree woodchips are produced by in-woods chipping of primarily top and limb wood piles left at log landings as part of mechanized whole-tree harvesting of timber.

Whole-tree chips vary widely in size due to the inconsistent nature of the material fed to the chipper. Whole-tree chips are lower-quality heating fuel due to higher ash content and less uniform chip shape and size. The presence of "stringers," long twigs (up to 9" inches in length), can cause feeding jams with augers if equipment is undersized.

Whole-tree harvesting generates waste piles of tops and limbs and other non-merchantable material that can be chipped at the harvest site. Trees, tops, and limbs are fed to the chipper and then blown directly into a trailer for transport to the customer.

PARAMETER	MAXIMUM	TYPICAL	MINIMUM
Particle Size			
Dimensions (length x width x thickness)	8" x 3" x 0.5"	2" x 2" x 0.25"	1" x 0.75" x 0.12"
Coarse materials (% retained by 2 inch mesh screen)	20%	10%	No minimum
Main materials (% retained by ½ mesh screen)	100%	85%	75%
Fines materials (% passed through ½ inch mesh screen)	25%	12%	No minimum
Ash Content			
Ash content by weight	4%	2%	No minimum
Alkali content (lbs/MMBtu)	0.5	0.2	No minimum
Moisture Content			
Moisture content by weight	50%	42%	25%
Energy Content			
At given moisture content	50%	42%	25%
Btu/green pound	4,125	4,785	6,600
Contaminants (rocks, ice, dirt & debris)	Very little	None	No minimum

GRADE D

Urban-Derived Wood Waste Chips

Sources: Wood Recycling Yards, Arborists, and Municipal Tree-Care Activities

Urban tree trimmings, recycled wood, Christmas trees, and other clean wood wastes are chipped for use as wood fuel.

It is difficult to control the fuel quality and there can often be contaminants such as foreign objects, dirt and debris, and leaves and needles. It is important to avoid pressure-treated or painted wood, or other chemical contaminants since burning these would be harmful.

Typically ground in tub or horizontal grinders, this process generally results in more irregular-shaped and stringy wood fuel than chipped material.

Due to this, its higher ash content, and greater risk for contamination, urban-derived wood fuel is the lowest quality woodchip for heating systems. It is most often used as feedstock for composting, as a mulch product, or for large industrial energy systems designed to burn low-quality fuel.

PARAMETER	MAXIMUM	TYPICAL	MINIMUM
Particle Size			
Dimensions (length x width x thickness)	8" x 3" x 0.5"	3" x 1.5" x 0.5"	0.75" x 0.75" x 0.12"
Coarse materials (% retained by 4 inch mesh screen)	20%	10%	No minimum
Main materials (% retained by ½ mesh screen)	100%	90%	80%
Fines materials (% passed through ½ inch mesh screen)	20%	10%	<1%
Ash Content			
Ash content by weight	5%	3%	No minimum
Alkali content (lbs/MMBtu)	0.5	0.3	No minimum
Moisture Content			
Moisture content by weight	50%	40%	20%
Energy Content			
At given moisture content	50%	42%	20%
Btu/green pound	4,125	4,785	6,600
Contaminants (rocks, ice, dirt & debris)	Some	A little	No minimum

Select Glossary

[generally accepted terms and definitions]

Alkali Content: The measured amount of basic compounds those with a pH greater than 7.0) or salts found naturally in wood. These compounds can be caustic or corrosive to combustion equipment and frequently aid in the formation of "clinkers."

Auger: An automated screw-arm used to move material such as woodchips.

Ash Content: The amount of inorganic substances naturally found in wood that produce ash when the wood is combusted. Often referred to as the mineral content of wood.

Biomass: Any plant- or animal-derived organic matter that can be burned for energy. Here used as synonymous with wood in its various forms.

Bole: The main stem or trunk of a tree, exclusive of branches and top.

Bole Chips: Medium-quality woodchip for heating systems. Produced by chipping the main stem or bole of a harvested tree most commonly without prior debarking and typically made by chipping pulp-grade roundwood.

Btu: British thermal unit, a standard unit of energy equal to the heat required to raise the temperature of 1 pound of water one degree Fahrenheit.

Chip Mill: A stationary and centralized plant set up to make incoming roundwood into woodchips. Chip mills typically produce chips to feed regional pulpmills with paper-grade chips.

Chipper: A large device that reduces logs, whole trees, slab wood, or lumber to chips of more or less uniform-size. Stationary chippers are used in sawmills, while trailer-mounted whole-tree chippers are used in the woods..

Clean, Mill, or Paper-Grade Chips: The highest-quality woodchip for heating systems. Produced as a by-product of lumber production by sawmills or as a primary product produced by chip mills that de-bark and chip roundwood and screen the resulting chips. They meet paper-making specifications

Clinker: A fragment of incombustible matter leftover after combustion; when cool becomes a hard, brittle mass.

Contaminants: In regards to woodchips, these can be foreign objects like nails, chipper knives and bolts, other pieces of metal, stones, gravel or dirt. It can also include chemicals, paints, or other treatments that are applied to wood products. These foreign materials can cause damage to fuel handling and combustion systems or emit harmful pollutants when burned.

Energy Content: The measured Btu content, by weight, of a wood fuel.

Green Biomass Fuel: Un-dried biomass fuel with approximately the same moisture content as at time of harvest. (see also Moisture Content)

Grinder: Machinery that processes wood by grinding it into smaller pieces for use as boiler fuel or mulch; the machinery used to grind wood is a hammermill, which consists of a rotating drum with rapidly spinning hammers inside that pound the material into small particles.

Ground Wood: Wood that has been passed through a grinder. Often lower-quality than chips due to the lack of uniformity of shape and size.

Log Landing: The central place at a harvest site where equipment is stationed and where harvested wood is aggregated, sorted, and processed for transport.

Hog: Shorthand for hog mill (or hammer mill), a device used to grind up various forms of biomass into chip-sized pieces.

Hogged Fuel: Biomass fuel produced by grinding up various forms of wood and bark, possibly mixed with sawdust. Often refers to a variable low-quality fuel. However, if produced from clean, high-quality dry scrap wood, it can be a relatively high-quality fuel.

Moisture Content: The measured amount of water, by weight, present in wood. Green wood has a moisture content of approx. 50%, meaning half of the weight of the material is water.

Pulpwood: Low-grade roundwood harvested and used for making pulp fiber for making paper and paper/cardboard products.

Roundwood: Log sections of wood typically sourced from the tree bole or main stem.

Screened Chips: Woodchips that have been sifted to typically remove both over- and under-sized pieces resulting in a highly consistent shape and size. Sifting equipment used can include deck screens using wire mesh through which the chips are passed and disk screens that allow desired material to drop through gaps and float over-sized material over a bed of spinning disks.

Stringers: Long pieces of chipped wood, un-chipped branches and twigs, or other pieces or wood ranging 4-9 inches long or more.

Ultimate Analysis: Laboratory analysis that tells the percentage of the elemental components of a fuel, including water and ash; gives the percent by weight of carbon, hydrogen, oxygen, sulfur, and nitrogen.

Urban-Derived Wood or Wood Waste Chips: Lowest-quality woodchip for heating sytems. Produced from sources like urban tree trimmings and removal, land and right-of-way clearing, and ground pallets and Christmas trees. Should not include any construction and demolition waste or any wood that has been painted, stained, or chemically treated.

Whole-Tree Chips: Low-quality woodchip for heating systems. Produced by in-woods chipping of top and limb wood piles left at the log landing as part of mechanized whole-tree harvesting of timber.

Woodchips: Small rectangular pieces of wood (approx. 1" x 2" x 1/2") produced by a chipper.

For further information on woodchip fuel specifications, contact:

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For general information on community-scale biomass energy—including case studies, a biomass facilities database, fact sheets, a glossary of wood-heating terminology, frequently asked questions, an image library, and links to additional resources—visit the BERC website at:

www.biomasscenter.org

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The Biomass Energy Resource Center (BERC) is an independent, national nonprofit organization located in Montpelier, Vermont with a Midwest office in Madison, Wisconsin, that assists communities, colleges and universities, state and local governments, businesses, utilities, schools, and others in making the most of their local biomass energy resources.

BERC's mission is to achieve a healthier environment, strengthen local economies, and increase energy security across the United States through the development of sustainable biomass energy systems at the community scale. BERC's particular focus is on the use of woody biomass and other pelletizable biomass fuels.

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