



GARN EPA Testing – Part 1

Occasionally questions arise regarding EPA testing and **GARN® WHS** equipment. It is reasonable for potential customers to know if units have been tested. The short answer is that the GARN units will be tested, but have not been tested to date for compliance with **EPA Phase 2** regulations.

After several years in development with the EPA, state air quality representatives, manufacturer representatives and other interested stake holders American Society of Testing and Materials (ASTM) Document E 2618 – 09 was issued in 2009. The title of this document is **Standard Test Method for Measurement of Particulate Emissions and Heating Efficiency of Outdoor Solid Fuel-Fired Hydronic Heating Appliances**. This document covers the testing of outdoor wood fired hydronic units that modulate combustion air as the method for controlling BUTH output.

Appendix XI of this document titled **Modified Test Method for Wood Fired Hydronic Equipment that Utilize Thermal Storage** covers the testing of thermal storage equipment that does **NOT** modulate combustion air as the method for controlling BUTH output. The testing of **GARN WHS** equipment is covered by this Appendix. It is very important to note that this document in its entirety requires “*Test fuel charge fuel shall be white or red oak cordwood 18 to 28 % moisture content–dry basis.*” Oak is one of the most common cordwood fuels available and used in the United States. Not only is this test fuel a logical choice, it has also been proven to be a reliable test fuel that produces *statically consistent* results.

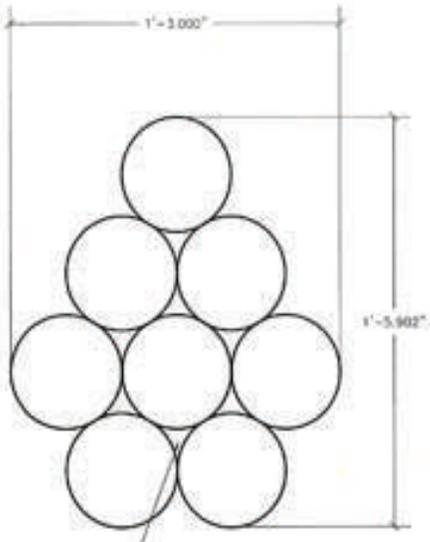
In issuing the Phase 2 voluntary standards, the EPA requires thermal storage equipment to be tested according to ASTM Appendix XI; however, the EPA also requires “*crib wood*” to be substituted for cordwood as the test fuel. So what is “*crib wood*,” does it affect testing and if so how does it affect testing?

Crib wood is a “specifically defined and *pre-assembled*” fuel load that is carefully placed in a combustion chamber. It consists of 4 x 4 sawn oak boards (18 to 28 % moisture content–dry basis) in a specific arrangement such that there is a $\frac{3}{4}$ ” air space around **every surface of every 4 x 4**. This $\frac{3}{4}$ ” space is maintained by utilizing $\frac{3}{4}$ ” thick oak spacers. The stack of oak boards and spacers are nailed into a rigid form, so that it cannot shift (miss align) during fuel loading or during the *initial* stages of combustion. Not exactly a fuel that most wood burners use due to availability, labor and cost!

To better understand the geometry of cordwood and crib wood, please refer to the attached drawing. The drawing is based on a combustion chamber of fixed dimensions, with the wood fuel weights as close as possible (cordwood weight = 96 lbs, crib wood weight = 97.8 lbs). Carefully review the notes for each fuel, especially the porosity figures. During the next month think about how this might affect emissions and efficiency performance.

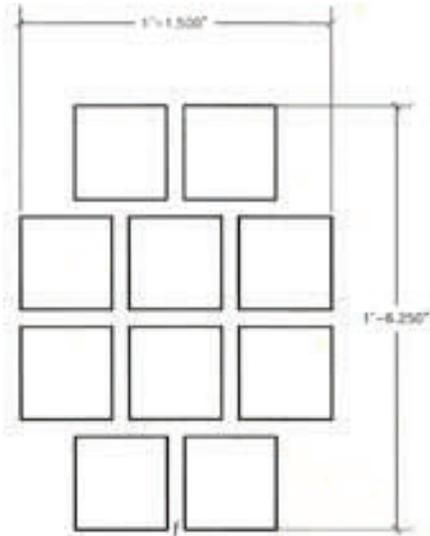
- Do the fuels yield different test results in the lab and in the field?
- Is one fuel a better indicator of field performance than the other?
- If so which one?

Please view on following page a geometry drawing of cordwood and crib wood.



5'x24' red oak
8 logs = 56 lbs. @205mc
Interstitial cross sectional area = 6.79 sq in.
Perimeter Length = 73.1 inches
Porosity = 4.3%

FRONT VIEW - LOGS



4'x4'x24' red oak cribs
10 logs = 87.8 lbs. @205mc
Interstitial cross sectional area = 33.0 sq in.
Perimeter Length = 56 inches
Porosity = 19.4%

FRONT VIEW - CRIBS



GARN EPA Testing – Part 2

In Part 1, I asked you to think about how the utilization of crib wood, in lieu of cord wood as a test fuel, might affect emissions and efficiency performance of a particular wood burning unit. Below is a picture of a **GARN® WHS** unit loaded with “crib wood” composed of 4x4 red oak prior to a test firing.



Comparing approximate equal weights of crib wood (97.8 lbs) to cord wood (96 lbs) one finds:

1. The available surface of crib wood is clean - free of bark, dirt and other “items” normally found in cord wood.
2. Neatly fabricated crib wood exhibits approximately 4 times the “fuel pile porosity” of a stack of round cord wood (19.4% vs. 4.3%).
3. The surface area available for combustion of crib wood is approximately 27% greater than for cord wood.

Wood burns from its surface inward. Because of its greater porosity and large available surface area, crib wood requires significantly more primary and secondary combustion air than required for cord wood. If sufficient combustion air is *not* provided, the wood burner will go into a “puffing mode,” which most wood heating operators have experienced at some point in their life. Let’s assume sufficient combustion air is provided to ensure clean, efficient crib wood combustion and the unit passes the EPA voluntary Phase II limits for emissions.

What happens when the unit is operated normally, utilizing cord wood? Cord wood has less available surface area for combustion and less porosity; however, the volume of combustion air is based on crib wood testing. As a result, the combustion chamber is flooded with significantly *more air* than is required for good combustion. This *lowers* the flame temperature, *increases* emissions and *lowers* overall efficiency. Thus actual in-field efficiency and emissions are usually not as good as the crib wood based test predictions.

The questions for Part 3 are:

- Is the ASTM test method generally a more accurate predictor of field performance than the EPA method?
- How does this affect **GARN WHS** products?



GARN EPA Testing – Part 3

In Part 2, I asked you to think about the following:

Is the ASTM test method generally a more accurate predictor of field performance than the EPA method?
How does this affect **GARN WHS** products?

As stated last month, crib wood requires significantly more secondary air for “clean combustion” than cordwood. So how does an EPA Phase II listed OWB **actually perform** in the field with cordwood, after having passed the EPA emissions test utilizing EPA required crib wood?



*This is an operating **EPA Phase II certified unit**: This unit is in its second winter of operation and is located in Alaska.*



Pictured is the combustion chamber loaded with cordwood. Note the volume of creosote on the combustion chamber surfaces and door:



Pictured is the flue of the above unit. Notice the creosote on the exterior of the flue.



Pictured here is a **25 year old** operating GARN WHS 500 unit that is **not EPA Phase II certified**. Notice the lack of creosote and lack of smoke rolling out of the loading door.



This is the flue of the operating GARN WHS 500 unit....note the **clear exhaust**. This horizontal flue installation **does not comply** with the GARN Installation Manual specifications.



Pictured is a **2 year old** operating GARN WHS 1500 unit. Again note the clear exhaust except for water vapor.



Here is the combustion chamber and door. Note the lack of creosote and lack of smoke rolling out of the loading door.

All models of the GARN product line have been developed **utilizing cordwood** because our customers use cordwood. GARN WHS equipment **could be modified** to pass the EPA Phase II test protocol utilizing crib wood; however, when operated utilizing cordwood the GARN WHS units would produce more emissions due to the excessive secondary air supply dictated by the crib wood test fuel. No one that I know burns sanitized crib wood in their GARN unit.

GARN WHS equipment will be tested in accordance with Appendix XI of ASTM Document E 2618 – 09 utilizing cordwood. It is very important to note that this document in its entirety requires “*Test fuel charge fuel shall be white or red oak **cordwood** 18 to 28 % moisture content–dry basis..*” Oak is one of the most common cordwood fuels available and used in the United States. Not only is this test fuel a logical choice, it has also been proven to be a reliable test fuel that produces *statically consistent* results.

The goal of the EPA Phase II voluntary standards is cleaner burning wood heating equipment. This is a good goal because it will clear the air of excessive OWB emissions. However, the ASTM test method is a *much better indicator* of real world in field performance than any test method that utilizes crib wood as the test fuel. It is interesting to note that European test protocols also require cordwood and **NOT** crib wood.

The EPA needs to modify its test protocol and specify cordwood as the required test fuel in lieu of crib wood. Presently many states are set to adopt the EPA Phase II voluntary standards and totally miss the primary objective of the standard.....cleaner air. However, if a sufficient number of concerned citizens’ contact their local and state Representatives, this process can be changed. Cleaner air cannot be obtained by utilizing an inappropriate test fuel. The ASTM test method is the preferred method; moreover, the EPA could simply specify this method as it stands **without modification**.