Yukon College Biomass Heating System
Schematic Design Report

ISSUED FOR PRELIMINARY REVIEW

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Prepared for:

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THIRD PARTY DISCLAIMER

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2 Introduction

2.1 Background

The Yukon College has had its Whitehorse campus at Yukon Place in the Takhini subdivision since June of 1988. It is with this newly constructed building complex that a fluidized bed gasifier was installed with a biomass feed system used for feeding wood chips. The gasifier has never operated as intended, so to take advantage of some of the existing infrastructure as well as the opportunity to lead the way in reducing greenhouse gas emissions the College is evaluating the option of installing a biomass heating plant.

A number of reports relating to the Yukon College's gasifier and to biomass systems in the Yukon have been completed, two of which are particularly applicable and are noted here for reference:

(CANMET Report) *Re-Capitalization of Yukon College Gasifier* by CANMET Energy Technology Centre – Ottawa for Yukon Mines Energy and Resources, May 2009

(Ventek Report) *Feasibility of and Options for a Public Bioenergy Heating* Systems *Retrofit* by Ventek Energy Systems Inc. for Energy Solutions Centre, Government of Yukon, March 31, 2009.

FSC Architects & Engineers was commissioned to complete this schematic design report to determine the scope of a new biomass heating plant. Its purpose is to facilitate design decision-making imperative to moving into the next phase of design.

2.2 Biomass alternative – fuel source, current technologies

Biomass fuel sources derive from organic material such as switch grass, straw, and wood. More common biomass fuels in Canada are wood pellets and wood chips. Both fuel sources provide common benefits then using fuel oil or propane. Some of the benefits to using locally processed wood-chips/wood pellets, as a primary source of heat is the reduction of oil and other fossil fuels, creating a localized forestry economy and promoting reduction of greenhouse gases.

There are four different types of fuel heating systems:

1. Fully Automated Systems:

Fully automated systems are operate with computer controls to energize auger conveyors, live bottom floors to convey the material into the boiler system. This type of system eliminates the boiler operator to handle any of thee wood fuel. These types of biomass heating systems are compared to fuel oil and / or propane in such a way that once the boiler is in operation there is minimal amount of supervision required.

This type of system is installed in Yellowknife, NWT.

PHOTO

2. Semi Automated systems:

Semi-automated or "surge bin" systems require more manpower than the fully automated system. This system has a smaller storage bin, shorter, simpler fuel conveyance system, and is designed to meet less than the full heat load of the facility. The rationale behind this is that wood fired boilers operate most efficiently when they are working hard, and that the peak heat load in our region is significantly higher than the load required on most days of the year. The peak load may only be required on one or two weeks of the year, and sizing a boiler to meet the peak would necessarily compromise its efficiency for the majority of the time it is in use.

The smaller, simpler surge bin system cost about 2/3 of the fully automated version

3. third type

4. fourth type

Biomass Benefits

- Use of local renewable energy source
- history of stable prices unaffected by global economics and political events, unlike fuel oil, propane, and natural gas
- Biomass systems burn cleanly (cleaner than wood stoves)
- The cost of biomass fuel is generally less than half the cost of fuel oil on a Btu basis.
- Implementing biomass may stimulate local industry in chips or pellets and result in use of local (Yukon) wood products.
- Reduce greenhouse gases: When wood is burned, it recycles carbon that was already in the natural carbon cycle. Consequently, the net effect of burning wood fuel is that no new CO_2 is added to the atmosphere.

2.3 Project Goal

(to be elaborated)

Determine biomass heating plant size

Evaluate biomass emissions, regulations, control technology

Determine biomass plant operator requirements

Select biomass heating equipment

Determine implementation cost

3 Preliminary Heating Load Calculations & Heating Plant Sizing

3.1 Heating Load

As the Yukon College is a long-standing building with established energy usage, heat loss calculations on the building were not performed. Rather, the design load was calculated for each of the past four years.

The Yukon College's energy usage history is somewhat inconsistent and appears to be on the rise as indicated by the high volume of fuel oil consumed in the most recent year April 2008-March 2009. Energy consumption over the past 4 years is shown in Table 1 below and the calculations made for estimating design load are found in Appendix B.

Year	Calculated Design Load	Fuel oil	Electricity	Heating Degree Days
Apr - Mar	kW	Litres	kWh	(>18^{o}C)
2005-06	1,796 kW	272,785	3,806,880	6373
2006-07	1,164 kW	294,030	3,257,760	7031
2007-08	1,701 kW	408,114	3,043,200	6680
2008-09	*N/A kW*	618,606	N/A	7204

Table 1: Design load and energy consumption

3.2 Heating Plant Sizing

As recommended in subsection 4.2.1 of the Ventek report, it is generally best to operate the biomass boilers at their peak capacity as much as possible to maintain high efficiency.

Table 1 above shows design load peaking at 1.8 MW. The optimum size for the biomass boiler plant to run at peak is 2 x 950 kW boilers.

Use existing boilers for peaking (-30 and below).

4 Discussion

4.1 Existing Heating Plant

(Require O&M Manuals)

Located in the back of the Yukon College complex, the Energy Centre contains the existing heating and cooling plant which is made up of four (4) existing boilers with thermal storage tanks, expansion tanks, recirculation pumps, and a chilled water system.

The Energy Centre's boilers consist of the following:

B1: 2900 kW (10 MMBTU) wood gasifier,

B2: 4000 kW (13.5 MMBTU) oil fired boiler,

B3: 800 kW (2.7 MMBTU) oil fired boiler and,

B4: 750 kW (2.6 MMBTU) electric boiler

B1 is currently decommissioned due to a long history of problems. B2 is used as the peaking boiler at extreme temperatures and is otherwise not operated. B3 and B4 provide the substantial portion of heating for Yukon College. B4 runs on secondary power, which is available at the discretion of Yukon Energy Corporation based on available supply of electricity. Last winter (Apr 2008 – Mar 2009) saw a 6% increase in heating degree days, more frequent unavailability of secondary power and more frequent operation of B2 than in previous years.

Recommended to keep backup B3 and B4

Recommended to evaluate change-out of B2 for smaller, or eliminate?

At the Energy Centre there is an existing underground storage bunker for boiler B1. It has an approximate capacity of 60m^3 and has an auger to deliver the biofuel to the boiler.

PHOTO OF BUNKER

4.2 New Biomass Heating Plant

The new biomass heating plant would include:

4.2.1 Building

Based on two 950 kW boilers requiring foundations of 11.2m2 each and another 50 m2 of space for the ash collection bins, pumps, heat exchanger, and emissions control equipment, the total footprint of the biomass boiler plant would be in the neighbourhood of 80 m2.

4.2.2 Storage

silo or bin

4.2.3 Fuel conveyor

Option 1: pneumatic conveyor from above-ground storage to existing bunker

Option 2: pneumatic conveyor from above-ground storage directly to boilers

4.2.4 Boiler

Boiler Controls

Fire Suppression System

Ash Collection System: ash extraction auger, sealed metal container

Pump

Heat exchanger

Tie-in piping & insulation

4.2.5 Baghouse

See Appendix C

4.2.6 Existing Equipment

This heating plant would rely on the existing infrastructure including: underground storage bunker and feed auger (for option 1 above), existing boilers for peak heating conditions, thermal storage (accumulator) tanks, and existing heating water distribution system (piping & fittings, pumps, expansion tanks, domestic hot water heating equipment, chemical pot feeder, heating equipment in and beyond the Energy Centre).

4.3 Operator Requirements

Yukon Public Safety Branch requires supervision by person holding 4th class power engineer's certification for systems over 750 kW in size. One qualified person can maintain the two proposed biomass boilers.

Initial Training

Operator Hours

Maintenance - every 300 to 500 hours. (Cleaning, lubrication)

Shut Down Cleaning – biannually

Ash removal - biannually

4.4 NEW HEATING PLANT BUILDING DESCRIPTION: SIZE, LOCATION, PRELIMINARY LAYOUT/PROGRAM

Discussion of building size, location, construction

Located adjacent to Energy Centre

Preliminary layout in Appendix D

4.5 FUEL SOURCES

For the Yukon, the two most practical options for a biomass boiler fuel source, or biofuel, are wood chips and wood pellets due to the "2200 square kilometre area of dead forest potentially available for energy use"[1] in the area around Haines Junction, and the relative lack of any other plant source in the territory. The availability, advantages and disadvantages of each of these are discussed in subsection 3.5.1 of the CANMET report and also in section 5 of the Ventek report. Table 2 summarizes some of the advantages and disadvantages of wood chips and wood pellets for the specific application at Yukon College.

	Wood Pellets	Wood Chips
Bunker/Auger Modifications	Not Required	Required
Storage	Relatively compact fuel	Bulky fuel
New storage	Silo – 55 tonne	Bin - 50 ton
Refill Requirements	3 weeks	1 week
Area	18' diameter	
Cost	~$30,000	~$300,000
Cost	~$300/tonne (oven dried)	~$150/tonne (oven dried)
Properties	Consistent	Inconsistent
Moisture Content (MC)	5%	50% green, ~20% dried
Bulk Density	>600kg/m^3	~200kg/ m^3 at 25% MC*
Heating Value	>20MJ/kg	~ 15MJ/kg at 20% MC
Quality	Stable	Varying
Combustion Emissions		
NOx		
PM10		
PM2.5		
CO		
Availability – present day	Imported - Trucked from Prince George area	Sourced locally - Trucked from Whitehorse area or Haines Junction

[1] CANMET Report subsection 3.5.1 pg. 53

Availability – future	Possible development of local wood-pelletization plant – based on demand and production $$	Increased demand = increased access to forested areas = increased availability
Local Employment Effects	Less Favourable	Favourable
Equipment Maintenance	Lower	Higher

*MC = Moisture Content

Table 2: Wood fuel comparison

4.6 Emission Control

The potential installation of a biomass boiler plant raises immediate questions about emissions.

Toxicological studies have shown that particulate matter from internal combustion engines, coal burning, residual oil combustion and wood burning have strong inflammatory potential.

Comparison chart showing emissions from fuel oil, natural gas, wood biomass HERE.

"PM controls: There are several technically feasible combustion control options available for existing small- and medium-sized boiler that will reduce emissions below 0.10 lb/mmBtu per hour. In order to reach these emission levels boiler operations must be optimized and advanced emission control devices, such as fabric filters and ESPs, will need to be installed Based upon discussions with air quality regulators, it is likely that the advanced combustion control devices would also be deemed economically feasible as well.

CO controls: There are no post combustion technologies available for these units, therefore boiler optimization is the best approach to minimize CO emissions

NOx: While there are several technically feasible options available that would reduce NOx emissions from wood-chip boilers, the costs associated with these units are likely to deem them as economically infeasible at this time."

All but the very best wood burning systems, whether in buildings or power plants, have significantly higher particulate matter (PM) emissions than do corresponding gas and oil systems. For this reason, it is necessary to focus emission control on effectively reducing ground-level concentrations of PM to acceptable levels.

The combination of emission control devices and advanced boiler designs on biomass boilers 300kW or greater is common in Europe, but emission control on biomass boilers is limited in North America. As the market continues to grow in North America, these products will likely be more available and be implemented more in Canada and the US as well.

The proposed boilers offer industry leading clean emissions and with emission control equipment the emissions from these boilers will be in the 20 mg/Nm^3 range and below, depending on boiler loading.

The following table summarizes the emission control options and their applicability.

(Reference NESCAUM http://www.nescaum.org/topics/commercial-wood-boilers)

Control	*Removal Effectiveness*	*Cost ($)**	*Comments*
Cyclone	PM_{10} -Moderate control	Installation	Inexpensive

	efficiency ~50 percent $PM_{2.5}$ – 0 to 10%	*7-10K* Maintenance *minimal*	Ineffective at removing fine PM Ineffective at removing gas phase PM (condensable PM)
Multicyclone	PM_{10} -Moderate control efficiency ~75 percent $PM_{2.5}$ – 0 to 10%	Installation *10-16K* Maintenance *minimal*	Inexpensive Ineffective at removing fine PM Ineffective at removing gas phase PM (condensable PM)
Core Separator	PM_{10} – 98 percent and higher $PM_{2.5}$ – 98 percent and higher	Installation *83-130K* Maintenance *Unknown*	Questions about availability Questions regarding effectiveness
Baghouse / fabric filter	PM_{10} – 98 percent and higher $PM_{2.5}$ – 98 percent and higher	Installation *100K* Maintenance *10K*	Higher cost Highly effective at removing fine PM Able to capture condensable PM
Electrostatic Precipitator	PM_{10} – 90 percent and higher $PM_{2.5}$ – 90 percent and higher	Installation *90-175K* Maintenance *1-2K*	Higher cost Highly effective at removing fine PM Ineffective at removing gas phase PM (condensable PM)

*Cost based on 2008 $US dollars and does not include transportation or taxes.

Table 3 Summary of Potentially Applicable PM Control Devices

For the Yukon College, either a baghouse based on "Ryton" bag material which is good up to 450F or an electrostatic precipitator will be recommended.

(Further details to come)

4.7 UTILITY REQUIREMENTS (POWER, WATER)

Expand

4.8 GEO-TECHNICAL CONSIDERATIONS

Expand

4.9 REGULATORY OBLIGATIONS AND STANDARDS FOR EMISSIONS

4.9.1 Air Emissions Regulations in Yukon

The Yukon's *Air Emissions Regulations* under the *Environment Act* have three pertinent clauses. In terms of emissions content, the only requirement is that the sulphur levels of the fuel itself not exceed 1.1%, which should not be a problem with a biomass boiler that burns wood as its fuel.

The second clause of importance pertains to the opacity of the emissions, limiting them to 40% from one source. This also is not burdensome with modern biomass boiler design.

These regulations will, however, require that a permit be obtained for the new heating plant. Schedule 1 of the regulations lists activities that require a permit, and the activity that relates to the biomass heating plant is quoted below:

> 5. Operation of equipment capable of generating, burning or using, according to the manufacturer's specifications, heat energy equivalent to or greater than 5,000,000 British Thermal Units per hour.

The permit application form is attached in Appendix C for reference.

4.9.2 YESAA

This proposed project will require an assessment under the *Yukon Environmental and Socio-economic Assessment Act* (YESAA) if three conditions are met.

1. The project will be located in the Yukon.
2. The federal YESAA regulations list the project activity as subject to assessment.
3. The proponent has applied for financial assistance for the project to a federal agency or federal independent regulatory agency.

Conditions 1 and 2 above are met for this project since the YESAA regulations list “Operation of equipment capable of generating, burning or using heat energy” “unless it is not capable of generating, burning or using, according to the manufacturer’s specifications, heat energy of 5,000,000 Btu/h or more” as subject to an assessment.

If funding from a federal agency (condition 3) is to be considered, an assessment will be required.

4.9.3 Canada-Wide Standards

In June 2000, the Canadian Council of Ministers of the Environment endorsed the *Canada-Wide Standards for Particulate Matter and Ozone*, which comprise ambient standards to be achieved by 2010. These standards were developed as a first step toward the goal of minimizing the risk posed by these two pollutants to human health and the environment[2]. This standard limits over time the PM2.5 ambient level to 30 µg/m3 as a 24-hour average.

4.9.4 International Standards

Appendix C contains numerous national and international emissions standards for reference. These all attempt to limit ambient levels of pollutants but do not specify limits to be respected for individual applications.

[2] Ref: http://www.ec.gc.ca/cleanair-airpur/caol/pollution_issues/cws/s1_e.cfm (Environment Canada website)

5 Opinion Of Probable Cost

6 Next Steps

Appendix A: Equipment Information

climate of innovation

Heating with Wood

Why Wood Heating?

Rising cost of fossil fuels and growing concern for the environment have led to an increasing demand for renewable energy. Modern wood heating is an eco-friendly and economical alternative (or addition) to conventional fossil fuel heating systems.

Did you know?
A number of federal, state and utility incentive programs are available throughout North America.
Visit www.dsire.org for a list of U.S. state incentive programs.
In Canada, check the Natural Resources Canada website www.nrcan.gc.ca. Or contact your local Viessmann Sales Representative.

Sustainable
When harvested in conjunction with sustainable forestry, wood is a renewable and environmentally-responsible form of energy and an important part of sustainable resource management.

CO_2-neutral
Burning wood releases as much CO_2 as trees absorb in their lifetime. Heating with wood is therefore CO_2-neutral and does not contribute to climate change.

Economical
As a local energy source, wood is affordable and independent of wide price fluctuations. In times of volatile energy prices, wood remains stable and highly competitive.

High-tech and reliable
Modern biomass systems are fully-automatic and equipped with high-tech control and safety devices for reliable, efficient and safe operation.

Local and independent
Wood is a local staple and independent of wide price fluctuations. Wood is harvested with minimal energy input and contributes to the regional economy.

What You Need to Know

What type of wood can I use?
Viessmann-KÖB wood heating systems can use a variety of untreated, high-quality wood fuels that vary in heating value, required storage capacity and cost (see right column). What fuel type you choose will largely depend on your storage capacity, system requirements and the availability of the fuel in your area. As the quality of the fuel impacts the efficiency and life expectancy of your system, it is best to choose a good-quality, untreated wood fuel with a low water content.

How economical is it?
In a biomass system, the operating cost (fuel and maintenance) is an estimated 60% of the total lifecycle cost. Choosing a high-efficiency wood-fired boiler and high-quality, cost-efficient wood fuel thus is key in optimizing the economy of your system. Compared to traditional fossil fuels, the average cost per heat unit of wood fuel is significantly lower in most areas in North America. So while the investment cost of a biomass system may in many cases be higher than a conventional heating system, the fuel cost savings per unit of heat can offset the investment in a relatively short timeframe - making your biomass system as economical or better than a fossil fuel heating system. Plus, with a fuel source that is local and independent, your fuel cost is less volatile than with traditional fuels.

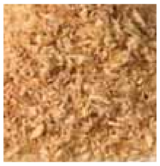
Is it safe?
Absolutely. Today's wood heating systems are as safe and reliable as leading gas/oil heating systems. Equipped with advanced safety and fire protection devices, and a digital control, the entire system is closely monitored and controlled - from the fuel feed right to the heat transfer and venting.
Viessmann-KÖB wood-fired boilers are built to ASME, Section IV requirements, are CRN registered, and have been tested to CSA/UL Safety Standards (including all safety controls).

Is it clean-burning?
Yes! Modern wood heating systems, when professionally operated and maintained, reach similar emission levels to leading fossil fuel heating systems. Better yet, wood heating is CO_2-neutral. Viessmann-KÖB wood-fired boilers meet the stringent regulations of the European Clean Air Act.

What applications can it be used for?
Our wood heating systems are ideally suited for commercial and industrial applications, such as schools, hospitals, community heating systems, wood processing plants and more. They are designed to carry either the entire heating load of your system or the baseload, when combined with an oil-/gas-fired boiler for peak times.
Our comprehensive product portfolio also allows you to expand your biomass installation into a fully integrated system, complete with Viessmann solar, oil/gas boiler and custom control technology (see page 13).

One of Germany's largest facilities powered by
KÖB biomass heating technology.
Recreational Pool and Spa. Kempten, Germany.

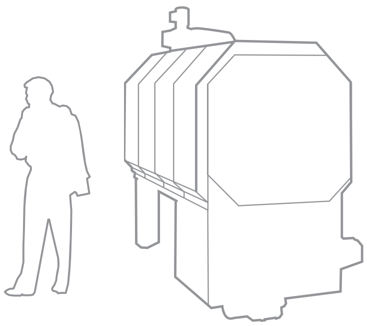
Pellets
Most compact wood fuel with least storage required. High heating value.



Sawdust
Untreated sawdust. Ideal for small storage. Sawmills, carpentry, wood processing facilities.

Woodchips
Shredded, untreated, with or without bark. Large storage required. Max. size: G50. Max. water content: 50%.

Mixed Woods
Unprocessed mix of woodchips, sawdust and bark. Max size: G50.



PYROT

Industry-leading rotary combustion wood-fired boiler, 512 to 1843 MBH

For wood fuels with max. water content of 35%

Industry-leading design

With its patented rotary combustion chamber design, the Pyrot boiler features the industry's most advanced combustion technology.
A feed auger continuously moves the wood fuel onto a moving grate, where gasification of the fuel (under precisely controlled primary air) takes place. The combustible gases (syngas) then rise into the rotary combustion chamber, where, through spin impulses of the rotation blower, the gases blend with precisely controlled secondary air, resulting in a complete combustion.

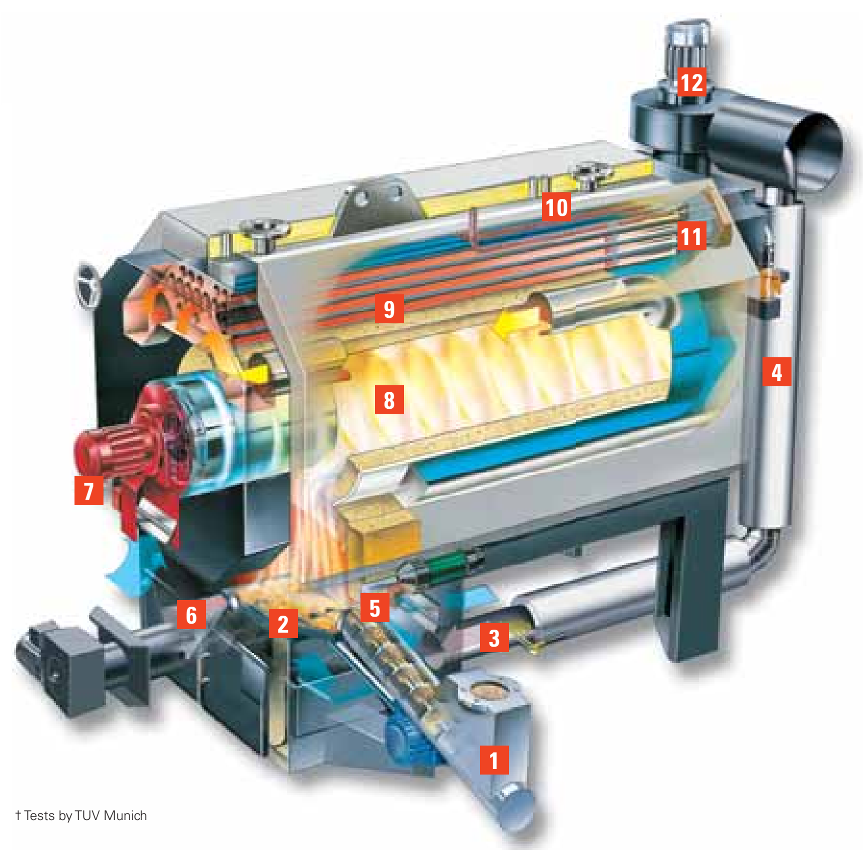
Clean-burning and efficient

Equivalent in quality to modern gas combustion, the advanced combustion process of the Pyrot also keeps emission levels of CO (<10 ppm), NOx (<75 ppm) and dust particles (<0.06 lb/MMBtu) to a minimum.†

Plus, unlike oil or gas, wood is a CO_2-neutral, renewable form of energy. Used with our digital, modulating-output control, the Pyrot boiler achieves an efficiency of 85%.

Containerized package

The Pyrot is available as a fully containerized package for applications where housing for the boiler is not available or onsite construction costs must be kept to a minimum.
This pre-packaged solution includes the boiler pre-installed in a specialized shipping container (see page 5) and all peripheral equipment.
Customized containerized packages are available to suit your individual needs.



1. Feed auger (with light barrier)
2. Moving grate
3. Primary air control valve
4. Flue gas recirculation system
5. Ignition fan
6. Deashing system
7. Secondary air control valve with rotation blower
8. Rotary combustion chamber
9. Triple-pass heat exchanger
10. Safety heat exchanger
11. Pneumatic pipe cleaning system
12. Induced draft fan

† Tests by TUV Munich

Pyrot with ash removal auger and external ash container

Containerized boiler package
(pellet silo field supplied)

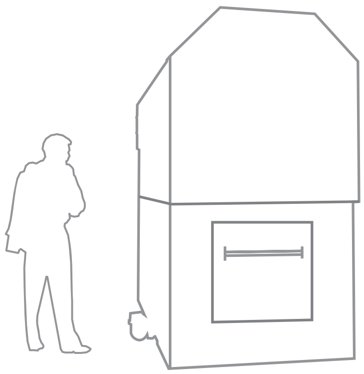
Specifications

- Fully-automatic rotary combustion wood-fired boiler
- 5 models from 512 to 1843 MBH
- For dry wood fuels with max. water content of 35%
- Efficiency: 85%
- Available for 30 or 60 psig max. operating pressure

For technical data, see page 12.

Benefits at a Glance

- High efficiency with advanced combustion technology, triple-pass heat exchanger and modulating output control (turndown ratio 4:1).
- Maximum heat transfer with triple-pass heat exchanger design.
- High efficiency and ultra-low emissions with precisely controlled primary and secondary air.
- Automatic ignition device limits idling and saves fuel.
- Low maintenance with fully-automatic deashing, optional pneumatic cleaning system and flue gas deduster.
- Advanced safety equipment ensures safe and reliable operation.
- Custom design of your system by our team of experts.
- Available as convenient containerized package.



PYROTEC

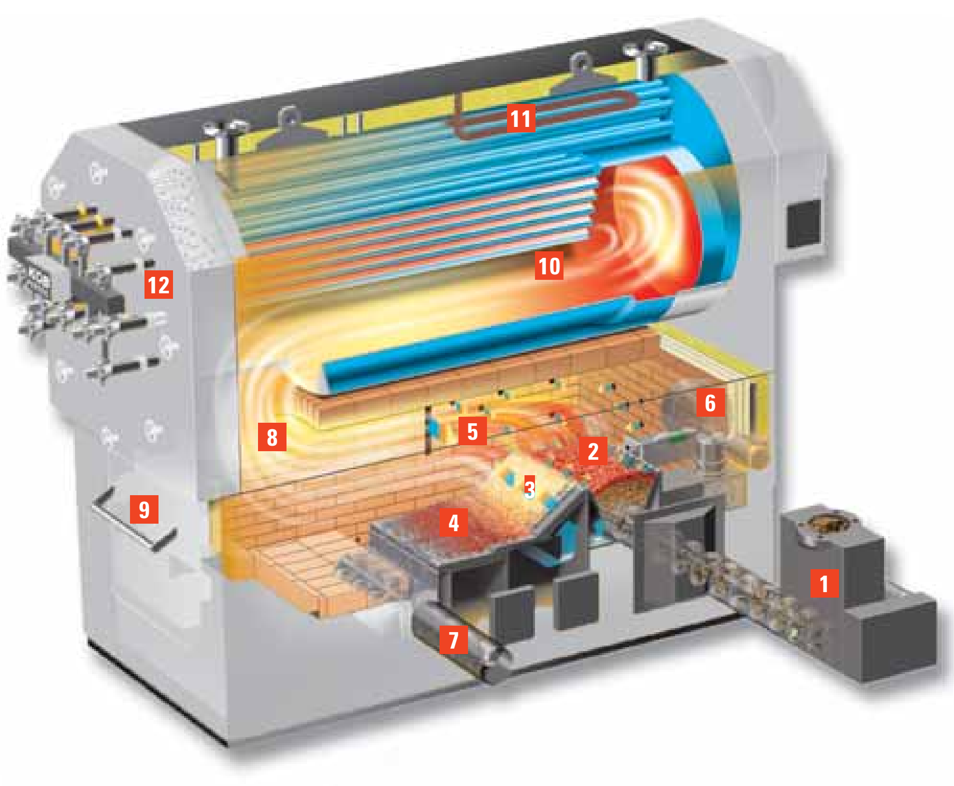
State-of-the-art underfeed combustion wood-fired boiler, 1330 to 4268 MBH

For wood fuels with max. water content of 50%

Grate firing at its best
The Pyrotec boiler uses a burner trough with an attached external grate and a moving annealing grate to achieve optimal combustion results. A feed auger moves the wood fuel into the burner trough where the fuel is pre-dried and gasified under precisely controlled primary air (underfeed combustion). On the external and the moving annealing grate the fuel completely gasifies (syngas). Precisely controlled secondary air is injected to fully combust the syngas and thermal energy is released into the boiler's triple-pass heat exchanger.

Quality design and construction
The Pyrotec boiler is quality-constructed to handle the toughest of loads. The combustion chamber is lined with compressed firebricks with a high alumina content for added durability. All grate elements are made of durable cast chrome steel to withstand even the highest temperatures. The Pyrotec boiler features a classic triple-pass heat exchanger design for maximum heat transfer and efficiency.

Clean-burning and efficient
Equivalent in quality to modern gas combustion, the advanced combustion process of the Pyrotec keeps emissions of CO and NOx to levels comparable to those of modern fossil fuel heating systems. Plus, unlike oil and gas, wood is a CO_2-neutral, renewable form of energy. Used with our digital, modulating-output control, the Pyrotec boiler achieves an efficiency of 85%.



1. Feed auger (with light barrier)
2. Burner trough with internal grate
3. External grate
4. Moving annealing grate
5. Secondary air flow
6. Ignition fan
7. Deashing system
8. High-temperature burnout zone
9. Combustion chamber door
10. Triple-pass heat exchanger
11. Safety heat exchanger
12. Pneumatic pipe cleaning system

Pyrotec boiler with feed auger and automatic fire-extinguishing safety system

Firebrick-lined combustion chamber with
external grate and moving annealing grate.

Large, air-cooled combustion chamber door with solid
double hinge. Creates a wide opening ideal for maintenance.

Specifications

- Fully-automatic underfeed combustion wood-fired boiler
- 5 models from 1330 to 4268 MBH
- For wood fuels with max. water content of 50%
- Efficiency: 85%
- Available for 30 or 60 psig max. operating pressure

For technical data, see page 12.

Benefits at a Glance

- High efficiency with advanced combustion technology, triple-pass heat exchanger and modulating output control (turndown ratio 4:1).
- Maximum heat transfer with triple-pass heat exchanger.
- High efficiency and ultra-low emissions with precisely controlled primary and secondary air.
- Low maintenance with fully-automatic deashing, optional pneumatic cleaning system and flue gas deduster.
- Advanced safety equipment ensures safe and reliable operation.
- Maximum system performance with heavy-duty construction and all system components from one source.
- Automatic ignition device limits idling and saves fuel *(optional - only for fuels with >40% moisture content).*
- Custom design of your system by our team of experts.

Fully Automatic and Low Maintenance

A complete range of system components from one source ensures reliable and smooth operation of the entire system.

Flue gas deduster to meet low dust emission requirements.

Automatic deashing system *(optional)*
Clean combustion leaves behind wood minerals in the form of ashes. A moving grate extracts the ashes from the combustion chamber and transfers them into the ash bin. Once cooled, the ash removal auger extracts the ashes into a large external ash container.

Pneumatic cleaning system *(optional)*
A clean heat exchanger is key for the longevity and efficiency of a boiler. The pneumatic pipe cleaning system periodically removes ashes from the heat exchanger with micro blasts of compressed air, extending the boiler's maintenance-free operation period significantly.

Flue gas recirculation system
(standard for Pyrot, optional for Pyrotec)
Flue gas contains little oxygen (6-8%). When mixed with primary air, it ensures complete gasification of the fuel under air deficiency. This produces a low grate temperature that results in increased boiler efficiency, reduced particle emissions as well as greater grate longevity.

Flue gas deduster *(optional)*
Minimizes dust emissions by filtering the flue gases through a multi-cyclone array. Comes fully insulated with an exhaust fan mounted on the side or top, and a 64 USG ash container. A 212 USG ash container is optional.

(Only required for fuels with high fine particle content, e.g. waste wood from wood processing plants or woodchips with fine particle content of > 4%.)

Automatic firetube cleaning brush *(service tool)*
Automated, pneumatic, vibrating cleaning brush cuts the cleaning time of boilers by 50%. When inserted from the front and activated, the brush "runs" through the individual tube and back, gently removing ash and dust deposits. Clean fire tubes ensure optimal heat transfer and increased efficiency.

Ash removal auger and external ash container

Pneumatic cleaning system

Flue gas recirculation system

Complete Energy Management

High-tech modulating-output control systems for maximum and safe performance of the heating system.

Modern biomass control systems provide the same control convenience as most standard fossil fuel control technology.
Equipped with a modulating-output control and a thermal storage tank, the system supply temperature can be accurately modulated to outdoor weather conditions.

Ecotronic boiler control *(for Pyrot)*
Digital modulating-output control ensures optimal combustion by precisely controlling the ratio of combustion air, recirculated flue gas and fuel. The control monitors:

- Boiler supply/return temperatures
- Firebed level
- Light barriers of the feed system
- Flue gas temperature
- O_2 content of flue gas (Lambda sensor)

Pyrocontrol boiler control *(for Pyrotec)*
Fully-programmable modulating-output combustion and system control. The control regulates all variable-speed fans and monitors:

- Boiler supply/return temperatures
- Light barriers of the feed system
- Pressure sensor for reliable negative pressure
- Flue gas temperature
- Combustion chamber sensor (temperature high limit)
- O_2 content of flue gas (Lambda sensor)

Thermal storage tank
In a biomass system, a thermal storage tank is a key component in achieving maximum control accuracy (ability to adjust system output to actual demand). The storage tank facilitates temperature stratification, effectively reducing cycling of the firing system and accurately matching the system supply temperature to the heat demand.
Five sensor inputs are available on all controls for optimal burner modulation according to tank temperature.

Vitocontrol multi-boiler control
Custom control solution for the staging and rotation of two Pyrot or Pyrotec boilers and the energy management of other integrated energy sources (solar, oil/gas, electric). Controls joint storage and feed system and interfaces with Building Management Systems (BMS).

Remote monitoring system *(optional)*
Off-site monitoring and maintenance of the heating system via web-interface. Allows for the observation and adjustment of various system parameters. Optional LonWorks® and BACnet® interface for local supervision (other interfaces available upon request). Ideal for system monitoring in a public facility or at community/district heating plants.

CSA approved
All biomass control systems are built in-house, and are CSA approved in North America in conjunction with our wood-fired boilers. Plus, benefit from...

- fast installation with all functions in one control
- ease of service and maintenance
- wiring diagrams for each system

Ecotronic boiler control for Pyrot

Pyrotec boiler control

Storage and Feed Systems

Each fuel storage and feed system is unique and designed for a specific application. Our advanced, fully-automatic feed solutions come ready for installation.

All Viessmann-KÖB wood-fired heating systems come equipped with...

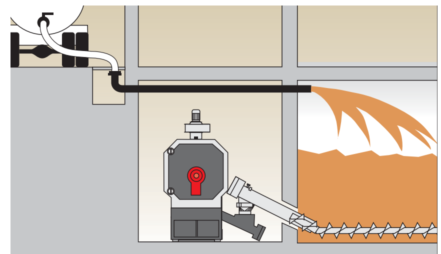
- large-diameter heavy-duty augers
- spur wheel back-geared motors for high torque
- optimized and large-dimension load passages
- certified equipment for effective fire protection

Basement storage with auger extraction
Basement rooms or rooms previously used for oil storage can be transformed into a pellet storage area without extensive remodeling. Pellets can be blown in over large distances and special feeders transport the pellets reliably and with little energy use.

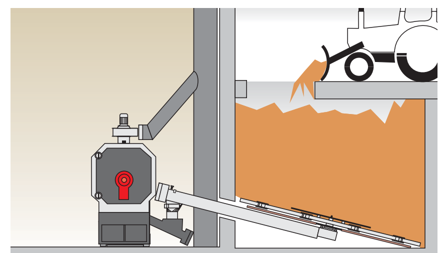
Bunker with rotary sweep extraction
A low-cost option for smaller square or slightly rectangular bunkers. A rotary sweep system moves the fuel onto an extraction auger.

Bunker with walking floor extraction
Ideal for large, rectangular storage bunkers. Sliding hydraulic pushrods move the fuel onto a conveyor auger. Allows for fast filling of large amounts of fuel.

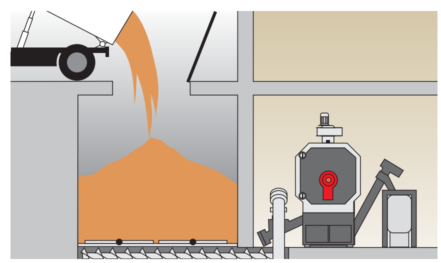
Silo funnel extraction
A pendulum system in the funnel extracts fuel from the silo. Fail-safe due to automatic reverse gearing. A fire-proof certified rotary valve separates the silo from the heating system. Recommended system for wood processing facilities.



Basement storage with pellet auger

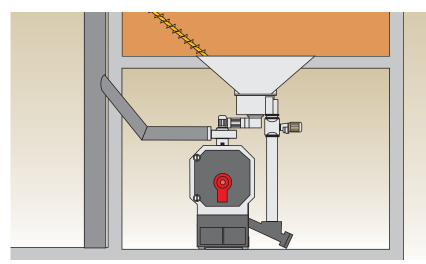


Bunker with rotary sweep extraction



Bunker with walking floor

Walking floor installation



Silo funnel extraction

Safe and Reliable Operation

Viessmann-KÖB wood-fired boilers are built to meet the most stringent safety requirements. High-tech, state-of the-art safety equipment ensures a safe and reliable operation of your system at all times.

Backflash safeguard
A water-filled metering container attached to the feed auger and controlled by an optical sensor. Prevents sparks from entering the fuel storage area. The backflash safeguard is a CSA safety requirement.

Burnback preventer
A sensor located in the fuel feed pipe detects any danger of burnback and quickly counteracts by increasing the feed to the boiler.

Burnback safeguard
A spring-loaded horizontally-acting slide valve interrupts the fuel line in case of power failure or danger of burnback.
If the fuel storage room is under negative pressure a rotary valve is used instead of the slide valve for the same function. The rotary valve prevents unwanted air leaks from reaching the combustion process.

Automatic fire-extinguishing system
A fire extinguishing water tank (25 ltr/ 6.6 USG) with flow switch will empty and prevent burnback in case of malfunction. If there is a shortage of water, the system will switch off automatically.

Safety heat exchanger
A safety heat exchanger built into the boiler connects to city water and prevents the boiler from overheating in case of a power outage. A non-electric, thermally activated valve is triggered at a fixed boiler temperature and cools the boiler water via indirect heat transfer through the heat exchanger.

Additional safety devices
In addition to the safety equipment listed, Viessmann-KÖB wood-fired boilers come with the standard safety devices required by the Safety Standards.

- Fixed temperature high limit
- ASME pressure relief valve
- Low water cut-off (LWCO)
- Pressure and temperature gages

The Pyrot and Pyrotec boilers are built to ASME, Section IV requirements and 30 or 60 psig max. operating pressure. They have been tested and approved to applicable CSA/UL Safety Standards. Pressure vessels for Canada are registered in each province with a Canadian Registration Number (CRN).

Technical Specifications

Pyrot Rotary Combustion Boiler

For wood fuels with water content < 35%

Model		150	220	300	400	540
Output	MBH	512	751	1024	1365	1843
	kW	150	220	300	400	540
Efficiency		85%				
Max. Operating Pressure		30 or 60 psig				
Dimensions (inches)	Height	70	80	80	90	92
	Length	92	97	97	110	120
	Width	40	52	52	62	62

Pyrotec Underfeed Combustion Boiler

For wood fuels with water content < 50%

Model		390	530	720	950	1250
Output	MBH	1330	1809	2457	3242	4268
	kW	390	530	720	950	1250
Efficiency		85%				
Max. Operating Pressure		30 or 60 psig				
Dimensions (inches)	Height	94	100	112	120	130
	Length	129	150	153	150	170
	Width	49	50	55	64	64

The Perfect Match for Your System

With Viessmann System Technology you can easily expand your biomass system and reap the added benefits from a fully integrated renewable energy system.

Wood-fired boilers are ideal for integration with one or more energy sources, such as fossil fuel or solar. Our comprehensive product portfolio offers heating solutions for all energy types that are far more than just individual heating components. Whether it's an oil/gas heating boiler or a solar thermal system, all are designed to integrate perfectly into one reliable and economical system.

Performance solar systems

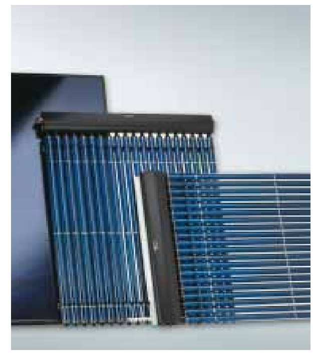
Our high-performance flat plate and vacuum tube solar systems are ideal to heat domestic hot water and to provide space heating backup for your biomass system.
By integrating solar, you can offset your domestic hot water heating cost by as much as 65% (depending on size of solar system) and further reduce your environmental footprint.

Powerful DHW tanks

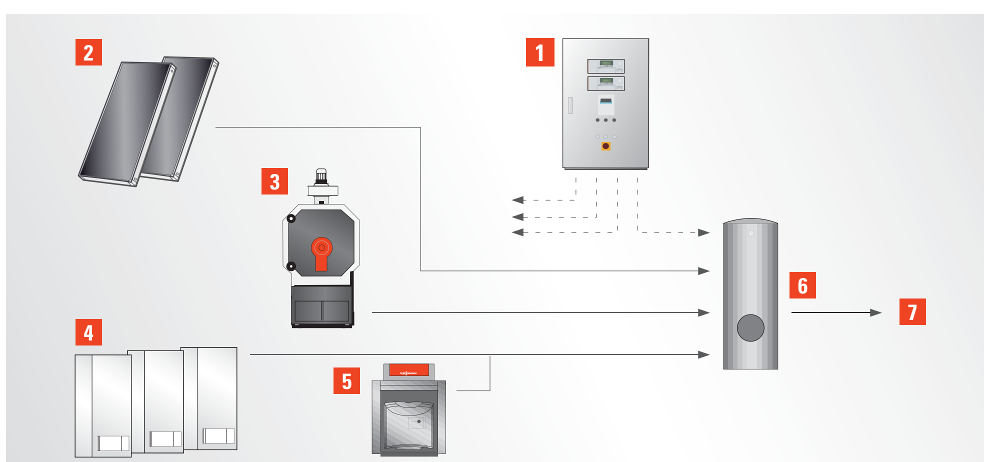
Our Vitocell line of indirect-fired domestic hot water (DHW) storage tanks offers high-quality construction and fast recovery rates for an abundant, reliable hot water supply at all times. For applications with a high hot water load, combine our vertical or horizontal DHW tanks into tank batteries.
Integrating indirect domestic hot water heating in your biomass system can save as much as 50% in operating cost compared to conventional direct-fired hot water production.

Proven heating boilers

In an integrated renewable energy system, biomass heating is often coupled with conventional oil-/gas-fired boilers to handle peak loads or to provide backup to the biomass boiler. Depending on the type and temperature requirements of your system, Viessmann offers highly-efficient wall-mount and floor-standing condensing boilers or sectional cast iron boilers to integrate with your biomass system.



1 Viessmann custom control panel
2 Solar thermal system
3 Wood heating system
4 Condensing boiler(s)
5 Non-condensing boiler
6 Thermal storage tank
7 System distribution



Biomass Systems at Work

More than 1500 installations worldwide are powered by KÖB biomass technology.

KÖB biomass systems
For over 30 years KÖB has installed large-scale, wood-fired heating systems, and has earned recognition for innovative and environmentally-friendly product advancements. KÖB is part of the Viessmann Group of innovative, high-efficiency heating solutions and renewable energy systems.

Design and commissioning services
Each Viessmann-KÖB installation begins with a system design from our in-house team of experts. By examining the unique requirements and conditions of your project, we propose a customized system solution – from a stand-alone wood-fired boiler to a fully integrated system, including fossil fuel heating and solar systems.

Comprehensive system solutions and services from one manufacturer!

Portable Building Package
Harney District Hospital
Burns, Oregon

Recreational Pool and Spa.
Kempten, Germany

Pyrotec Installation
Brunstad Congress Center, Norway

The Viessmann Group

Since 1917 Viessmann has been committed to providing heating solutions that are convenient, economical and environmentally responsible.

The Viessmann Group

For three generations Viessmann has provided efficient and environmentally-responsible heating solutions, tailored to the needs of our customers. Through ongoing research and product development, Viessmann has pioneered technologies that set standards and made the company a technological innovator and industry pacesetter.

KÖB-Viessmann

KÖB has been part of the Viessmann Group since 2007 and brings over 30 years of experience in wood heating. Specializing in high-quality large-scale biomass systems, KÖB is a valuable addition to the Viessmann Group, and contributes to our diversified product portfolio.

Viessmann International

With 13 manufacturing facilities in Europe, Canada and China, sales organizations in 36 countries, and 120 sales offices worldwide, Viessmann provides a strong global presence and customer proximity.
In North America, Viessmann has delivered state-of-the-art heating solutions for over 25 years. With three locations across North America, an outstanding support network and Academy training, Viessmann provides top-quality service and support that is second to none.

Our Values

Environmental and social responsibility, fair business practices, and striving for perfection and maximum efficiency in all company operations are core values for Viessmann. Together with our products and services, this allows us to offer our customers and partners the benefit and added value of a strong brand.

E — Innovative heating solutions and renewable energy systems for oil, gas, solar and biomass.

kW — Residential and commercial systems up to 20 mW.

1·2·3 — A multi-level program of heating products for every application and budget.

SYS — Designed to integrate seamlessly to ensure maximum system efficiency and performance.

Viessmann U.S.A Head Office
Warwick, RI

VIESSMANN
climate of innovation

VIESSMANN Group

KÖB
Wärme aus Holz

MAWERA
...aus Holz wird Energie

BIOFerm

KWT

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www.bioferm-es.com

C US

Technical information subject to change without notice.
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Description:

The PYRTEC Boiler Plant combines in optimum fashion the advantages of underfeed firing with the advantages of grate firing. With its tried and trusted burner trough, drop-type external grate and travelling burn-out grate, outstanding controllability of output and maximum safety against burn-back are obtained along with automatic de-ashing of the furnace. This triple-phase firing system enables all-purpose use of the boiler plant from dry pellets (W5) (with flue gas recirculation system, see Accessories) to wet forest wood chips (W50).
This boiler plant has been inspected and approved in accordance with the latest quality criteria following EN 303-5 heating boiler for solid fuels, the CE certification as per European Machinery Directive 98/37/EC, with continuous quality control by TÜV and consists of:

FEED AUGER WITH ISOLATING LAYER:
A solid and heat-resistant feed auger with a powerful drive moves the material to be burned over the burner trough and into the grate zone, which drops down and travels.
Situated on the conveyor pipe are the holding devices both for the electrical safeguard against burn-back and for the thermal extinguishing valve. Above the auger there is the metering container with a light barrier for setting the level for the fuel isolating layer required according to TRD 414.
The drive is carried out by a maintenance-free spur wheel back-geared motor and chain drive in a dust-tight chain guard.
Inlet flange: 220 x 220 mm
Accessories: extinguishing valve with dirt trap, extinguishing water container with holding device

FIRING BLOCK:
The solid, horizontally positioned and large-volume firing block has been optimised in terms of incineration, consists of a high-quality fireclay brick lining and is multiply insulated for the lowest possible surface temperatures. The burner trough and incineration grates are made of highly refractory cast steel (material no: 1.4823; approx. 12 mm) and are individually replaceable.
In the lower part, the primary airflow is supplied to the incineration grates via a supply air fan (or flue gas recirculation system) in an output-controlled fashion and pre-heated.
In the upper part of the firing block, the secondary airflow is blown into the gas space of the firing system by an output-controlled fan via an encircling ring with high turbulence via individually adjustable nozzles. The firebox door is solidly constructed, air-cooled and very well insulated. Opening the firebox door with solid double-knuckle hinges is an ideal solution for maintenance purposes.

BOILER:
The hot-water boiler resting on the fire block has been thoroughly optimised to provide high heat transmission and a long service life. It is possible to mount the pneumatic cleaning system in the insulated door on the front of the boiler.
Located on top of the boiler is a cover that can be walked on, which makes installation and maintenance easier and protects the thermal insulation from getting damaged.
The boiler and fire block are well insulated and attractively encased.

Max. flow temperature:	100°C
Max. operating pressure:	3.0 bar

EXAHAUST FAN:
A fan especially for wood heating systems, very quiet, motor with a solid, heat-resistant design with heat dissipation hub and spring-supported. The fan housing on the intake port rotates infinitely variably, and the blow-out nozzle is round. It is usually mounted on the exhaust gas deduster (separately priced item).

ACCESSORIES include:

- Safety heat exchanger:	Built into boiler
- Counter-flange:	Forward and return flow, including bolts and seal
- Cleaning utensils:	Scraper for firing, cleaning brush (D 52 mm) with spring steel rod

ACCESSORIES for PYRTEC grate firing (Item KPT- …) at extra charge:

Designation	*Item*	*Text*	*Dimensions*	*Use*
Exhaust gas de-duster 240 l	*KPT-E…-2*	*7110*	*7110*	*Required (exception: pellets)*
Exhaust gas de-duster 800 l	*KPT-E…-8*	*7110*	*7110*	*Variation of 240-litre*
Preparation system for de-ashing	*KPT-AV*	*7120*	*-*	*Optional for KPT-A2-S*
De-ashing into bin, 240 l	*KPT- A2-S*	*7120*	*7010*	*Optional for KPT-AV*
De-ashing into skip 800 l	*KPT- A8-S*	*7120*	*7010*	*Variation of 240-litre*
Pneumatic cleaning system	*KPT-W…-S*	*7120*	*7010*	*Optional*
Electric ignition system	*KPT-ZG-S*	*7200*	*7010*	*not suited for > W40*
Set of displacement rods	*KPT-V…*	*7200*	*-*	*Base load boiler*
Flue gas recirculation system	*KPT-R…-S*	*7200*	*-*	*For fuels < W20*
Pyrocontrol control system	*PYR- …*	*7800*	*-*	*Required*

Technical specs:

			PYRTEC Grate Firing System			
Trade name			**530**	**720**	**950**	**1250**
Item No:			**KPT-530**	**KPT-720**	**KPT-950**	**KPT-1250**
Performance data						
Rated heat output	Q_N	[kW]	530	720	950	1250
Continuous output [1]	Q_D	[kW]	530	720	950	1250
Minimum heat output [2]	Q_{min}	[kW]	132	180	238	312
Heat output, W45 chips	Q_{W45}	[kW]	515	700	920	1210
Efficiency in operation to be performed [3]		[%]	> 90			
Maximum water content [4]		[%]	W 50			
Size of the chips [5]			G 30 / G 50 as per ÖNORM M7133			
Exhaust gas figures						
Mass flow rate	Q_N; W5; O_2 8%;	[g/s]	297	404	532	700
Volume flow	Q_N; W5; O_2 8%; 150°C	[m³/s]	0.36	0.48	0.63	0.83
Mass flow rate	Q_{W45}; W45; O_2 10%;	[g/s]	412	560	736	968
Volume flow	Q_{W45}; W 45; O_2 10%; 150°C	[m³/s]	0.50	0.67	0.88	1.15
Average exhaust gas temperature at Q_N [6]		[°C]	160			
Average exhaust gas temperature at Q_{min} [6]		[°C]	120			
Chimney draught required		[Pa]	+-0			
Electrical connections						
Electrical connections (Σ boiler plant)		[kW]	7.02	8.12	9.35	11.15
Ignition device		[kW]	1.6			
Exhaust gas fan		[kW]	1.1	2.2	2.2	4.0
Feed auger		[kW]	1.5	1.5	2.2	2.2
Primary airflow fan 1		[kW]	0.3	0.3	0.48	0.48
Primary airflow fan 2		[kW]	0.9			
Secondary airflow fan		[kW]	1.5	1.5	1.85	1.85
Grate drive unit		[kW]	0.12			
Electric power consumption at Q_N		[kW]	3.57	4.56	5.17	6.79
Electric power consumption at Q_{min}		[kW]	2.9	3.71	4.15	5.47
Heating-relevant specs						
Volume on heating gas side		[l]	2280	2830	4050	5210
Volume of ash container for grate ash		[l]	240 / 800			
Volume of ash container for exhaust gas de-duster		[l]	240 / 800			
Water-bearing resistance (Diff. 15 K)		[mbar]	23	43	26	45
Boiler water volume		[l]	1444	1861	1943	2482
Heating surface		[m²]	42.50	55.50	74.80	91.00
Test pressure		[bar]	7,8			
Maximum operating pressure		[bar]	6			
Maximum boiler temperature		[°C]	100			
Minimum return temperature		[°C]	65			
Weights						
Weight of fire block		[kg]	3833	4665	5892	7252
Weight of heat exchanger		[kg]	1986	2562	4128	5431
Weight of exhaust gas de-duster		[kg]	463	463	695	695
Weight of feed auger		[kg]	126	126	148	148
Total weight without water [7]		[kg]	6802	8210	11401	14064
Total weight with water [7]		[kg]	8246	10071	13344	16546

[1] Continuous output: Output levelling out as base load boiler in continuous operation with pneumatic cleaning system (for track time, see Operating Instructions)

[2] $Q \geq Q_{min}$: Operation with modulated control
$Q \leq Q_{min}$: Low load with ON Q_{min} / ember maintenance operation

[3] Efficiency: Specification with displacement rods and flue gas recirculation system
for dry fuels (W5 to W20) without flue gas recirculation system-reduced values

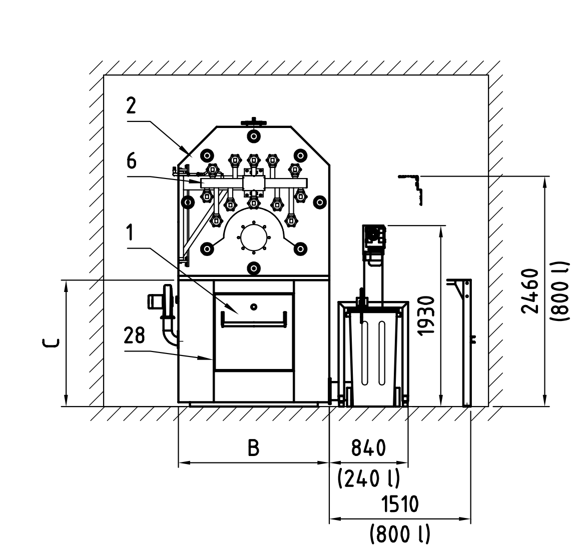
[4] Wet fuels: >W45 further restrictions in terms of output, efficiency and control behaviour

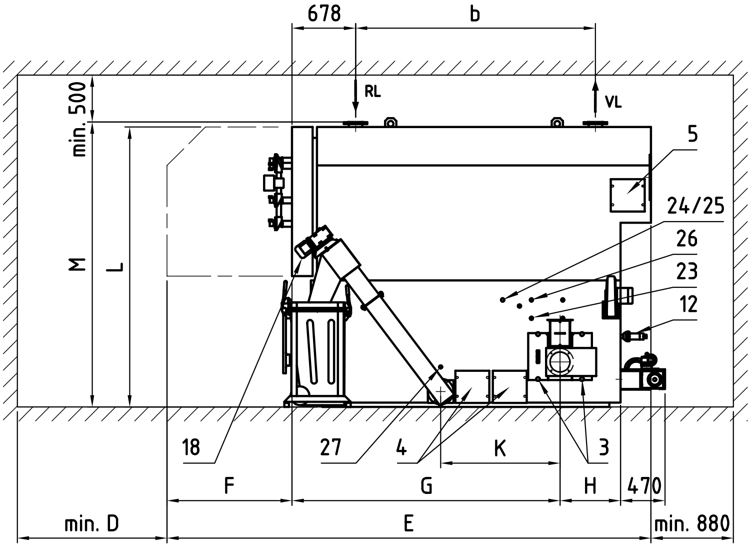
[5] Specification: See Spec Sheet 1010, Minimum Requirements for Wooden Fuels

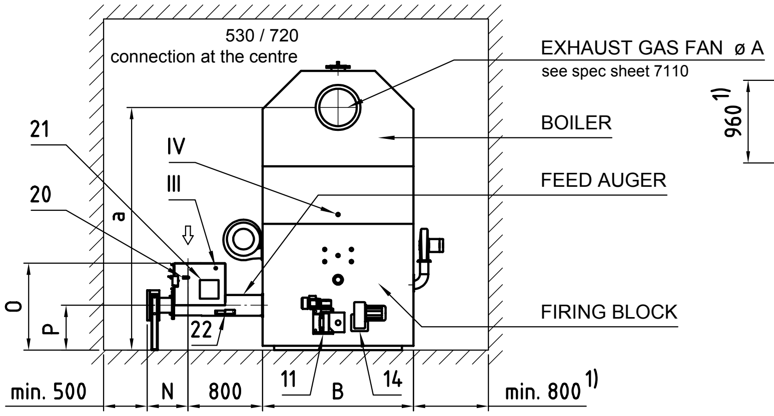
[6] Exhaust gas temperature: A reduction is possible by installing the displacement rods (Q_N - 20°C; Q_{min} – 10°C)
Other influences: fuel water content, ash content, pneumatic cleaning system yes/no, track time (number of operating hours without cleaning) Specifications for the start of the track time (toward the end of the track time there is an increase in the exhaust gas temperature by approx. +15°C)

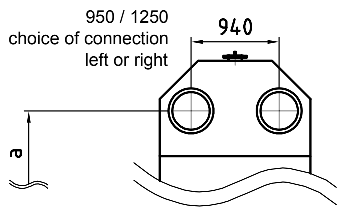
[7] Total weight: incl. displacement rods

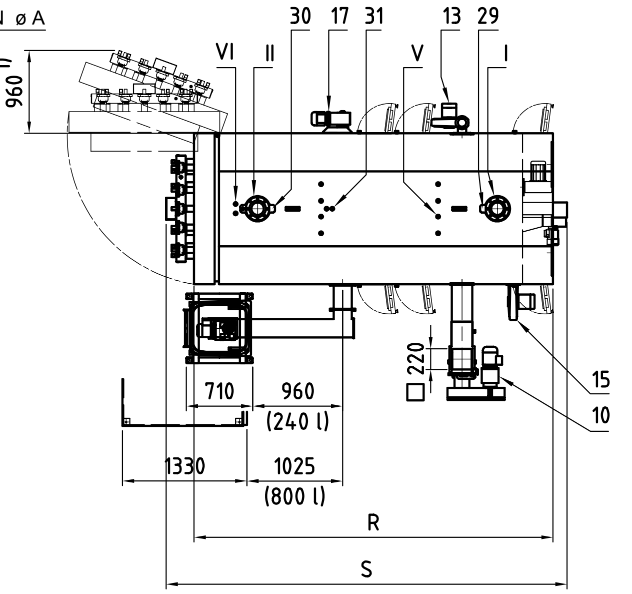
Dimensional drawing:







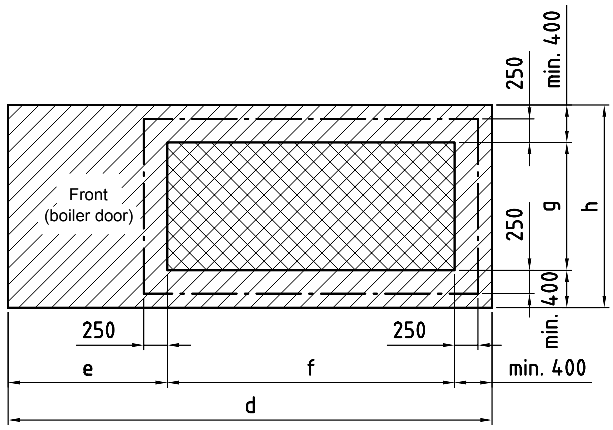




Boiler bearing surface

Floor with heat-resistant design additional

The floor construction has to be free of any pipes or installation lines! Danger through the effects of heat!



1) 800 mm access, firing block
960 mm if there is a door stop & pneum. cleaning system
Position of approx. 110° required for manual cleaning of heat exchanger

Connections/dimensions:

PYRTEC [Item no.]			KPT-530	KPT-720	KPT-950	KPT-1250
Water connections PN 6 (see Spec Sheet 7960)						
I	Boiler forward flow		DN 100	DN 100	DN 125	DN 125
II	Boiler return flow		DN 100	DN 100	DN 125	DN 125
III	Connection for extinguishing water		R ¾“ AG	R ¾“ AG	R ¾“ AG	R ¾“ AG
IV	Drain valve for boiler		R 1 ½“IG	R 1 ½“ IG	R 1 ½“ IG	R 1 ½“ IG
V	Safety heat exchanger		4 x R ½“ AG	8 x R ½“ AG	8 x R ½“ AG	8 x R ½“ AG
VI	Dipping shell for thermal run-off safety valve		1 x R ½“ IG	2 x R ½“ IG	2 x R ½“ IG	2 x R ½“ IG
Connection for exhaust gas pipe Ø [mm]		A	350	350	450	450
Location of the connections [mm]		a	2359	2491	2444	2639
		b	1922	2562	2562	3107
Dimensions of the foundations [mm]		d	4272	4912	5096	5641
		e	1400	1400	1630	1630
		f	2472	3112	3066	3611
		g	1112	1112	1360	1360
		h	1912	1912	2160	2160
Dimensions of the boiler [mm]		B	1380	1380	1612	1612
		C	1283	1413	1371	1566
		D	760	1430	1050	1550
		E	4617	5257	5447	5992
		F	1380	1380	1612	1612
		G	2353	2993	2861	3406
		H	577	577	657	657
		K	1200	1200	1275	1275
		L	2654	2784	2981	3176
		M	2702	2834	3035	3230
		N	308	308	440	440
		O	803	803	929	929
		P	453	453	479	479
		R	3237	3877	3835	4380
		S	3794	4434	4392	4937

Parts for maintenance			
1	Fire box door with solid double hinging		
2	Boiler door		
3	Cleaning lid for burner trough		
4	Cleaning lid for external grate		
5	Cleaning lid for heat exchanger		
6	Pneumatic cleaning system	Item KPT-W…-S	Spec Sheet 7120
Electric drives; ignition			
10	Feed auger		
11	Drive for feed grate		
12	Ignition device		
13	Primary airflow fan 1		
14	Primary airflow fan 2		
15	Secondary airflow fan		
16	Exhaust gas fan	Dimensions:	/ Spec Sheet 7110
17	De-ashing, fire box auger	Item KPT-A.-S	/ Spec Sheet 7120
18	De-ashing, ascending conveyor auger	Item KPT-A.-S	/ Spec Sheet 7120
Switches and sensors	These items are part of the Pyrocontrol control system	Item PYR-…	/ Spec Sheet 7800
20	Light barrier for feed auger		
21	Limit switch for maintenance cover		
22	Temperature sensor for feed auger		
23	Light barrier for embers		
24	Fire box temperature sensor (insertion side)		
25	Negative pressure sensor (opposite insertion side)		
26	Overpressure monitor for fire box		
27	Light barrier for de-ashing		
28	Limit switch for fire box door		
29	Boiler sensor		
30	Return flow sensor		
31	Temperature-limiting safety switch (TLSS)		
32	Exhaust gas sensor	Location:	Spec Sheet 7110
33	Lambda sensor with measuring transducer	Location:	Spec Sheet 7110

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NCHT Series Specifications (2.66" Corrugation)

FCHT Specifications - 4.00" Corrugated Sidewall

45 Degree Hopper FCHT's = 18' Dia. | 21' Dia. | 24' Dia.

Series	Max Bu. Capacity	Eave Height (Feet)	Peak Height (Feet)	Capacity (Cubic Feet)	Hopper Clearance	Metric Tons 800 kg/m^3	Metric Tons 721 kg/m^3	Metric Tons 640 kg/m^3	Eave Height (Meters)	Peak Height (Meters)	Maximum Capacity (Cubic Mtrs.)
FCHT18-345F	3371	22'-3"	26'-11"	3956	32"	96	86	76	6.78	8.20	112
FCHT18-445F	4157	25'-11"	30'-7"	4880	32"	118	106	94	7.90	9.33	138
FCHT18-545F	4943	29'-7"	34'-3"	5804	32"	140	126	112	9.02	10.44	164
FCHT18-645F	5730	33'-3"	37'-11"	6727	32"	162	146	129	10.13	11.56	190
FCHT18-745F	6516	36'-11"	41'-7"	7650	32"	185	166	148	11.25	12.68	217
FCHT18-845F	7303	40'-7"	45'-3"	8573	32"	207	186	165	12.37	13.79	243
FCHT18-945F	8089	44'-3"	48'-11"	9496	32"	229	206	183	13.49	14.91	269
FCHT21-345F	4811	23'-7"	29'-2"	5648	32"	136	121	109	7.20	8.89	159
FCHT21-445F	5881	27'-3"	32'-10"	6904	32"	166	149	133	8.31	10.01	195
FCHT21-545F	6951	30'-11"	36'-6"	8160	32"	196	177	157	9.42	11.13	231
FCHT21-645F	8021	34'-7"	40'-2"	9417	32"	227	204	182	10.54	12.24	267
FCHT21-745F	9092	38'-3"	43'-10"	10674	32"	257	231	205	11.66	13.36	302
FCHT21-845F	10162	41'-11"	47'-6"	11930	32"	287	258	230	12.78	14.48	338
FCHT21-945F	11232	45'-7"	51'-2"	13187	32"	317	285	254	13.89	15.60	373
FCHT24-445F	7971	28'-3"	34'-9"	9358	32"	225	203	180	8.61	10.60	265
FCHT24-545F	9369	31'-11"	38'-5"	11000	32"	264	238	211	9.73	11.71	311
FCHT24-645F	10767	35'-7"	42'-1"	12641	32"	304	274	243	10.85	12.83	358
FCHT24-745F	12165	39'-3"	45'-9"	14282	32"	343	309	275	11.96	13.95	404
FCHT24-845F	13563	42'-11"	49'-5"	15923	32"	383	345	306	13.08	15.06	451
FCHT24-945F	14961	46'-7"	53'-1"	17565	32"	422	380	338	14.20	16.18	497

Cubic Meters based on 28 degree angle of repose.
Specifications and design are subject to change without notice.
All commercial bins are designed for the storage of grain and other free-flowing materials weighing up to 52 lbs. per cubic foot.
Maximum bushel capacity based on 6% compaction.
Maximum storage capacities reflect grain peaked on center, using an agnle of repose of 28 degrees.
Other ring heights for 30 degree slope roofs.
Peak heights shown for 30 degree slope roofs.

Typical Grain Densities:
Wheat approximately 800 kg/m^3 (50 lb/ft^3);
Corn approximately 721 kg/m^3 (45 lb/ft^3);
Rice approximately 640 kg/m^3 (40 lb/ft^3);

< Back

SGS

CERTIFICATE OF ANALYSIS

PINNACLE PELLET INC.
4252 Dog Prairie Road
Quesnel, BC V2J 6K9

May 7, 2007

CERTIFICATE OF ANALYSIS

Date: May 7, 2007

VESSEL	:	M.V. " STAR ISTIND"
COMMODITY DESCRIBED AS	:	WOOD PELLETS, in bulk
LOADING DETAILS	:	7,005.00 Metric Tons loaded to Nos. 4 and 5 Holds on May 3, 2007 at Fibreco Terminal Ltd., Port of Vancouver, British Columbia, Canada

Our ref: 203-

ANALYSIS		**AS RECEIVED BASIS**	**DRY BASIS**
Total Moisture	%	**4.87**	xxxx
Ash	%	xxxx	**0.30**

PARAMETER	**MEASURE**	**VALUE**
Hydrogen, (dry basis)	% of weight	**6.14**
Nitrogen, (dry basis)	% of weight	**0.08**
Oxygen, (dry basis)	% of weight	**43.33**
Carbon (dry basis)	% of weight	**50.14**
Sulphur (dry basis)	% of weight	**0.01**

CALORIFIC VALUE (ISO 1928)	**MJ/kg**	**Kcal/kg**	**MWh/tonne**	**BTU/lb**
Net Calorific Value at Constant Pressure, including moisture (as received basis)	**18.14**	**4335**	**5.04**	**7799**
Net Calorific Value at Constant Volume, including moisture(as received basis)	**18.21**	**4353**	**5.06**	**7831**
Net Calorific Value at Constant Pressure (dry basis)	**19.19**	**4587**	**5.33**	**8252**
Net Caloriic Value at Constant Volume (dry basis)	**19.26**	**4604**	**5.35**	**8283**

This analysis is based on samples submitted to the laboratory of SGS Canada Inc., Minerals Services.

M. Bryan, Laboratory Manager

Appendix B: Preliminary Calculations

Heating Design Load Estimation

Project:	**Yukon College Biomass**
Date Prepared:	19-Aug-09
Prepared by:	Sbirrell
location:	Whitehorse
FSC Ref#:	2009-4350

2008-2009

ASSUMPTIONS:

1 E = CD*(86.4*Qls*DD)/(k*DT)
ref: ASHRAE Fundementals handbook, 1989, SI ver, pg F28.2
where:
E= fuel or energy consumption for estaimte period, kJ
CD = correction factor for heating effect vs. kelvin degree days
Qls = design heat loss incl. infiltration and ventilation, W
DD= Kelvin degree days, C
k = correction factor for heating system
DT = design temperature difference, C

2 Use degree day data for Whitehorse, Yk

3 fuel oil consumption = E/fuel oil heating value

4 Day loss and hours assume ventilation system off at night, therefore outdoor air off so night heat loss lower.

5 old heating system, assume inefficient.

6 fuel oil = # 2 diesel fuel oil

INPUT DATA: (input yellow)

Heating Degree days - Environment Canada 2008-2009

16%	Jan DD	1142	July DD	128	2%
13%	Feb DD	955	Aug DD	178	2%
12%	Mar DD	869	Sep DD	322	4%
7%	Apr DD	532	Oct DD	563	8%
5%	May DD	354	Nov DD	783	11%
3%	Jun DD	193	Dec DD	1186	16%
			Total DD:	7204	100%

Correction factor CD:	0.8	
heat loss day		
heat loss night	0 W	
ave occupied hours	24 hrs	
ave unoccupied hours	0 hrs	
correction factor k:	0.5	
Delta Temp	62 C	
Fuel Oil heating Value, mJ/L	38.2 mJ/L	ref. ASHRAE 1989, F15.6, table 6
Equipment efficiency	80%	

OUTPUT: Monthly design peak load W

Jan		July	
Feb		Aug	
Mar		Sep	
Apr		Oct	
May		Nov	
Jun		Dec	

Peak load

Heating Design Load Estimation

Project: **Yukon College Biomass**
Date Prepared: 19-Aug-09
Prepared by: Sbirrell
location: Whitehorse
FSC Ref#: 2009-4350

2007-2008

ASSUMPTIONS:

1 E = CD*(86.4*Qls*DD)/(k*DT)
ref: ASHRAE Fundementals handbook, 1989, SI ver, pg F28.2
where:
E= fuel or energy consumption for estaimte period, kJ
CD = correction factor for heating effect vs. kelvin degree days
Qls = design heat loss incl. inflitration and ventilation, W
DD= Kelvin degree days, C
k = correction factor for heating system
DT = design temperature difference, C

2 Use degree day data for Whitehorse, Yk

3 fuel oil consumption = E/fuel oil heating value

4 Day loss and hours assume ventilation system off at night, therefore outdoor air off so night heat loss lower.

5 old heating system, assume inefficient.

6 fuel oil = # 2 diesel fuel oil

INPUT DATA: (input yellow)

Heating Degree days - Environment Canada 2007-08

17%	Jan DD	1114	July DD	102	2%
14%	Feb DD	955	Aug DD	154	2%
11%	Mar DD	735	Sep DD	308	5%
8%	Apr DD	512	Oct DD	544	8%
5%	May DD	322	Nov DD	725	11%
2%	Jun DD	141	Dec DD	1070	16%
			Total DD:	6680	100%

Correction factor CD:	0.8	
heat loss day		
heat loss night	0 W	
ave occupied hours	24 hrs	
ave unoccupied hours	0 hrs	
correction factor k:	0.5	
Delta Temp	62 C	
Fuel Oil heating Value, mJ/L	38.2 mJ/L	ref. ASHRAE 1989, F15.6, table 6
Equipment efficiency	80%	

OUTPUT: Monthly design peak load W

Jan	1,119,832 W	July	
Feb	1,286,288 W	Aug	
Mar	1,529,313 W	Sep	
Apr		Oct	1,701,134 W
May		Nov	1,347,508 W
Jun		Dec	1,379,359 W

Peak load 1,701 kW

Heating Design Load Estimation

Project:	**Yukon College Biomass**
Date Prepared:	19-Aug-09
Prepared by:	Sbirrell
location:	Whitehorse
FSC Ref#:	2009-4350

2006-2007

ASSUMPTIONS:

1 E = CD*(86.4*Qls*DD)/(k*DT)
ref: ASHRAE Fundementals handbook, 1989, SI ver, pg F28.2
where:
E= fuel or energy consumption for estaimte period, kJ
CD = correction factor for heating effect vs. kelvin degree days
Qls = design heat loss incl. infiltration and ventilation, W
DD= Kelvin degree days, C
k = correction factor for heating system
DT = design temperature difference, C

2 Use degree day data for Whitehorse, Yk

3 fuel oil consumption = E/fuel oil heating value

4 Day loss and hours assume ventilation system off at night, therefore outdoor air off so night heat loss lower.

5 old heating system, assume inefficient.

6 fuel oil = # 2 diesel fuel oil

INPUT DATA: (input yellow)

Heating Degree days - Environment Canada 2006-07

13%	Jan DD	916	July DD	118	2%
14%	Feb DD	999	Aug DD	202	3%
14%	Mar DD	954	Sep DD	296	4%
7%	Apr DD	519	Oct DD	521	7%
5%	May DD	347	Nov DD	1162	17%
2%	Jun DD	173	Dec DD	824	12%
			Total DD:	7031	100%

Correction factor CD:	0.8	
heat loss day		
heat loss night	0 W	
ave occupied hours	24 hrs	
ave unoccupied hours	0 hrs	
correction factor k:	0.5	
Delta Temp	62 C	
Fuel Oil heating Value, mJ/L	38.2 mJ/L	ref. ASHRAE 1989, F15.6, table 6
Equipment efficiency	80%	

OUTPUT: Monthly design peak load W

Jan	1,088,431 W	July	
Feb	1,026,227 W	Aug	
Mar	1,046,785 W	Sep	
Apr		Oct	1,163,721 W
May		Nov	1,102,735 W
Jun		Dec	1,155,365 W

Peak load 1,164 kW

Heating Design Load Estimation

Project: **Yukon College Biomass**
Date Prepared: 19-Aug-09
Prepared by: Sbirrell
location: Whitehorse
FSC Ref#: 2009-4350

2005-2006

ASSUMPTIONS:

1 E = CD*(86.4*Qls*DD)/(k*DT)
ref: ASHRAE Fundementals handbook, 1989, SI ver, pg F28.2
where:
E= fuel or energy consumption for estaimte period, kJ
CD = correction factor for heating effect vs. kelvin degree days
Qls = design heat loss incl. infiltration and ventilation, W
DD= Kelvin degree days, C
k = correction factor for heating system
DT = design temperature difference, C

2 Use degree day data for Whitehorse, Yk

3 fuel oil consumption = E/fuel oil heating value

4 Day loss and hours assume ventilation system off at night, therefore outdoor air off so night heat loss lower.

5 old heating system, assume inefficient.

6 fuel oil = # 2 diesel fuel oil

INPUT DATA: (input yellow)

Heating Degree days - Environment Canada 2005-06

17%	Jan DD	1096	July DD	133	2%
13%	Feb DD	821	Aug DD	151	2%
14%	Mar DD	906	Sep DD	299	5%
7%	Apr DD	453	Oct DD	535	8%
4%	May DD	257	Nov DD	774	12%
2%	Jun DD	154	Dec DD	794	12%
			Total DD:	6373	100%

Correction factor CD:	0.8	
heat loss day		
heat loss night	0 W	
ave occupied hours	24 hrs	
ave unoccupied hours	0 hrs	
correction factor k:	0.5	
Delta Temp	62 C	
Fuel Oil heating Value, mJ/L	38.2 mJ/L	ref. ASHRAE 1989, F15.6, table 6
Equipment efficiency	80%	

OUTPUT: Monthly design peak load W

Jan	1,117,706 W	July	
Feb	1,091,685 W	Aug	
Mar	1,269,277 W	Sep	
Apr		Oct	1,796,240 W
May		Nov	1,421,738 W
Jun		Dec	1,547,114 W

Peak load 1,796 kW

Appendix C: Reference Material

Table 5.1
Summary of Regulatory Criteria for $PM_{2.5}$

Country	Province, State or Municipality	Current Criteria (µg/m³)			Proposed Criteria (µg/m³)				Implementation
		3 h	24 h	annual	1 h	4-8 h	24 h	annual	
Canada	Canada-Wide Standard		30						Final CWS was set at 30 µg/m³, 98th percentile averaged over 3 consecutive years, spatially averaged over community-oriented area monitors; achievement by 2010
	Newfoundland		25						Standard adopted in 1996 based on 50% of PM_{10} objectives in BC and Ontario
	Alberta				80		30		Draft objectives proposed in 2005, to be used for permitting purposes
			20-30						Monitoring and non-mandatory management planning
			15-20						Monitoring only
	Manitoba		30						Objective used for permitting purposes
	Quebec	35	25						Used for air quality index
	Montreal	35	25						Used for air quality index
	Ontario	<23							3-h average denotes “Good” air quality in provincial air quality index; 24-h average used as benchmark value
	British Columbia								
	CRD		25						Monitoring and reporting guideline value
	GVRD	25	12						Adopted in 2005
	City of Quesnel		20						98th percentile averaged over 3 consecutive years; goal to be achieved by 2007
			18						98th percentile averaged over 3 consecutive years; goal to be achieved by 2010
	Whistler							~5-6	Implied $PM_{2.5}$ target level, based on a proposed PM_{10} target level of 10 µg/m³
Australia			25	8					Advisory reporting standard only; community-oriented monitoring sites; review of standard to begin in 2005
New Zealand			25						Interim guideline; review of guideline to begin in 2005

Country	Province, State or Municipality	Current Criteria ($\mu g/m^3$)			Proposed Criteria ($\mu g/m^3$)				Implementation
		3 h	24 h	annual	1 h	4-8 h	24 h	annual	
World Health Organization			25	10					99th percentile for the 24-hour average guideline
			75, 50, 37.5	35, 25, 15					Suggested interim targets to be used to gauge progress towards the recommended guidelines
European Union	All member states							25	Averaged over all urban background monitoring sites in the EU Member state, over 3 consecutive years; achievement by 2010
United States	NAAQS		65	15			25-35	15	Primary NAAQS Option 'A': 98th percentile form of the standard if the 24-hour average standard is set at 25-30 $\mu g/m^3$, or the 99th percentile if the standard is set in the 30-35 $\mu g/m^3$ range; elimination of area averaging for proposed primary standards
							30-40	12-14	Primary NAAQS Option 'B': percentile form of the standard is not defined
						20-30			Daylight hours only (92-98th percentile) for secondary NAAQS
	California			12					24-h average proposed by Health Committee in 2002 but not adopted due to GAM statistical error
	Puget Sound Region		25	15					Proposed as goals by Health Committee in 1999 and adopted as goals by the Region, but 24-hour average value not adopted as standard; annual average value based on 1 year

Colour Key:

(orange)	Legally-binding standards
(yellow)	Objectives or monitoring and reporting standards
(green)	Monitoring or reporting standards, guidelines, or targets

Note: The compilation of information on $PM_{2.5}$ criteria in other jurisdictions was completed in December 2005, and may not reflect subsequent changes, particularly with respect to the proposed revisions of the NAAQS in the United States.

National Ambient Air Quality Standards (NAAQS)

The Clean Air Act, which was last amended in 1990, requires EPA to set **National Ambient Air Quality Standards** (40 CFR part 50) for pollutants considered harmful to public health and the environment. The Clean Air Act established two types of national air quality standards. ***Primary standards*** set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. ***Secondary standards*** set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

The EPA Office of Air Quality Planning and Standards (OAQPS) has set National Ambient Air Quality Standards for six principal pollutants, which are called "criteria" pollutants. They are listed below. Units of measure for the standards are parts per million (ppm) by volume, milligrams per cubic meter of air (mg/m^3), and micrograms per cubic meter of air ($\mu g/m^3$).

National Ambient Air Quality Standards

	Primary Standards		Secondary Standards	
Pollutant	**Level**	**Averaging Time**	**Level**	**Averaging Time**
Carbon Monoxide	9 ppm (10 mg/m^3)	8-hour [1]	None	
	35 ppm (40 mg/m^3)	1-hour [1]		
Lead	0.15 $\mu g/m^3$ [2]	Rolling 3-Month Average	Same as Primary	
	1.5 $\mu g/m^3$	Quarterly Average	Same as Primary	
Nitrogen Dioxide	0.053 ppm (100 $\mu g/m^3$)	Annual (Arithmetic Mean)	Same as Primary	
Particulate Matter (PM_{10})	150 $\mu g/m^3$	24-hour [3]	Same as Primary	
Particulate Matter ($PM_{2.5}$)	15.0 $\mu g/m^3$	Annual [4] (Arithmetic Mean)	Same as Primary	
	35 $\mu g/m^3$	24-hour [5]	Same as Primary	
Ozone	0.075 ppm (2008 std)	8-hour [6]	Same as Primary	
	0.08 ppm (1997 std)	8-hour [7]	Same as Primary	
	0.12 ppm	1-hour [8]	Same as Primary	
Sulfur Dioxide	0.03 ppm	Annual (Arithmetic Mean)	0.5 ppm (1300 $\mu g/m^3$)	3-hour [1]
	0.14 ppm	24-hour [1]		

(1) Not to be exceeded more than once per year.

(2) Final rule signed October 15, 2008.

(3) Not to be exceeded more than once per year on average over 3 years.

(4) To attain this standard, the 3-year average of the weighted annual mean PM2.5 concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/m3.

(5) To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m3 (effective December 17, 2006).

(6) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm. (effective May 27, 2008)

(7) (a) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.

(b) The 1997 standard—and the implementation rules for that standard—will remain in place for implementation purposes as EPA undertakes rulemaking to address the transition from the 1997 ozone standard to the 2008 ozone standard.

(8) (a) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is $\leq$ 1.

(b) As of June 15, 2005 EPA has revoked the 1-hour ozone standard in all areas except the fourteen 8-hour ozone nonattainment Early Action Compact (EAC) Areas. For one of the 14 EAC areas (Denver, CO), the 1-hour standard was revoked on November 20, 2008. For the other 13 EAC areas, the 1-hour standard was revoked on April 15, 2009.

Air Quality Standards

Humans can be adversely affected by exposure to air pollutants in ambient air. In response, the European Union has developed an extensive body of legislation which establishes health based standards and objectives for a number of pollutants in air. These standards and objectives are summarised in the table below. These apply over differing periods of time because the observed health impacts associated with the various pollutants occur over different exposure times.

Pollutant	***Concentration***	***Averaging period***	***Legal nature***	***Permitted exceedences each year***
Fine articles (PM2.5)	25 µg/m3***	1 year	Target value enters into force 1.1.2010 Limit value enters into force 1.1.2015	n/a
Sulphur dioxide (SO2)	350 µg/m3	1 hour	Limit value enters into force 1.1.2005	24
	125 µg/m3	24 hours	Limit value enters into force 1.1.2005	3
Nitrogen dioxide (NO2)	200 µg/m3	1 hour	Limit value enters into force 1.1.2010	18
	40 µg/m3	1 year	Limit value enters into force 1.1.2010*	n/a
PM10	50 µg/m3	24 hours	Limit value enters into force 1.1.2005**	35
	40 µg/m3	1 year	Limit value enters into force 1.1.2005**	n/a

Lead (Pb)	0.5 µg/m3	1 year	Limit value enters into force 1.1.2005 (or 1.1.2010 in the immediate vicinity of specific, notified industrial sources; and a 1.0 µg/m3 limit value applies from 1.1.2005 to 31.12.2009)	n/a
Carbon monoxide (CO)	10 mg/m3	Maximum daily 8 hour mean	Limit value enters into force 1.1.2005	n/a
Benzene	5 µg/m3	1 year	Limit value enters into force 1.1.2010**	n/a
Ozone	120 µg/m3	Maximum daily 8 hour mean	Target value enters into force 1.1.2010	25 days averaged over 3 years
Arsenic (As)	6 ng/m3	1 year	Target value enters into force 1.1.2012	n/a
Cadmium (Cd)	5 ng/m3	1 year	Target value enters into force 1.1.2012	n/a
Nickel (Ni)	20 ng/m3	1 year	Target value enters into force 1.1.2012	n/a
Polycyclic Aromatic Hydrocarbons	1 ng/m3 (expressed as concentration of Benzo(a)pyrene)	1 year	Target value enters into force 1.1.2012	n/a

**Under the new Directive the member State can apply for an extension of up to five years (i.e. maximum up to 2015) in a specific zone. Request is subject to assessment by the Commission. . In such cases within the time extension period the limit value applies at the level of the limit value + maximum margin of tolerance (* 48 µg/m3 for annual NO2 limit value).

***Under the new Directive the Member State can apply for an extension until three years after the date of entry into force of the new Directive (i.e. May 20011) in a specific zone. Request is subject to assessment by the Commission. In such cases within the time extension period the limit value applies at the level of the limit value + maximum margin of tolerance (35 days at 75*µg/m3 for daily PM10 limit value, 48 µg/m3 for annual Pm10 limit value).

****Standard introduced by the new Directive.*

Under EU law a limit value is legally binding from the date it enters into force subject to any exceedances permitted by the legislation. A target value is to be attained as far as possible by the attainment date and so is less strict than a limit value.

The new Directive is introducing additional PM2.5 objectives targetting the **exposure** of the population to fine particles. These objectives are set at the national level and are based on the average exposure indicator (AEI).

AEI is determined as a 3-year running annual mean PM2.5 concentration averaged over the selected monitoring stations in agglomerations and larger urban areas, set in urban background locations to best assess the PM2.5 exposure to the general population.

Title	***Metric***	***Averaging period***	***Legal nature***	***Permitted exceedences each year***
PM2.5 Exposure concentration obligation	20 µg/m3 (AEI)	Based on 3 year average	Legally binding in 2015 (years 2013,2014,2015)	n/a
PM2.5 Exposure reduction target	Percentage reduction* + all measures to reach 18 µg/m3 (AEI)	Based on 3 year average	Reduction to be attained where possible in 2020, determined on the basis of the value of exposure indicator in 2010	n/a

** Depending on the value of AEI in 2010, a percentage reduction requirement (0,10,15, or 20%) is set in the Directive. If AEI in 2010 is assessed to be over 22 µg/m3, all appropriate measures need to be taken to achieve 18 µg/m3 by 2020.*

Principles

European legislation on air quality is built on certain principles. The first of these is that the Member States divide their territory into a number of zones and agglomerations. In these zones and agglomerations, the Member States should undertake assessments of air pollution levels using measurements and modelling and other empirical techniques. Where levels are elevated, the Member States should prepare an air quality plan or programme to ensure compliance with the limit value before the date when the limit value formally enters into force. In addition, information on air quality should be disseminated to the public. See more under Implementation.

Air Quality Standards

Air quality is measured by comparing against a range of health-effects based standards. This page gives information about what this means.

- Standards
- Air Pollution Information Service
- Index or Banding

Air Quality Standards and Objectives

Standards for air pollution are concentrations over a given time period that are considered to be acceptable in the light of what is scientifically known about the effects of each pollutant on health and on the environment. They can also be used as a benchmark to see if air pollution is getting better or worse.

An exceedence of a standard is a period of time (which is defined in each standard) where the concentration is higher than that set down by the standard. In order to make useful comparisons between pollutants, for which the standards may be expressed in terms of different averaging times, the number of days on which an exceedence has been recorded is often reported.

An objective is the target date on which exceedences of a standard must not exceed a specified number.

The objectives adopted in the UK are defined in the latest Air Quality Strategy for England, Scotland, Wales and Northern Ireland, published on 17th July 2007. Those which are limit values required by EU Daughter Directives on Air Quality have been transposed into UK law through the Air Quality Standards Regulations 2007 which came into force on 15th February 2007.

A summary of the current UK Air Quality Objectives is provided here.

UK Air Quality Objectives for protection of human health, July 2007 - New objectives highlighted in shading

Pollutant	Air Quality Objective		To be achieved by
	Concentration	Measured as	
Benzene All authorities	16.25 µg m^{-3}	Running annual mean	31 December 2003
England and Wales Only	5.00 µg m^{-3}	Annual mean	31 December 2010
Scotland and N. Ireland	3.25 µg m^{-3}	Running annual mean	31 December 2010
1,3-Butadiene	2.25 µg m^{-3}	Running annual mean	31 December 2003
Carbon Monoxide England, Wales and N. Ireland	10.0 mg m^{-3}	Maximum daily running 8-hour mean	31 December 2003
Scotland Only	10.0 mg m^{-3}	Running 8-hour mean	31 December 2003
Lead	0.5 µg m^{-3}	Annual mean	31 December 2004
	0.25 µg m^{-3}	Annual mean	31 December 2008
Nitrogen Dioxide	200 µg m^{-3} not to be exceeded more than 18 times a year	1-hour mean	31 December 2005
	40 µg m^{-3}	Annual mean	31 December

			2005
Particles (PM10) (gravimetric) All authorities	50 µg m^{-3}, not to be exceeded more than 35 times a year	Daily mean	31 December 2004
	40 µg m^{-3}	Annual mean	31 December 2004
Scotland Only	50 µg m^{-3}, not to be exceeded more than 7 times a year	Daily mean	31 December 2010
	18 µg m^{-3}	Annual mean	31 December 2010
Particles (PM2.5) (gravimetric) *	25 µg m^{-3} (target)	Annual mean	2020
All authorities	15% cut in urban background exposure	Annual mean	2010 - 2020
Scotland Only	12 µg m^{-3} (limit)	Annual mean	2010
Sulphur dioxide	350 µg m^{-3}, not to be exceeded more than 24 times a year	1-hour mean	31 December 2004
	125 µg m^{-3}, not to be exceeded more than 3 times a year	24-hour mean	31 December 2004
	266 µg m^{-3}, not to be exceeded more than 35 times a year	15-minute mean	31 December 2005
PAH *	0.25 ng m^{-3}	Annual mean	31 December 2010
Ozone *	100 µg m^{-3} not to be exceeded more than 10 times a year	8 hourly running or hourly mean*	31 December 2005

*** not included in regulations at present**
Shaded data shows new objectives

UK Air Quality Objectives for protection of vegetation and ecosystems, July 2007 - New objectives highlighted in shading

Pollutant	Air Quality Objective		To be achieved by
	Concentration	Measured as	
Nitrogen dioxide (for protection of vegetation & ecosystems) *	30 µg m^{-3}	Annual mean	31 December 2000
Sulphur dioxide (for protection of vegetation & ecosystems) *	20 µg m^{-3} 20 µg m^{-3}	Annual mean Winter Average (Oct - Mar)	31 December 2000
Ozone *	18000 µg m^{-3}.h	AOT40+, calculated from 1h values May-July. Mean of 5 years, starting 2010	01 January 2010

*** not included in regulations at present**
+ AOT 40 is the sum of the differences between hourly concentrations greater han 80 µg m^{-3} (=40ppb) and 80 µg m^{-3}, over a given period using only the 1-hour averages measured between 0800 and 2000.
Shaded data shows new objectives

Air Pollution Information Service

Index and Bands

In the UK most air pollution information services use the index and banding system approved by the **Committee on Medical Effects of Air Pollution Episodes** (COMEAP). The system uses 1-10 index divided into four bands to provide more detail about air pollution levels in a simple way, similar to the sun index or pollen index.

1-3 (Low)

4-6 (Moderate)

7-9 (High)

10 (Very High)

The overall air pollution index for a site or region is calculated from the highest concentration of five pollutants:

Nitrogen Dioxide

Sulphur Dioxide

Ozone

Carbon Monoxide

Particles < 10µm (PM10)

Air Pollution Forecasts

Air Quality Forecasts are issued on a regional basis for three different area types:

In towns and cities near busy roads

Elsewhere in towns and cities

In rural areas

Forecasts are based on the prediction of air pollution index for the **worst-case** of the five pollutants listed above, for each region.

Health Advice

Latest studies report that:

When air pollution is LOW (1-3) effects are unlikely to be noticed even by those who are sensitive to air pollution.

When air pollution is MODERATE (4-6) sensitive people may notice mild effects but these are unlikely to need action.

When air pollution is HIGH (7-9) sensitive people may notice significant effects and may need to take action.

When air pollution is VERY HIGH (10) effects on sensitive people, described for HIGH pollution, may worsen.

Air pollution can cause short-term health effects to sensitive individuals (people who suffer from heart disease or lung diseases, including asthma). Effects on sensitive people can be reduced by spending less time outdoors. 'Reliever' inhalers should lessen effects on asthma sufferers.

More details on effects, including long-term, are available in a free leaflet **'Air Pollution - what it means for your health'.**

Air Pollution Bandings and Index and the Impact on the health of People who are Sensitive to Air Pollution

Banding	Index	Health Descriptor
Low	1, 2, or 3	Effects are unlikely to be noticed even by individuals who know they are sensitive to air pollutants
Moderate	4, 5, or 6	Mild effects, unlikely to require action, may be noticed amongst sensitive individuals.
High	7, 8, or 9	Significant effects may be noticed by sensitive individuals and action to avoid or reduce these effects may be needed (e.g. reducing exposure by spending less time in polluted areas outdoors). Asthmatics will find that their 'reliever' inhaler is likely to reverse the effects on the lung.
Very High	10	The effects on sensitive individuals described for 'High' levels of pollution may worsen.

Boundaries Between Index Points for Each Pollutant

Band	Index	Ozone		Nitrogen Dioxide		Sulphur Dioxide		Carbon Monoxide		PM10 Particles	
		Running 8 hourly or hourly mean*		hourly mean		15 minute mean		Running 8 hourly mean		Running 24 hour mean	
		µgm^{-3}	ppb	µgm^{-3}	ppb	µgm^{-3}	ppb	mgm^{-3}	ppm	µgm^{-3} (Grav. Equiv.)	µgm^{-3} (Ref. Equiv.)
Low											
	1	**0-33**	**0-16**	**0-95**	**0-49**	**0-88**	**0-32**	**0-3.8**	**0.0-3.2**	**0-21**	**0-19**
	2	34-65	17-32	96-190	50-99	89-176	33-66	3.9-7.6	3.3-6.6	22-42	20-40
	3	66-99	33-49	191-286	100-149	177-265	67-99	7.7-11.5	6.7-9.9	43-64	41-62
Moderate											
	4	100-125	50-62	287-381	150-199	266-354	100-132	11.6-13.4	10.0-11.5	65-74	63-72
	5	126-153	63-76	382-477	200-249	355-442	133-166	13.5-15.4	11.6-13.2	75-86	73-84
	6	154-179	77-89	478-572	250-299	443-531	167-199	15.5-17.3	13.3-14.9	87-96	85-94
High											
	7	180-239	90-119	573-635	300-332	532-708	200-266	17.4-19.2	15.0-16.5	97-107	95-105
	8	240-299	120-149	636-700	333-366	709-886	267-332	19.3-21.2	16.6-18.2	108-118	106-116
	9	300-359	150-179	701-763	367-399	887-1063	333-399	21.3-23.1	18.3-19.9	119-129	117-127
Very High											
	10	360 or more	180 or more	764 or more	400 or more	1064 or more	400 or more	23.2 or more	20 or more	130 or more	128 or more

* For ozone, the maximum of the 8 hourly and hourly mean is used to calculate the index value.

Appendix D: Sketches (Heating Schematic, Site plan, plant layout)