205 HORSEPOWER / 6.9 mmBTU / 15 PSIG DESIGN

WET WOODY BIOMASS FIRED STEAM PLANT

GENERAL SPECIFICATIONS

1.	Scope of Equipment:	One (1) substoichiometric, wet biomass or biomass pellet fuel gasifier, combustor and heat recovery system fed from metering bin(s).
2.	Gasifier Fuel Requirements:	1-1/2" x 2-1/2" x 5/8" or less in size, 50% or less in moisture content, <2% ash content and a minimum BTU content of 4,347 BTU/lb.
3.	Approximate Fuel Usage at Maximum Firing Rate:	~2,254 lbs. per hour @ 50% moisture content. (~9,800,000 BTU/Hr input).
4.	Boiler Rating:	205 Boiler horsepower, 7,073 PPH gross steam output from and @ 212°F.
5.	Boiler Pressure:	15 PSI design pressure. Safety valves shall be set @ 15 PSI.
6.	Boiler Design:	Low Pressure Firebox, Model #FB-1332-15-UF (Fire Tube design) Built in accordance with the ASME Code.

1.1 ENGINEERING SERVICES

Hurst Boiler & Welding Co., Inc. will supply all required design and specifications for the proposed equipment.

Engineering will include:

1. Boiler room layout drawings for locating new equipment.

2. Foundation details for proposed waste fired boiler based on 2500 PSF soil conditions.

3. Assistance in completing and filing of boiler's environmental emission permit.

4. Electrical wiring prints and specifications required to install the proposed electrical equipment.

5. All drawings listed above shall be provided in hard copy and digital (AutoCAD 14 or earlier) formats.

6. Two (2) sets of operating and maintenance manuals.

1.2 INSTALLATION SERVICES OPTIONAL

Hurst Boiler and Welding Co., Inc. will furnish, upon receipt of separate purchase order, one (1) experienced, highly trained and certified supervisor employed by Hurst Boiler and Welding Co., Inc. to supervise the confirmation of receipt of materials and the setting of the main system components (by others) to include: casing, boiler vessel, air handling system, fuel handling system and soot blowers and coordinate with the clients contractors.

All work will be completed in a workman-like manner according to standard practices.

The installation will be executed by the client, TSI, as outlined below:

1. The client shall provide all crane services required for unloading and erection of hot water plant (to occur simultaneously).

2. TSI shall furnish all materials, tools, equipment and labor necessary to complete the equipment installation to include:

   Setting and anchoring major components; combustion chamber, combustion air fans and ductwork, pressure vessel, breeching, multicyclone collector(s), flue gas ductwork, induced draft fan and transition to additional pollution control systems, as may be necessary. Concrete anchors, nuts, bolts, gaskets and other materials required for the assembly of the major components are supplied as part of the installation.

   Installation of minor equipment components (stoker drive assembly, rotary valves, soot blower compressed air accumulator, etc.) including necessary nuts, bolts, washers, gaskets and other materials to complete installation.

3. HBC shall furnish all pipe, fittings and gaskets necessary to complete the mounting and plumbing, by TSI, of boiler trim and controls to include:

   Water columns and water column drain piping
   Relief valves and venting to building exterior
   Drain valving and piping to approved drain
   Main supply and return valving
   Pressure gauge
   Limit controls.

4. TSI shall provide all rigid conduit, wire and other materials necessary for the interconnection of all motors, electrical components provided by Hurst Boiler and Welding Co., Inc. All necessary labor will be furnished and installation will be

completed in accordance with applicable NEMA standards. Termination of wiring and providing main disconnects, as required, are a part of the electrical installation.

5. TSI shall furnish tools and labor required to install the internal gasification/combustion chamber insulation and refractory with hanger clips and hanger bricks. Materials provided by HBC.

6. TSI shall furnish materials, fabricate and install access platforms, ladders and one set of stairs to access:
   Front smoke box tube access doors and soot blowers
   Water columns
   Induced draft fan
   Main outlet and relief valving.

7. Painting of field fabricated components and touch-up of all equipment is included as part of the installation and shall be by TSI. Piping will be color coded and OSHA yellow will be used as required on platforms and drive guards.

8. The client will keep the work area clean of all debris resulting from our work and place it in a receptacle provided and removed by the purchaser.

Installation supervision services are offered and will be billed on a T&M basis (including travel time from Coolidge, GA to the job site and back to Coolidge, GA), payable net 10 days, with a base price of (regular time), base rate times 1.5 for overtime, base rate times 2 for holidays, plus expenses and travel costs.

Using our past experiences and our standard installation parameters, please accept the following estimated installation schedule. Installing the equipment will take approximately nine (9) weeks from the receipt of all shipments; allowing one (1) week to confirm the receipt of all equipment shipped in good condition and the initial erection of the equipment, two (2) weeks to erect the building (by others) and six (6) weeks to complete piping, wiring and refractory.

1.3 SYSTEM START-UP

When installation of the equipment supplied is completed, Hurst Boiler & Welding Co., Inc. will provide one start up technician to assist in the curing of the refractory system, start the equipment and train personnel on the proper maintenance and operation of the system to include:

1. Check out of all system components to assure proper rotation, alignment, sequencing, function, etc.

2. Application of hot water to the system to test operation of valving, controls and other related equipment.

3. Adjustment of controls to provide efficient operation of all boiler functions.

4. Start-up of the equipment with mill personnel to familiarize them with proper operation and maintenance procedures.

5. The maximum duration of these services is five (5) days.

6. Additional time/travel, as may be required, will be billed on a T&M basis (including travel time from Coolidge, GA to the job site and back to Coolidge, GA), payable net 10 days, with a base price of (regular time), base rate times 1.5 for overtime, base rate times 2 for holidays, plus expenses and travel costs.

2.1 GASIFIER

Substoichiometric wood fuel gasifier to include a heavy duty combustion chamber, refractory and insulation shipped loose, will be furnished to combust the solid fuel as specified. The unit will be complete with the following:

1. One single screw metering bin complete with AC-type variable speed controller, rotary air lock and bin level indicator (Sonac) to control the fuel conveyor.

2. One (1) retort type underfeed stoker, Model UF-205, to include:

   -Heavy duty, underfeed stoker screw conveyor mounted on solid shaft with thermocouple and water valve to prevent "burn back".

   -Sch 40 fuel feed conveyor housing with flanged end opening for easy screw removal and thermocouple with quenching system to prevent burn back.

   -Heavy duty thrust bearing and stoker/rotary valve drive.

   -Retort and grates cast of Warite, a cast iron alloy of chrome and nickel.

3. Substoichiometric combustion air system to include:

   -One (1) belt driven blower with TEFC motor and OSHA belt guard.

   -Prefabricated combustion air ductwork for interconnection of blower to under grate zone and gasifier air preheater (see Section 2.5, Item 2).

   -Zoned, under grate plenum.

   -One (1) combustion air blower incorporates welded steel housing, flanged outlet, flanged inlet, high efficiency impeller wheel and variable frequency AC drive for improved control of combustion airflow. This fan is designed to modulate with steam demand.

4. Gasification chamber casing to include:

   -Furnace front of steel plate.

   -Furnace sides and rear of reinforced steel plate.

   -Chamber lining (to be field installed) of:

-9" refractory wall and radiant arch with a service temperature of: 3000° F. The refractory walls are constructed using a proprietary refractory compound. Hurst Mud® is a very high density, low clay, high alumna content ram-able refractory.

-2" "M" block, service temperature of: 1900° F.

-2" mineral wool, service temperature: 1200° F.

-refractory anchor brick that include a two-part clipping system of stainless steel. This allows the refractory and the casing to independently expand and contract thereby greatly reducing refractory maintenance.

5. One (1) air-cooled observation port, front, with heat shield and site glass.

6. Cast iron over fire access door with heat shield and lockable handle.

7. Under grate access door.

8. Skids and support assembly.

2.2 GAS BURNER

Combustion air system to include:

1. One (1) prefabricated zoned over fire combustion air plenum encircling the entire combustion casing with nozzles that penetrate the casing interior and manually adjustable dampers.

2. Prefabricated combustion air ductwork for interconnection of blower to zoned air plenum.

3. One (1) combustion air blower incorporates welded steel housing, flanged outlet, flanged inlet, high efficiency impeller wheel and variable frequency AC drive for improved control of combustion airflow. This fan is designed to automatically modulate in response to the O_2 sensor system mounted in the rear smoke box of the boiler vessel.

4. Combustion chamber casing to include:

   -Furnace front of steel plate.

   -Furnace sides and rear of reinforced steel plate.

   -Chamber lining (to be field installed) of:

      -9" refractory wall and radiant arch with a service temperature of: 3000° F. The refractory walls are constructed using a proprietary refractory compound. Hurst Mud® is a very high density, low clay, high alumna content ram-able refractory.

      -2" "M" block, service temperature of: 1900° F.

      -2" mineral wool, service temperature: 1200° F.

      -refractory anchor brick that include a two-part clipping system of stainless steel. This allows the refractory and the casing to independently expand and contract thereby greatly reducing refractory maintenance.

5. Over fire inspection/access doors with lockable handles.

2.3 PRESSURE VESSEL

Hurst Firebox boiler vessel designed for efficient heat recovery from wet solid fuel combustion, and support structure. The unit shall be built in strict accordance with the ASME Code and stamps, all construction will be performed under the constant quality control inspection by a National Board Commissioned Inspector and the boiler vessel will be *rated at no less than 6.5 square feet of heating surface per boiler horsepower output*.

The generator (fire tube) section includes:

1. Front and rear smoke boxes complete with twin hinged airtight doors. The doors on the Hurst boiler are internally insulated, incorporate an abrasion resistant shield on the interior of the doors and allow for full access to all fire tubes and the soot blower system.

2. Large furnace volume for advanced combustion efficiency.

3. Steam, water inspection and blow down openings.

4. Support assembly for attaching to combustion chamber casing.

5. Drain openings, two on each side of water membrane to total eight openings.

6. Lifting eyes, two (2), top of boiler vessel.

The generator section of the Firebox boiler is insulated with 2" of high-density fiberglass and clad with 22 gauge "Paint-Grip" zinc coated steel jacket material and galvanized screws for attachment and joining.

The HBC Firebox boiler vessel is designed with generous shell proportions that provide large water storage capacity. This is a desirable feature for wood fired boiler vessels that are inherently less sensitive to sharp fluctuations in hot water demand. Overall thermal design of the Firebox boiler vessel is computed and analyzed to insure the highest possible efficiency is maintained throughout the system's operating range.

2.4 BOILER TRIM AND LIMIT CONTROLS

1. Relief valves per ASME Code.

2. Boiler bottom blow down valves:
   -One (1) quick-opening.
   -One (1) slow opening.

3. Surface blow down valves consisting of one (1) needle and one (1) gate.

4. Main steam valves, two (2) gates, per ASME Code (By Others).

5. Chemical feed valves consisting of one (1) gate and two (2) check valves.

6. Steam pressure gauge with pigtail and gauge cock.

7. Boiler feed water valves to include: one (1) globe valve and two (2) check valves.

8. Quick fill valves consisting of one (1) check and one (1) gate.

9. Low water limits:
   -Primary: Probe type with tricocks, gauge glass and pump controller.
   -Secondary: Probe type.

10. Pressure limits include:
    -Operating limit.
    -High-pressure limit.
    -Low-pressure limit.
    -4-20 milliamp pressure transmitter for fuel feed / combination air modulation.

11. Boiler fire tube soot blowers, fixed zone with necessary compressed air piping, header, timer-actuated valves, compressed air accumulator tank and drain valve.

The supply of compressed air (10 scfm @ 100 PSI) to the compressed air accumulator tank by others.

12. Access Platforms (By Others):
Platforms and ladders will be provided to access:
-Front smoke box.
-Water column.
-Main steam valves.

13. One (1) blow down separator built in accordance with ASME Code to include:
-Blow down inlet
-Drain
-Vent
-Exhaust stack to vent above building roofline.

14. Necessary pipe and fittings for the installation of the above trim.

2.5 POLLUTION CONTROL AND INDUCED DRAFT EQUIPMENT

HURST BOILER & WELDING CO., INC. GUARANTEES THIS PLANT NOT TO EXCEED THE EMISSION RATE OF 0.3 LBS PARTICULATE OR STATE ALLOWABLE, WHICHEVER IS GREATER.

Pollution control and induced draft system consisting of:

1. Flanged flue gas ducting, prefabricated of angle iron reinforced steel plate, designed to prevent pulsation and vibration cracking, for routing flue gas from boiler to gasification/combustion air preheater.

2. One (1) gasifier/combustion air preheater, tubular, air-air, horizontal orientation. The unit will have flanged inlet and outlet.

3. Flanged flue gas ducting, prefabricated of angle iron reinforced steel plate, designed to prevent pulsation and vibration cracking, for routing flue gas from boiler to multi cyclone.

4. One (1) primary dry mechanical multiple cyclone flyash arrestor with cyclones, 9" diameter, each mounted on ¼" steel tube sheets. The body of the collector will be fabricated of 3/16" steel plate, reinforced with angle iron and flat bar. The unit will have flanged inlet, outlet and hopper connections. The collection hopper will be fabricated of 3/16" steel plate with flanged bottom outlet for connection of the air lock valve, hopper vibrator and access door. One (1) mechanical rotary air lock discharge valve, high temperature service discharge chute to ash receptacle. Receptacle by others.

5. Flanged flue gas ducting, prefabricated of angle iron reinforced 3/16" steel plate, designed to prevent pulsation and vibration cracking, for routing flue gas from multi cyclone into induced draft fan.

6. Centrifugal type induced draft fan designed for combustion air service complete with high efficiency radial tip wheel to reduce required motor horsepower and remain as clean as possible. The fan will be fabricated of heavy gauge steel plate

with pillow block roller bearings (located outside hot gas stream), heavy-duty shaft with heat slinger, TEFC drive motor, variable frequency drive, belt drive and OSHA belt guard. This fan will be rack mounted.

Note: HBC shall design the control for the draft fan motor variable frequency drive to assure the boiler remains negatively pressurized (Low Draft Limit).

7. Flanged transition from ID fan outlet flange to exhaust stack with exhaust stack to extend to an elevation of 20' above boiler room floor.

The entire exhaust gas system will be designed to minimize vibration and noise. The use of inlet boxes with properly designed dampers and radial tip wheel fans insure that noise levels will not exceed acceptable standards.

Exhaust monitoring/reporting equipment, controls and installation, as may be required, shall be provided by others.

2.6 ELECTRICAL CONTROL SYSTEM

An integrated, control system housed in a freestanding, pre-wired panel to be mounted in air conditioned control room for automatic operation to include:

1. Control panel fabricated of 10 gauge steel plate (NEMA 12 enclosure), primed and painted interior and exterior with main disconnect, cooling, as required, with air-air exchanger and lock-out / tag-out compliance.

2. One (1) programmable logic controller, Allen Bradley or equal, with power supply, rack, communication modules and input/output modules.

3. One (1) Pentium-based cabinet mounted computer with network and modem remote annunciation capabilities and operator interface software, RSView Runtime or equal, for automatic control of operating steam pressure, temperatures, fuel flow and combustion airflow.

   The control system incorporates a 4-20 milliamp steam pressure transmitter to sense changes in steam flow by measuring variations in boiler pressure and regulates the fuel feed and combustion air flow accordingly by adjusting the frequency of the metering bin and the combustion air fans' variable frequency drives.

   An oxygen-sensing device will be located in the boiler's rear smoke box and will measure variations in the percentage of excess oxygen in the combustion gases. The system's target is +/- 6% O_2 for optimized combustion characteristics. As changes in the percentage occur due to inconsistent moisture content, fuel density, fuel BTU content or consistency of the fuel quality, the device measures these changes in millisecond increments and signal the control's ladder logic to bias the fuel/combustion air (over fire) ratio by adjusting the variable frequency drive of the forced draft blower motor thus providing the most efficient combustion.

4. Variable frequency drives for the stoker drive, under fire air fan, over fire air fan and induced draft fan motors with input line reactors and communication to the processor.

5. Circuit breakers for all motors furnished by Hurst Boiler & Welding Co., Inc.

6. Motor starters for all motors furnished by Hurst Boiler & Welding Co., Inc.

7. Local motor disconnects are provided at each motor.

8. Furnace draft consistency will be maintained by constantly monitoring the draft and regulating the induced draft fan motor's variable frequency drive as required by the draft controller.

9. Instrumentation with 4-20 milliamp transmitters to indicate and control the following will be furnished:

   -Steam pressure (PSI above and below set point).

   -Water level.

   -Furnace draft (+ water column inches).

10. Thermocouple with high temperature limit to monitor gasifier temperature.

11. Limits will be provided to shut down the steam plant in the event of a system failure as follows:

    -Primary low water limit (automatic reset).

    -Secondary low water limit (manual reset).

    -High boiler water pressure (automatic reset).

    -Low boiler water pressure (automatic reset).

    -High furnace temperature (automatic reset).

    -Low draft (automatic reset).

The master control panel is factory wired, tested and equipped with incoming control voltage overload protection, interlocking circuit devices and terminal strip termination of all control circuits.

2.7 BOILER FEED WATER SYSTEM

One (1) HBC Feedmiser, open vented, feed water system sized to provide a minimum, steam preheated feed water storage capacity of 200 gallons. This is a complete stand mounted tank with all required internals, feed water steam pre-heater, pumps, motors, variable frequency drives and controls.

Boiler Feed Water System trim to include:

1. Automatic, internal float actuated fresh water make up valve assembly

2. Gauge glass, one each, full coverage with shut-off cocks and drain.

3. Thermometer, one each.

4. Low water alarm, probe type.

5. One (1) steam preheater (high temp return) with perforated injector pipe, self contained temperature regulator, globe valve and strainer.

6. Pump suction piping manifold with two (2) outlets sized to the specified pumps below. Suction manifold shall mount on the tank and the tank shall use a 4" coupling, internally mounted on the feed water suction pump outlet to reduce "trash" pick up from the bottom of the tank.

7. Pumps: Two (2) each, electric driven pumps, Grundfos.

8. Pump motors, two (2) each.

9. On-off pump controls.

11. Water pressure gauge, two (2) each.

12. Pump isolating valves, two (2) each (suction and discharge of each pump), gate

Pumps to be mounted on structural steel tank base; pump suction piping plumbed at factory and dismantled for shipping. Tank trim mounted at factory (some components may be removed for shipping).

Hurst Boiler and Welding Co., Inc. will provide a Nema 1 (UL Listed) control cabinet enclosure fabricated from 10 gauge mild steel, primed and painted on interior and exterior, with hinged door, magnetic across the line motor starters, pump selector switch, alarm horn with silencer, running lights and circuit breakers. To be mounted on the structural steel base.

2.8 BIOMASS FUEL STORAGE AND DELIVERY SYSTEM

1. Two (2) "tree" sections, each constructed of 6" x 6" heavy wall square tubing with 3/8" x 4" x 7" angle iron flighting (wedges) on 3'-6" centers.

2. UHMW bearings, 0.5" thick, pre-mounted on 6' wide x 33' long x 3/8" thick steel plate for floor mounting of reciprocating floor sections with stationary wedges of 2/8" x 3" x 5" angle iron, two (2) sets of roller-type floor section hold-downs with grease fittings and four (4) UHMV lined hold-downs.

3. Two (2) heavy-duty hydraulic cylinders, 6" x 24" x 2.5" with caps and fixed clevis mount, pre-mounted on reciprocating floor sections. All necessary hoses and fittings required for installation included.

4. Concrete drawings and steel beam embedment (sized for four rakes) necessary for the installation of the reciprocating floor shall be provided by the reciprocating floor manufacturer.

5. Hydraulic power, Parker-Hannifin or approved equal, unit(s) to include:
    a. One (1) 7.5 hp, 3/60/480v, 1750 rpm, TEFC electric motor hydraulic power unit to include 11 gpm variable volume piston pump.
    b. One (1) 0-5, 000 psig liquid filled pressure gauge(s) with shut off valve(s).
    c. One (1) air bleeder valves(s)
    d. One (1) two station aluminum manifold(s) with integral pressure relief valves and control valves.
    e. Two (2) each, 3 position, 4-way, closed center, 120 VAC soft shift directional control valves.
    f. One (1) 10 micron return filter(s) with visual indicator.
    g. One (1) low pressure sensor
    h. One (1) high oil temperature

6. Vibrating Pan Conveyor to include:
    a. One (1) Webster or approved equal, cross-over, vibrating conveyor with sizing screen, trough, stands and motor, approx. 25' long. TEFC electric motor 3hp, 3/60/480v

7. Screw conveyor, receiving fuel from vibrating conveyor to the boiler metering bin, to include:
    a. One (1) Hurst or approved equal, screw conveyor trough, screw, bearings, drive and electric motor. Heavy duty shafts to include flange bearings with waste pack type seals with transition (reverse repose) to metering bin.

3.1 RESPONSIBILITIES OF PURCHASER

-Obtain all necessary building and applicable permits and or testing.

-Provide P.E. stamp, if necessary.

-Return approved, final plan view and elevation layout drawings within ten (10) days of receipt.

-Provide all site preparation to assure a minimum soil bearing capacity of 2500 PSF.

-Install foundation per Hurst Boiler & Welding Co., Inc. drawings and specifications.

-Provide freight from Coolidge, GA to the job site.

-Provide all crane, lifting and man lift services, supervisors, laborers, tools, materials, etc. required to unload, set and install the equipment proposed.

-Building necessary to house boiler system and associated equipment with lighting and electrical service.

-Furnish interconnecting hot water and return piping from Hurst Boiler and Welding Co., Inc.'s scope of supply to plant.

-Piping from drain valve discharge to approved drain.

-Provide treated feed water supply, water softeners and chemical feed equipment, etc. as specified to each boiler economizer.

-Chemical treatment and disposal of waste water used in boiling out of boilers.

-Provide one (1) telephone line and one (1) high speed internet portal to the boiler control room. The telephone line shall be for use with a telephone and the portal shall be for the computer modems. These lines shall be operational prior to start up.

-Dried compressed air, as specified, piped to the soot blowers' compressed air accumulator tank and the collector air lock valves.

-All secondary pollution control equipment, exhaust monitoring equipment system(s) and installation as may be required to meet emission regulations.

-Inspect, receive and protect materials prior to the start of construction.

-Provide main disconnect and wiring to main lugs located in master control panel (and optional fuel storage control cabinet).

-Provide unrestricted access to the job site.

-Insulation on hot service piping and exhaust air-handling equipment, if required.

-Furnish fuel receiving, handling and storage system to include delivery of fuel to metering bin.

-Provide enough fuel, quality as specified, of a consistent type for three days of operation at full firing rate prior to start-up and prior to emission testing.

4.1 PRICE

The pricing, FOB Coolidge, GA, USA, for the basic boiler system is as follows:

-One (1) HBC 205 BHP, 15 PSI design steam plant, 7,073 PPH steam output from and @ 212°F, woody biomass fuel @ 50% M.C. / <2% ash. Equipment only. No installation included. Start up included.	
Adder for combustion chamber	
Adder for refractory kit	
Adder for underfeed stoker	
Adder for metering bin and stoker screw	
Adder for fire tube soot blowers	
Adder for combustion air and over fire air fans with VFD's	
Adder for induced draft fan with VFD and multi cyclone collector	
Adder for exhaust stack, 20' above boiler room grade	
Adder for combustion air preheater, horizontal	
Adder for BioMaster control system	
Adder for HBC Feedmiser feed water system	
Add one (1) type fuel storage and feed system designed for solid fuel service consisting of:	
Concrete foundation embedment.	
Two (2) reciprocating members with wedges and "UHMW" bearings	
Stationary wedges and hold-downs with "UHMW" bearings.	
One (1) hydraulic power unit with tank, pump, motor, valving and necessary high pressure hoses for interconnection of hydraulic cylinders.	
Two (2) hydraulic cylinders with forward and reverse switches.	
Receiving cross over vibrating conveyor complete with trough, sizing screen and motor w/ transfer screw conveyor to metering bin. Overs receptacle by others.	
Total	

Note: HBC reserves the right to update final pricing, as may be required, prior to order acceptance.

4.2 DELIVERY

Hurst Boiler & Welding Co., Inc. will have the hot water plant complete and ready for shipment four (4) months from receipt of approved layout drawings.