Trinity Consultants
8705 SW Nimbus Ave, Ste 350, Beaverton, OR 97008 / P 503.713.5550 / **trinityconsultants.com**

March 29, 2023

Danny Phipps
Air Quality Engineer 1
Southwest Clean Air Agency
11815 NE 99th Street, Suite 1294
Vancouver, WA 98682
Danny@swcleanair.org

RE: Completeness Determination for ADP Application CO-1057 dated August 25, 2022

Dear Danny Phipps:

Pinnacle Renewable Holdings (USA) Inc., branded as part of Drax (Drax) submitted an Air Discharge Permit (ADP) application (the Application) to the Southwest Clean Air Agency (SWCAA) in July 2022 for a new greenfield wood pellet processing facility in Longview, WA (the Facility). This letter includes information on the following items: (a) a summary of major changes to the Facility's design from that represented in the Application;(b) a summary of emission calculations and modeling changes;(c) a response to the August 25, 2022 SWCCA completeness determination letter for ADP Application CO-1057; and (d) responses to questions posed during a September 9, 2022 call between SWCAA, Drax, and Trinity Consultants. The completeness determination letter and relevant SWCAA correspondence can be found in Attachment 1.

SUMMARY OF PROCESS CHANGES

Abort Stacks

The dryer and furnace each have separate abort stacks prior to any control devices, herein referred to as the dryer abort stack and furnace abort stack. The only time the dryer abort stack will be used is during upset conditions (i.e., power outages, when the wet electrostatic precipitator (WESP) is in fault mode) and will not operate more than four hours in a day. The furnace abort stack is prior to the dryer and will be used during upset conditions (i.e., when the temperature or pressure gets too high in the furnace) and during a low idle state when the dryer is not operating. The furnace and dryer abort stacks will not be used during startup or shutdown events unless there is an upset condition as previously described. Emission calculations now include emissions that will be released from each of these two stacks.

Hammermills and Pelletizers

Instead of the cyclones described in the Application, the particulate matter (PM) emissions from the pelletizers will be controlled by a baghouse; the exhaust from the baghouse will be routed to the regenerative catalytic oxidizer (RCO). Additionally, exhaust from the hammermills will be routed to a baghouse (as originally described in the Application) and then to the same RCO as the pelletizers in order to control PM and VOC emissions, respectively. Pelletizer and hammermill VOC, hazardous air pollutant (HAP), and Washington toxic air pollutant (TAP) emission factors are obtained from stack test results from the Drax facility in Gloster, MS (ABE Facility). Maximum emission factors in pounds per oven dried ton (lbs/ODT) are obtained from 2018 and 2021 stack testing at the ABE Facility. The stack tests used as the basis for the emission factors are provided in Attachment 2 of this letter. The ABE Facility routes emissions from both the hammermills and pelletizers to an RCO, similar to the Facility. The emission factors are divided by 2 to represent half of the RCO emissions for the hammermills and pelletizers. A 25% safety factor has been applied to the emission factors for conservatism.

Emergency Engines

The emergency engines will be installed with diesel particulate filters (DPFs) that will provide at least 90% control of diesel particulate matter. In the Application, Drax proposed that the engines would operate a maximum of 200 hours per year (hrs/yr) of operation. Drax is now proposing that the engines operate a maximum of 125 hrs/yr. These changes are reflected in the updated emission calculations in Attachment 2.

SUMMARY OF EMISSION CALCULATION AND MODELING CHANGES

A summary of changes made to the emission calculations between the Application submittal and current submittal is provided below. Updated emission calculations for the Facility are provided in Attachment 2.

- HAP/TAP and VOC emissions from the hammermills and pelletizers were updated to use stack test data from a representative site, the ABE Facility in Gloster, MS. Additionally, HAP/TAP emissions from the dryer use stack test data from the ABE Facility to supplement the AP-42 factors used in the Application. A safety factor of 25% is applied to the emission factors for conservatism. This resulted in additional HAP/TAP being included in the emission calculations.
- Emission calculations for the dryer abort, furnace abort, and furnace idle scenarios were added.
  - The calculations for these scenarios assume the same emission factor basis as normal operation, without controls. Emission factors for criteria pollutants are back calculated using the manufacturer's guarantee of control efficiency and the manufacturer's controlled emission factors. Emission factors for HAPs/TAPs are determined from AP-42 Section 1.6 – Wood Residue Combustion and the stack testing completed in Gloster, MS.
  - Hours of operation for the dryer and furnace abort stacks are based on the following:
    - Dryer Abort = 50 hrs/yr or 4 hours/day at maximum heat input;
    - Furnace Abort (upset conditions) = 360 hrs/yr or 24 hours/day at maximum heat input; and
    - Furnace Abort (idle conditions) = 500 hrs/yr or 24 hours/day at 50% heat input.
- Emissions of SO_2 from the combustion of wood residuals were added to the dryer emission calculations using the emission factors from AP-42 Section 1.6-Wood Residue Combustion at hourly capacity.
- An updated dryer vendor guarantee was provided to Drax after the Application submittal. The following changes were made and are reflected in the emission calculations in Attachment 2 and vendor guarantee in Attachment 3:
  - Emission factors for CO and NO_X were updated to 42 pounds per hour (lbs/hr) and 52 lbs/hr respectively;
  - The heat input for the regenerative thermal oxidizer (RTO) was updated to 8.8 million British thermal units (MMBtu/hr); and
  - The heat input for the RCO was updated to 2.2 MMBtu/hr.
- Emission factors for particulate matter associated with the emergency engines were updated to use the Tier II EPA standards (0.20 g/kW-hr) for nonroad compression-ignition engines. Additionally, the fire pump and generator will be controlled by a diesel particulate filter able to achieve at least 90% particulate control. Use of these units will be limited to 125 hrs/yr.
- TAP emissions from the Facility are compared to both the 1998 and 2019 TAP rules[1] to determine pollutants required to show compliance with the acceptable source impact level (ASIL). Pollutants, on

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[1] WAC 173-460

either TAP list, are modeled if (a) emission rates are above the SQER or (b) if there is an assigned ASIL, but no assigned SQER for a given pollutant (1998 rule only).[2]

The air dispersion model incorporated the above emission rate changes. Additionally, the following updates were made. Updated model input files are provided in Attachment 4.

- New emission points for the dryer abort, furnace abort, and furnace idle were added to the air dispersion models.[3] Emissions from these sources and the emergency fire pump and generator are modeled in addition to the normal operating scenario with continuous operation (8,760 hrs/yr). For modeled short term results there are several available scenarios detailed below. Results are detailed for the highest modeled concentration from any given scenario. All scenarios assume the emergency fire pump and generator are operating at the same time as a given scenario for conservatism.
  - Normal – furnace exhaust is routed to the dryer, control devices associated with the dryer are operating, and all units are at full capacity.
  - FRNA – dryer is not operational (removal of source RTO), furnace is operating at maximum heat input and emissions are routed through the furnace abort stack.
  - FRNI – dryer is not operational (removal of source RTO), furnace is operating at 50% of maximum heat input and emissions are routed through the furnace abort stack.
  - RD – furnace is not operational (removal of source RTO), dryer is operating at maximum throughput and emissions are routed through the dryer abort stack. The dryer abort stack is limited to four hours of operation per day.
  - RD & FRN – emissions from dryer and furnace are routed to individual abort stacks, each at 100% capacity. The dryer abort stack is limited to four hours of operation per day.
  - Emissions from both the dryer and furnace abort stacks are included in the criteria pollutant and TAP models.
- With the addition of SO_2 emissions from wood combustion, a 1-hr SO_2 model was added to show compliance with the NAAQS.
- The inventory of TAPs modeled to show compliance with the ASIL expanded with the update to include the 2019 rule and the additional TAP emissions detailed in the previous section. All model results show compliance with the 2019 TAP rule.

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[2] This TAP analysis methodology is based on guidance from Danny Phipps (SWCAA) via email communication on February 3, 2023.

[3] Stack parameters (height and diameter) for the dryer and furnace abort stacks were obtained from Drax personnel via email communication on December 1, 2022. All other dispersion parameters were obtained from the dryer island mass balances included in Attachment 3.

AUGUST 25, 2022 SWCAA LETTER

The August 25, 2022 SWCAA letter is included in Attachment 1 of this letter. SWCAA's requests are provided in **bold text** while Drax's responses are in normal text.

1. **<u>Hammermill TAP Emissions</u>. In the submitted application Trinity stated that toxic air pollutant (TAP) emission factors with an EPA rating of C, D, or E were not evaluated. For this reason, TAP emissions for the Hammermills were not included as part of the application. The potential to emit for the Hammermills for volatile organic compounds (VOC) was calculated to be 151.91 tons per year. Based on the character of these emissions, it is likely that TAPs are emitted and Drax must produce an estimate of these emissions and perform the associated modeling.**

   Hammermill TAP emissions have been included in the updated emission calculations for the Facility. As discussed previously, emission factors from the ABE Facility are used to calculate emission estimates for the hammermill. Because these emissions are now being routed to the RCO, total annual VOC emissions are estimated to be 17.57 tons per year (tpy). These changes are reflected in the updated emission calculations in Attachment 2 and air dispersion modeling files in Attachment 4.

2. **<u>Best Available Control Technology (BACT) Analysis for the Rotary Dryer</u>. Trinity stated that the only reasonable control option for nitrogen oxides (NO_X) is good combustion controls/practices. More detail needs to be provided as to why additional controls for NO_X are not cost effective.**

   Drax will install and operate low NO_X burners on the furnace/rotary dryer. A low NO_X burner is a demonstrated control technology in pellet manufacturing facilities and is technically feasible for NO_x control. As such, the proposed burners will be classified as low NO_x burners and will constitute BACT for the dryer's NO_x emissions. A guarantee from the dryer vendor is included in Attachment 3.

   Please find below an updated top-down NO_X BACT analysis for the furnace/rotary dryer.

BACT Analysis for NO_X Emissions

Step 1: Identify All Available Control Technologies

NO_x emissions result primarily from thermal NO_X formation from nitrogen and oxygen in the combustion air. An RBLC search was performed to identify NO_X control technologies. The following technologies were identified for use on dryers of similar capacity to Drax's proposed dryer (≥100 MMBtu/hr):

- Low NO_x Burner (LNB)
- Good Combustion Controls/Practices

Drax considers these technologies to be available for the dryer.

Step 2: Eliminate Technically Infeasible Options

A LNB is a demonstrated control technology in pellet manufacturing facilities; as such, it is technically feasible for NO_x control.

Step 3: Rank Remaining Control Technologies by Effectiveness

The following control technologies are available and feasible to control NO_x emissions from the dryer:

1. LNB
2. Good Combustion Practices

Drax proposes LNB as BACT for the furnace/rotary dryer's NO_x emissions.

3. **<u>Alterative Operating Scenarios</u>. It is the understanding of SWCAA that in some cases, an electrostatic precipitator (ESP) cannot be utilized immediately upon startup. If the ESP is not actively controlling emissions, it is presumed that the regenerative thermal oxidizer (RTO) must be bypassed as well. Drax must come up with an estimate of the length of the startup period and emission factors must be provided for the startup period. Drax must also provide some assurance that ambient air quality standards will not be violated during this period. If there are similar alternative operating scenarios, they must be identified as well.**

   Before the dryer can be started and run, the WESP and RTO must be available. The WESP and RTO will function while the dryer is started up, such that PM and VOC emissions are controlled before exhausting to the atmosphere. Similarly, the WESP and RTO will operate during shutdown of the dryer. Additional information is included in a letter from the dryer vendor in Attachment 3.

4. **<u>Wood Species</u>. Emissions can vary dramatically based on the wood species burned. SWCAA requests information about what wood species will be burned at the processing facility, and how the wood species will impact emissions.**

   Drax will predominantly burn the wood species Spruce-Pine-Fir (SPF). The potential criteria pollutant emissions of the dryer are based on vendor guarantees, with the exception of SO_2, which is based on an emission factor from EPA's AP-42 and is not specific to the species of wood burned. SPF-specific emission factors could not be found for HAP/TAP emissions from a dryer comparable to Drax's proposed dryer for the Facility. AP-42 biomass combustion HAP/TAP emission factors are used. HAP/TAP emission factors from Drax's Gloster, MS facility were incorporated to supplement the AP-42 factors and are expected to be the most representative emission factors available.

5. **<u>Fugitive Emissions</u>. In the application, the truck tipper that processes wet material is assumed to have zero fugitive emissions and the ship loadout is estimated to have negligible emissions. SWCAA requests additional details including video of other facilities or descriptions of process enclosure which assure that these emissions will be minimal.**

   Please refer to the video for the truck tipper at the following link: <u>BRUKS - Keystone Drive-over Truck Dumper Showcase Video.</u>

   Refer to the emission calculations in Table C-8 as provided in Attachment 2 of this letter for quantified ship loadout emissions. The ship loadout system will use a Cleveland Cascade spout with a skirt to minimize fugitive emissions from loading pellets into ships.

6. **<u>BACT for particulate matter (PM) control at the Pelletizer</u>. Pelletizing potential PM emissions are estimated assuming an emission rate of 0.005 gr/dscf. This is considered BACT for dust collectors, however in this case a scrubber is used. Drax must provide analysis or a manufacturers guarantee demonstrating that the scrubber will meet the proposed emission standards.**

As described in the "Summary of Process Changes" section above, Drax proposes a baghouse to control PM emissions from the pelletizers rather than the cyclones described in the Application.

Among technically feasible options, Drax ranked the following technologies for further review: baghouse, WESP, dry ESP, scrubber, and cyclone. Baghouses, WESPs, and dry ESPs can generally be designed with control efficiencies up to 99.9% for PM emissions, while scrubbers can reach 95%.[4,5,6,7] Cyclones are primarily used to control particulate matter greater than 10 micrometers; accordingly, the control efficiencies are as follows: 90% for PM and PM_{10}, 40% for $PM_{2.5}$.[8] As such, cyclones alone are not considered BACT for control of particulate emissions from Pelletizers.

Due to its equally as high control efficiency as the other control technologies, Drax proposes the use of a baghouse as BACT for the pelletizer's PM emissions. Based on the BACT determination for dust collectors, use of a baghouse will achieve a limit of 0.005 gr/dscf.

7. **Operating Parameters. The application does not specify essential operating parameters of the emission control devices. The following information, at minimum, must be provided:**
    a) Operating parameters for the cyclone scrubber that controls the pelletizer:
        1. The minimum water recirculation rate; and
        2. The maximum differential pressure.
    b) Operating parameters for baghouses that control the truck tipper and the hammermills:
        1. The maximum differential pressure.
    c) Operating parameters for the ESP that controls the rotary dryer:
        1. the minimum current level in each ESP field;
        2. the minimum secondary voltage in each ESP field;
        3. the minimum spark rate in each ESP field;
        4. the minimum outlet temperature.

Drax will utilize a baghouse instead of a cyclone scrubber for control of the pelletizer emissions. The maximum differential pressure of the hammermill, pelletizer, and truck tipper baghouses are unknown as of the date of this letter.

Operating parameters of the ESP for the rotary dryer are as follows:

1. Minimum current level in each ESP field of 800 Milliampere (mA)
2. Minimum secondary voltage in each ESP field of 50 kilovolts (kV)
3. Minimum spark rate in each ESP field of 20 sparks per minute
4. Minimum outlet temperature of 160 °F

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[4] EPA, *Air Pollution Control Technology Fact Sheet, Fabric filter Pulse-jet cleaned type (also referred to as Baghouses)*, EPA-452/F-03-025. (https://www3.epa.gov/ttnchie1/mkb/documents/ff-pulse.pdf)

[5] EPA, *Air Pollution Control Technology Fact Sheet, Wet Electrostatic Precipitator (ESP)- Wire-Plate Type*, EPA-452/F-03-030. (https://www3.epa.gov/ttnchie1/mkb/documents/fwespwpl.pdf)

[6] EPA, *Air Pollution Control Technology Fact Sheet, Dry Electrostatic Precipitator (ESP)- Wire-Plate Type*, EPA-452/F-03-027. (https://www3.epa.gov/ttncatc1/dir1/fdespwpi.pdf)

[7] EPA, *Air Pollution Control Technology Fact Sheet, Packed-Bed/Packed-Tower Wet Scrubber*, EPA-452/F-03-015. (https://www3.epa.gov/ttncatc1/dir1/fpack.pdf)

[8] EPA, *Air Pollution Control Technology Fact Sheet, Cyclones*, EPA-452/F-03-005 (https://www3.epa.gov/ttnchie1/mkb/documents/fcyclon.pdf)

8. **<u>Sulfur dioxide (SO_2) Emissions</u>. No sulfur dioxide emissions are estimated for wood combustion. Drax must provide as estimate of sulfur dioxide emissions or provide data or rational explaining why this is not necessary.**

   SO_2 emissions for wood combustion at the furnace have been included using emission factors from AP-42 Table 1.6-2 for Wood Residue Combustion. These changes are reflected in the updated emission calculations in Attachment 2.

9. **<u>Design Criteria for Control Equipment.</u> More information is required regarding the design criteria of the ESP and the cyclone scrubber. The information provided in the application is not sufficient for SWCAA to evaluate whether the designed equipment can control emissions at the expected level. For each piece of control equipment on site Drax must provide the following information:**
   a) Make and model;
   b) Maximum rated load/capacity;
   c) Operating parameters associated with the equipment;
   d) Height, diameter, flow, and configuration of the ambient discharge point; and
   e) Manufacturer's control efficiency guarantees for relevant pollutants.

   Design criteria is included for each control device in the table below:

Table 1. Control Device Design Criteria

Control Device	Make and Model	Maximum Rated Load/ Capacity	Associated Operating Parameters	Height, Diameter, Flow, and Configuration of Discharge	Manufacturer's Control Efficiency Guarantees
RCO	TBD. 120,000 acfm RCO.	2.2 MMBtu/hr	Temperature: 120°F Particulate: ≤115 mg/Nm^3 Humidity: ≥5 vol% Gas Pressure: 20-40 psig	Height: 60 ft Diameter: 72 in Exhaust Stack	VOC: ≥94%
Hammermill Baghouse	Allied/Air-Cure 544RF12W	44,200 acfm	TBD	Height (above ground): 60 ft Diameter: 6.56 ft Flow: 19.7 ft/sec Exhaust Stack	PM: ≤0.005 gr/dscf
Pelletizer Baghouse	Allied/Air-Cure 544RF12W	76,000 acfm	TBD	Height (above ground): 60 ft Diameter: 6.56 ft Flow: 19.7 ft/sec Exhaust Stack	PM: ≤0.005 gr/dscf
Truck Tipper Baghouse	Donaldson Torit 200RP	27,700 acfm	TBD	Height (above ground): 41.7 ft Diameter: 2.99 ft Flow: 65.4 ft/sec	PM: ≤0.002 gr/dscf

Control Device	Make and Model	Maximum Rated Load/ Capacity	Associated Operating Parameters	Height, Diameter, Flow, and Configuration of Discharge	Manufacturer's Control Efficiency Guarantees
				Exhaust Stack	
WESP	TSI-WESP-936		Pressure: ±25" w.c. pH: 6-8 *See Question 7 for remaining parameters*	Centrifuge, routed to RTO Exhaust Stack	PM (front-half): ≥95%
RTO	TSI-RTO-4 CAN-11'x34;	8.8 MMBtu/hr	Gas Pressure: 20-40 psig Temperature: ≥1500°F Residence Time: ≥0.5 sec	Height: 60 ft Diameter: 90 in Exhaust Stack	VOC: ≥95%; PM (back-half): ≥95%

10. **<u>Binding Agent</u>. The application does not cite the use of any binding agent in the pelletizing process. If binding agents are used in the process, Drax must submit chemical constituent data for each binding agent and provide an estimate of associated pollutant emissions.**

    There will not be any binding agent used in the pelletizing process.

11. **<u>VOC Emissions from Stockpile Storage</u>. Drax estimated PM emissions from stockpile storage, however wood products can also produce VOCs. Drax must provide an estimate of VOC emissions from these stockpiles and provide a plan for minimizing these emissions.**

    Per a September 9, 2022 SWCAA email, it was determined that additional information was needed to ensure that odors from stockpiles would be minimized. The stockpiles will be on site for a continual rollover basis. Drax will target to maintain a half-month's supply necessary to operate the plant. At some points in the year (notably, winter and spring), Drax will increase this volume to address supply risks – potentially up to one month. Across its facilities, Drax typically only measures the temperatures of its grind piles on an as-needed basis to address concerns. Drax does not plan to measure pH.

12. **<u>Compliance Assurance Monitoring</u>. The application describes emission units that have a control device and emit over 100 ton of a pollutant, prior to the control unit. These units meet the criteria under 40 cfr part 64 and a plan must be provided for continuous compliance assurance.**

    Per 40 CFR 64.5(b) and if applicable to the emission units at the facility, Compliance Assurance Monitoring (CAM) requirements are to be submitted as part of a Title V renewal application. Drax will evaluate applicability of the CAM requirements in the initial Title V application for the Facility.

SWCAA QUESTIONS FROM 9/9/2022 CONFERENCE CALL

SWCAA's questions from the September 9, 2022 conference call are provided in **bold text** while Drax's responses are in normal text.

1. **Did Drax evaluate the feasibility of installing a scrubber to control PM emissions from the hammermills?**

   Baghouses can generally be designed with control efficiencies up to 99.9% for PM emissions, while scrubbers can reach 95%.[9,10] To achieve the best available control efficiency, Drax is proposing the installation of a baghouse to control PM from the hammermills. The baghouse will achieve a grain loading limit of 0.005 gr/dscf.

2. **Would Drax prefer a large testing event every five years, or to test a smaller number of emission units each year?**

   Drax prefers to conduct a single testing event every five years.

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If you have any questions or comments about the information presented in this letter, please do not hesitate to call me at 253.867.5600 x4804.

Sincerely,

TRINITY CONSULTANTS

Jennifer Pohlman
Senior Consultant

Attachments

cc: Wayne Kooy, Drax Group (Vancouver, BC)
Melissa Hillman, Trinity Consultants (Portland, Oregon)

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[9] EPA, *Air Pollution Control Technology Fact Sheet, Fabric filter Pulse-jet cleaned type (also referred to as Baghouses)*, EPA-452/F-03-025. (https://www3.epa.gov/ttnchie1/mkb/documents/ff-pulse.pdf)

[10] EPA, *Air Pollution Control Technology Fact Sheet, Packed-Bed/Packed-Tower Wet Scrubber*, EPA-452/F-03-015. (https://www3.epa.gov/ttncatc1/dir1/fpack.pdf)
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ATTACHMENT 1

SWCAA Letter and Relevant Email Correspondence

SWCAA
Southwest Clean Air Agency

11815 NE 99th Street, Suite 1294
Vancouver, WA 98682
(360) 574-3058
www.swcleanair.org

August 25, 2022

Wayne Kooy, Senior Environmental Manager
Drax Group
543 Granville Street, Suite 1100, Vancouver, BC V6C 1X8

RE: Completeness Determination for ADP Application CO-1057

Dear Mr. Kooy:

The Southwest Clean Air Agency (SWCAA) has received your Air Discharge Permit (ADP) application to install and operate a wood pellet processing facility, submitted by Trinity Consultants on your behalf. This application has been designated as ADP Application CO-1057.

SWCAA has determined, after review, that the application is incomplete under SWCAA 400-110(2). Additional information is needed before SWCAA can continue processing the application. Please provide the following no later than **September 30, 2022**:

- Hammermill TAP Emissions. In the submitted application Trinity stated that toxic air pollutant (TAP) emission factors with an EPA rating of C, D, or E were not evaluated. For this reason, TAP emissions for the Hammermills were not included as part of the application. The potential to emit for the Hammermills for volatile organic compounds (VOC) was calculated to be 151.91 tons per year. Based on the character of these emissions, it is likely that TAPs are emitted and Drax must produce an estimate of these emissions and perform the associated modeling.
- Best Available Control Technology (BACT) Analysis for the Rotary Dryer. Trinity stated that the only reasonable control option for nitrogen oxides (NO_x) is good combustion controls/practices. More detail needs to be provided as to why additional controls for NO_x are not cost effective.
- Alterative Operating Scenarios. It is the understanding of SWCAA that in some cases, an electrostatic precipitator (ESP) cannot be utilized immediately upon startup. If the ESP is not actively controlling emissions, it is presumed that the regenerative thermal oxidizer (RTO) must be bypassed as well. Drax must come up with an estimate of the length of the startup period and emission factors must be provided for the startup period. Drax must also provide some assurance that ambient air quality standards will not be violated during this period. If there are similar alternative operating scenarios, they must be identified as well.
- Wood Species. Emissions can vary dramatically based on the wood species burned. SWCAA requests information about what wood species will be burned at the processing facility, and how the wood species will impact emissions.
- Fugitive Emissions. In the application, the truck tipper that processes wet material is assumed to have zero fugitive emissions and the ship loadout is estimated to have negligible emissions. SWCAA requests additional details including video of other facilities or descriptions of process enclosure which assure that these emissions will be minimal.
- BACT for particulate matter (PM) control at the Pelletetizer. Pelletizing potential PM emissions are estimated assuming an emission rate of 0.005 gr/dscf. This is considered BACT for dust collectors, however in this case a scrubber is used. Drax must provide analysis or a

manufacturers guarantee demonstrating that the scrubber will meet the proposed emission standards.

- Operating Parameters. The application does not specify essential operating parameters of the emission control devices. The following information, at minimum, must be provided:
    a) Operating parameters for the cyclone scrubber that controls the pelletizer:
        1. The minimum water recirculation rate; and
        2. The maximum differential pressure.
    b) Operating parameters for baghouses that control the truck tipper and the hammermills:
        1. The maximum differential pressure.
    c) Operating parameters for the ESP that controls the rotary dryer:
        1. the minimum current level in each ESP field;
        2. the minimum secondary voltage in each ESP field;
        3. the minimum spark rate in each ESP field;
        4. the minimum outlet temperature.
- Sulfur dioxide (SO_2) Emissions. No sulfur dioxide emissions are estimated for wood combustion. Drax must provide as estimate of sulfur dioxide emissions or provide data or rational explaining why this is not necessary.
- Design Criteria for Control Equipment. More information is required regarding the design criteria of the ESP and the cyclone scrubber. The information provided in the application is not sufficient for SWCAA to evaluate whether the designed equipment can control emissions at the expected level. For each piece of control equipment on site Drax must provide the following information:
    a) Make and model;
    b) Maximum rated load/capacity;
    c) Operating parameters associate with the equipment;
    d) Height, diameter, flow, and configuration of the ambient discharge point; and
    e) Manufacturer's control efficiency guarantees for relevant pollutants.
- Binding Agent. The application does not cite the use of any binding agent in the pelletizing process. If binding agents are used in the process, Drax must submit chemical constituent data for each binding agent and provide an estimate of associated pollutant emissions.
- VOC Emissions from Stockpile Storage. Drax estimated PM emissions from stockpile storage, however wood products can also produce VOCs. Drax must provide an estimate of VOC emissions from these stockpiles and provide a plan for minimizing these emissions.
- Compliance Assurance Monitoring. The application describes emission units that have a control device and emit over 100 ton of a pollutant, prior to the control unit. These units meet the criteria under 40 cfr part 64 and a plan must be provided for continuous compliance assurance.

Should additional time for preparation of the above items be needed, SWCAA will grant any reasonable request. Please note that SWCAA may still request additional information to clarifying the application during the forthcoming permitting process. If you need further assistance or have any questions on this matter, please contact me at (360) 574-3058 ext. 124.

Sincerely,

Danny Phipps
Air Quality Engineer I

From: Danny Phipps
To: Jennifer Pohlman
Cc: Wayne Kooy; Melissa Hillman; Maddie Coates
Subject: RE: Drax Longview 2019 TAP Rule
Date: Friday, February 3, 2023 1:05:48 PM
Attachments: image002.png
image003.png

Good afternoon Jennifer,

My answers are below in Red. Let me know if you need further clarification beyond what it written below.

Thanks,

Danny Phipps, PE
Air Quality Engineer
Southwest Clean Air Agency
360-574-3058 x 124
danny@swcleanair.gov

Hours: Tuesday through Friday 7:00 am to 5:30 pm

From: Jennifer Pohlman <JPohlman@trinityconsultants.com>
Sent: Friday, February 3, 2023 9:40 AM
To: Danny Phipps <Danny@swcleanair.org>
Cc: Wayne Kooy <Wayne.Kooy@drax.com>; Melissa Hillman <MHillman@trinityconsultants.com>; Maddie Coates <Madison.Coates@trinityconsultants.com>
Subject: Drax Longview 2019 TAP Rule

Danny,

We completed a full comparison of TAP emissions from the Drax Longview site to the 2019 TAP rule and we are able to get all pollutants to pass the SQER/ASIL using the 2019 TAP rule. We just wanted to get confirmation from you on how we should proceed with the TAP comparison:

- Were you able to get confirmation that it is acceptable to compare to the 2019 SQERs and ASILs instead of or in addition to the 1998 thresholds? If so:
    - Should we use the 1998 rule and compare to the 2019 ASIL for pollutants which exceed the 1998 ASIL but have a higher ASIL in the 2019 rule? Or
    - Should we compare all TAP to the 2019 rule thresholds?

If a TAP is not listed in the 2019 rule, but it is in the 1998 list, then use the 1998 standard. For all other pollutants the 2019 ASIL should be used. Make a note of those that exceed the 1998 standard. In the technical support document of the permit I will reference the conversation with Gary Palcisko and the letter that was issued for Sierra Pacific.

Also, just a few miscellaneous items:

- Regarding modeling of emergency engines, would you agree that it is appropriate to model only projected operating hours for testing and maintenance, rather than using the PTE estimate of 200 hrs/yr (which includes emergency hours of operation)?

The PTE estimate should be used as it considers both estimated emergency usage and the operation and maintenance time.

- We wanted to follow-up on whether we can annualize emissions from the abort stacks for short-term modeling purposes.

Since those scenarios amount to almost 1,000 hours and are planned we have decided that it would not be appropriate to average them over the course of the year. Please model those as short term emissions (not annualized).

Please let us know if you have any questions.

Thank you,

Jennifer

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ATTACHMENT 2

Updated Potential Emission Calculations and Stack Test Data

Table C-1a. Input Values

Total Pellet Throughput [1]	450,000	ODMT/yr
Hourly Pellet Throughput [1]	62	ODMT/hr
Total Dryer Throughput	450,000	ODMT/yr
Max Hourly Dryer Throughput [1]	62	ODMT/hr
Total Hammermill Throughput	450,000	ODMT/yr
Max Hourly Hammermill Throughput [1]	75	ODMT/hr
Total Pellet Cooler Throughput	450,000	ODMT/yr
Max Hourly Pellet Cooler Throughput [1]	75	ODMT/hr
Facility Operating Hours	8,760	hrs/yr
Controlled Hammermill VOC Emission Factor[3]	0.071	lb/ODT
Controlled Pellet Cooler VOC Emission Factor[3]	0.071	lb/ODT
RTO VOC Control Efficiency for Rotary Dryer	95%	
RTO CO Control Efficiency for Rotary Dryer	0%	
RCO VOC Control Efficiency for Pellet Cooler and Hammermill	95%	
RCO CO Control Efficiency for Pellet Cooler and Hammermill	0%	

[1] Maximum throughputs were provided to Trinity Consultants in process flow diagram on 12/21/2021.

[2] RTO and RCO control efficiencies per manufacturer specification sheets.

[3] Emission factors obtained from the Drax facility in Gloster, MS (ABE) stack testing. Maximum emission factors in lbs/ODT obtained from 2018 and 2021 stack testing. The ABE facility routes emissions from both the hammermill and pelletizer to the RCO similar to the proposed Longview facility. The emission factors are divided by 2 to represent half of the RCO emissions for each piece of equipment. A 25% safety factor has been included for conservatism.

Table C-1b. Conversion Factors

1	short ton	=	0.907	metric tonnes

Table C-2a. Facility-Wide Potential Emissions - Criteria Pollutant Summary

EU ID	Emission Sources	Title V/PSD Fugitive?	Facility-Wide Potential Emissions (tpy)							
			PM	Total PM_{10}	Total $PM_{2.5}$	SO_2	NO_X	VOC	CO	CO_2e
BIO	Biosizer	Yes	5.37E-03	2.54E-03	3.85E-04	--	--	--	--	--
RD	Biomass Rotary Dryer	No	21.90	21.90	21.90	20.55	227.76	65.70	183.96	178,574.43
DCS	Dry Chip Storage Tent	Yes	0.06	0.03	3.98E-03	--	--	--	--	--
HM1	Hammermill No. 1	No								
HM2	Hammermill No. 2	No	7.52	7.52	7.52	--	--	17.57	--	--
HM3	Hammermill No. 3	No								
HM4	Hammermill No. 4	No								
PC1	Pelletizer No. 1	No								
PC2	Pelletizer No. 2	No								
PC3	Pelletizer No. 3	No								
PC4	Pelletizer No. 4	No								
PC5	Pelletizer No. 5	No								
PC6	Pelletizer No. 6	No	12.93	12.93	12.93	--	--	17.57	--	--
PC7	Pelletizer No. 7	No								
PC8	Pelletizer No. 8	No								
PC9	Pelletizer No. 9	No								
PC10	Pelletizer No. 10	No								
PC11	Pelletizer No. 11	No								
PSS1	Pellet Storage Dome 1	No	0.04	0.02	2.54E-03	--	--	--	--	--
PSS2	Pellet Storage Dome 2	No	0.04	0.02	2.54E-03	--	--	--	--	--
SLS	Ship Loadout System	Yes	0.07	0.03	0.01	--	--	--	--	--
HR	Haul Roads	Yes	2.39	0.48	0.12	--	--	--	--	--
SP1	Wet Material Stockpile	Yes	0.38	0.18	0.03	--	--	--	--	--
ENG1	625 kW Emergency Generator	No	1.72E-03	1.72E-03	1.72E-03	5.55E-04	1.17	0.03	0.31	60.71
FWP1	164 kW Fire Pump Engine	No	4.52E-04	4.52E-04	4.52E-04	0.03	0.42	0.03	0.09	15.90
BAG2	Truck Tipper	No	1.80	1.80	1.80	--	--	--	--	--
RTO	Dryer RTO *(Emissions from Natural Gas Combustion)*	No	--	--	--	0.02	--	--	--	4,561.54
RCO	Pelletizer RCO *(Emissions from Natural Gas Combustion)*	No	0.07	0.07	0.07	0.01	0.94	0.05	0.79	1,140.38
RD - A	Biomass Rotary Dryer - Abort	No	2.50	2.50	2.50	0.12	1.30	7.50	1.05	1,230.18
FRN - A	Furnace - Abort	No	19.49	17.47	15.10	0.84	7.43	0.57	20.27	6,736.89
FRN	Furnace - Idle	No	13.54	12.13	10.49	0.59	5.16	0.40	14.08	4,678.40
		Total Point Source Emissions (Title V/PSD Regulated):	**79.8**	**76.4**	**72.3**	**22.2**	**244.2**	**109.4**	**220.6**	**196,998**
		Total Emissions (including fugitives):	**82.7**	**77.1**	**72.5**	**22.2**	**244.2**	**109.44**	**220.6**	**196,998**
		Title V Threshold:	**--**	**100.0**	**100.0**	**100.0**	**100.0**	**100.00**	**100.0**	**--**
		Title V Threshold Exceeded (Yes/No):	**No**	**No**	**No**	**No**	**Yes**	**Yes**	**Yes**	**No**
		PSD Threshold (tons/12-months):	**250**	**250**	**250**	**250**	**250**	**250**	**250**	**100,000**
		PSD Threshold Exceeded[1] (Yes/No):	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**Yes**

[1] PSD for GHG is only exceeded if PSD is exceeded for another regulated pollutant.

Table C-2b. Facility-Wide Potential Emissions - HAP/TAP Summary

Pollutants	CAS #	HAP?	1998 TAP?	1998 TAP Class	2019 TAP?	Dryer Maximum Hourly Emissions (lb/hr)	Dryer Potential Annual Emissions (tpy)	RTO Maximum Hourly Emissions (lb/hr)	RTO Potential Annual Emissions (tpy)	RCO Maximum Hourly Emissions (lb/hr)	RCO Potential Annual Emissions (tpy)	Hammermill Maximum Hourly Emissions (lb/hr)	Hammermill Potential Annual Emissions (tpy)	Pelletizers Maximum Hourly Emissions (lb/hr)	Pelletizers Potential Annual Emissions (tpy)	Dryer - Abort Maximum Hourly Emissions (lb/hr)	Dryer - Abort Potential Annual Emissions (tpy)	Furnace - Abort Maximum Hourly Emissions (lb/hr)	Furnace - Abort Potential Annual Emissions (tpy)	Furnace - Idle Maximum Hourly Emissions (lb/hr)	Furnace - Idle Potential Annual Emissions (tpy)	Emergency Engines Maximum Hourly Emissions (lb/hr)	Emergency Engines Potential Annual Emissions (tpy)	Total Maximum Hourly Emissions (lb/hr)	Total Potential Annual Emissions (tpy)	1998 SQER[1] Averaging Period	1998 SQER[1] (lb/yr)	1998 SQER[1] (lb/hr)	2019 SQER Averaging Period	2019 SQER (lb/avg. period)	Modeling Required?
Acenaphthene	83-32-9	Yes - PAH	No	--	No	8.54E-06	3.74E-05	0	0	0	0	0	0	0	0	1.71E-04	4.27E-06	1.71E-04	3.07E-05	8.54E-05	2.14E-05	0	0	3.42E-04	9.38E-05	--	--	--	--	--	No
Acenaphthylene	208-96-8	Yes - PAH	No	--	No	4.69E-05	2.06E-04	0	0	0	0	0	0	0	0	9.39E-04	2.35E-05	9.39E-04	1.69E-04	4.69E-04	1.17E-04	0	0	1.88E-03	5.15E-04	--	--	--	--	--	No
Acetaldehyde	75-07-0	Yes	Yes	A	Yes	5.67E-01	2.06E+00	0	0	0	0	2.18E-03	5.41E-01	1.80E-01	5.41E-01	1.13E+01	2.83E-01	1.56E-01	2.80E-02	7.79E-02	1.95E-02	0	0	1.17E+01	3.47E+00	Annual	5.00E+01	--	year	6.00E+01	Yes
Acrolein	107-02-8	Yes	Yes	B	Yes	2.43E-01	8.82E-01	0	0	0	0	8.18E-04	2.03E-01	6.74E-02	2.03E-01	4.86E+00	1.21E-01	0	0	0	0	0	0	4.93E+00	1.41E+00	1-hr and Annual	1.75E+02	2.00E-02	24-hr	2.60E-02	Yes
Anthracene	120-12-7	Yes - PAH	No	--	No	2.82E-05	1.23E-04	0	0	0	0	0	0	0	0	5.63E-04	1.41E-05	5.63E-04	1.01E-04	2.82E-04	7.04E-05	0	0	1.13E-03	3.09E-04	--	--	--	--	--	No
Benz[a]anthracene	56-55-3	Yes - PAH	Yes	A	Yes	6.10E-07	2.67E-06	0	0	0	0	0	0	0	0	1.22E-05	3.05E-07	1.22E-05	2.20E-06	6.10E-06	1.53E-06	0	0	2.44E-05	6.70E-06	N/A	--	--	year	8.90E-01	No
Benzene	71-43-2	Yes	Yes	A	Yes	3.94E-02	1.73E-01	1.81E-05	7.94E-05	4.53E-06	1.98E-05	0	0	0	0	7.88E-01	1.97E-02	7.88E-01	1.42E-01	3.94E-01	9.85E-02	0	0	1.58E+00	4.33E-01	Annual	2.00E+01	--	year	2.10E+01	Yes
Benzo(a)pyrene	50-32-8	Yes - PAH	Yes	A	Yes	2.44E-05	1.07E-04	0	0	0	0	0	0	0	0	4.88E-04	1.22E-05	4.88E-04	8.78E-05	2.44E-04	6.10E-05	0	0	9.76E-04	2.68E-04	N/A	--	--	year	1.60E-01	Yes
Benzo(b)fluoranthene	205-99-2	Yes - PAH	Yes	A	Yes	9.39E-07	4.11E-06	0	0	0	0	0	0	0	0	1.88E-05	4.69E-07	1.88E-05	3.38E-06	9.39E-06	2.35E-06	0	0	3.75E-05	1.03E-05	N/A	--	--	year	8.90E-01	No
Benzo(g,h,i)perylene	191-24-2	Yes - PAH	No	--	No	8.73E-07	3.82E-06	0	0	0	0	0	0	0	0	1.75E-05	4.36E-07	1.75E-05	3.14E-06	8.73E-06	2.18E-06	0	0	3.49E-05	9.58E-06	--	--	--	--	--	No
Benzo(k)fluoranthene	207-08-9	Yes - PAH	Yes	A	Yes	3.38E-07	1.48E-06	0	0	0	0	0	0	0	0	6.76E-06	1.69E-07	6.76E-06	1.22E-06	3.38E-06	8.45E-07	0	0	1.35E-05	3.71E-06	N/A	--	--	year	8.90E-01	No
Chrysene	218-01-9	Yes - PAH	No	--	Yes	3.57E-07	1.56E-06	0	0	0	0	0	0	0	0	7.13E-06	1.78E-07	7.13E-06	1.28E-06	3.57E-06	8.92E-07	0	0	1.43E-05	3.92E-06	N/A	--	--	year	8.90E+00	No
Dibenzo(a,h)anthracene	53-70-3	Yes - PAH	Yes	A	Yes	8.54E-08	3.74E-07	0	0	0	0	0	0	0	0	1.71E-06	4.27E-08	1.71E-06	3.07E-07	8.54E-07	2.14E-07	0	0	3.42E-06	9.38E-07	N/A	--	--	year	8.20E-02	No
Fluoranthene	206-44-0	Yes - PAH	No	--	No	1.50E-05	6.58E-05	0	0	0	0	0	0	0	0	3.00E-04	7.51E-06	3.00E-04	5.41E-05	1.50E-04	3.75E-05	0	0	6.01E-04	1.65E-04	--	--	--	--	--	No
Fluorene	86-73-7	Yes - PAH	No	--	No	3.19E-05	1.40E-04	0	0	0	0	0	0	0	0	6.38E-04	1.60E-05	6.38E-04	1.15E-04	3.19E-04	7.98E-05	0	0	1.28E-03	3.50E-04	--	--	--	--	--	No
Formaldehyde	50-00-0	Yes	Yes	A	Yes	1.43E+00	5.17E+00	6.47E-04	2.83E-03	1.62E-04	7.09E-04	2.09E-03	5.18E-01	1.72E-01	5.18E-01	2.85E+01	7.13E-01	8.26E-01	1.49E-01	4.13E-01	1.03E-01	0	0	2.95E+01	7.18E+00	Annual	2.00E+01	--	year	2.70E+01	Yes
Hydrochloric acid	7647-01-0	Yes	Yes	B	Yes	1.78E-01	6.46E-01	0	0	0	0	4.54E-04	1.13E-01	3.75E-02	1.13E-01	3.56E+00	8.91E-02	0	0	0	0	0	0	3.60E+00	9.61E-01	1-hr and Annual	1.75E+02	2.00E-02	24-hr	6.70E-01	Yes
Indeno(1,2,3-c,d)pyrene	193-39-5	Yes - PAH	Yes	A	Yes	8.16E-07	3.58E-06	0	0	0	0	0	0	0	0	1.63E-05	4.08E-07	1.63E-05	2.94E-06	8.16E-06	2.04E-06	0	0	3.27E-05	8.97E-06	N/A	--	--	year	8.90E-01	No
Methanol	67-56-1	Yes	Yes	B	Yes	2.56E+00	9.29E+00	0	0	0	0	2.42E-02	5.99E+00	1.99E+00	5.99E+00	5.12E+01	1.28E+00	0	0	0	0	0	0	5.32E+01	2.26E+01	1-hr and Annual	4.37E+04	5.00E+00	24-hr	1.50E+03	Yes
Naphthalene	91-20-3	Yes - PAH	Yes	B	Yes	9.10E-04	3.99E-03	0	0	0	0	0	0	0	0	1.82E-02	4.55E-04	1.82E-02	3.28E-03	9.10E-03	2.28E-03	0	0	3.64E-02	1.00E-02	1-hr and Annual	2.28E+04	2.60E+00	year	4.80E+00	Yes
[3] Octachlorodibenzo-p-dioxins	3268-87-9	No	No	--	Yes	6.19E-07	2.71E-06	0	0	0	0	0	0	0	0	1.24E-05	3.10E-07	1.24E-05	2.23E-06	6.19E-06	1.55E-06	0	0	2.48E-05	6.80E-06	N/A	--	--	year	1.50E-02	No
[3] Pentachlorodibenzo-p-dioxins	40321-76-4	No	No	--	Yes	1.41E-08	6.17E-08	0	0	0	0	0	0	0	0	2.82E-07	7.04E-09	2.82E-07	5.07E-08	1.41E-07	3.52E-08	0	0	5.63E-07	1.55E-07	N/A	--	--	year	4.30E-06	Yes
Phenanthrene	85-01-8	Yes - PAH	No	--	No	6.57E-05	2.88E-04	0	0	0	0	0	0	0	0	1.31E-03	3.28E-05	1.31E-03	2.37E-04	6.57E-04	1.64E-04	0	0	2.63E-03	7.21E-04	--	--	--	--	--	No
Phenol	108-95-2	Yes	Yes	B	Yes	1.10E+00	4.00E+00	0	0	0	0	1.31E-02	3.24E+00	1.08E+00	3.24E+00	2.20E+01	5.51E-01	0	0	0	0	0	0	2.31E+01	1.10E+01	1-hr and Annual	1.05E+04	1.20E+00	24-hr	1.50E+01	Yes
Propionaldehyde	123-38-6	Yes	Yes	B	Yes	1.62E-01	5.88E-01	0	0	0	0	2.00E-03	4.96E-01	1.65E-01	4.96E-01	3.24E+00	8.10E-02	0	0	0	0	0	0	3.41E+00	1.66E+00	No SQER	--	--	24-hr	5.90E-01	Yes
Pyrene	129-00-0	Yes - PAH	No	--	No	3.47E-05	1.52E-04	0	0	0	0	0	0	0	0	6.94E-04	1.74E-05	6.94E-04	1.25E-04	3.47E-04	8.68E-05	0	0	1.39E-03	3.81E-04	--	--	--	--	--	No
Arsenic	7440-38-2	Yes	Yes	A	Yes	2.06E-04	9.04E-04	0	0	0	0	0	0	0	0	4.13E-03	1.03E-04	4.13E-03	7.43E-04	2.06E-03	5.16E-04	0	0	8.26E-03	2.27E-03	No SQER	--	--	year	4.90E-02	Yes
Beryllium	7440-41-7	Yes	Yes	A	Yes	1.03E-05	4.52E-05	0	0	0	0	0	0	0	0	2.06E-04	5.16E-06	2.06E-04	3.72E-05	1.03E-04	2.58E-05	0	0	4.13E-04	1.13E-04	No SQER	--	--	year	6.80E-02	Yes
Cadmium	7440-43-9	Yes	Yes	A	Yes	3.85E-05	1.69E-04	0	0	0	0	0	0	0	0	7.70E-04	1.92E-05	7.70E-04	1.39E-04	3.85E-04	9.62E-05	0	0	1.54E-03	4.22E-04	No SQER	--	--	year	3.90E-02	Yes
Chromium VI	18540-29-9	No	Yes	A	Yes	3.28E-05	1.44E-04	0	0	0	0	0	0	0	0	6.57E-04	1.64E-05	6.57E-04	1.18E-04	3.28E-04	8.21E-05	0	0	1.31E-03	3.61E-04	No SQER	--	--	year	6.50E-04	Yes
[2] Chromium III	16065-83-1	No	Yes	B	Yes	1.97E-04	8.63E-04	0	0	0	0	0	0	0	0	3.94E-03	0	3.94E-03	7.10E-04	1.97E-03	4.93E-04	0	0	7.88E-03	2.07E-03	1-hr and Annual	1.75E+02	2.00E-02	24-hr	7.40E-03	Yes
[2] Chromium II	7440-47-3	Yes	Yes	B	No	1.97E-04	8.63E-04	0	0	0	0	0	0	0	0	3.94E-03	9.85E-05	3.94E-03	7.10E-04	1.97E-03	4.93E-04	0	0	7.88E-03	2.16E-03	1-hr and Annual	1.75E+02	2.00E-02	--	--	No
Copper	7440-50-8	No	Yes	B	Yes	4.60E-04	2.01E-03	0	0	0	0	0	0	0	0	9.20E-03	2.30E-04	9.20E-03	1.66E-03	4.60E-03	1.15E-03	0	0	1.84E-02	5.05E-03	1-hr and Annual	1.75E+02	2.00E-02	1-hr	1.90E-01	No
Manganese	7439-96-5	Yes	Yes	B	Yes	1.50E-02	6.58E-02	0	0	0	0	0	0	0	0	3.00E-01	7.51E-03	3.00E-01	5.41E-02	1.50E-01	3.75E-02	0	0	6.01E-01	1.65E-01	1-hr and Annual	1.75E+02	2.00E-02	24-hr	2.20E-02	Yes
Mercury	7439-97-6	Yes	Yes	B	Yes	6.57E-04	2.88E-03	0	0	0	0	0	0	0	0	6.57E-04	1.64E-05	6.57E-04	1.18E-04	3.28E-04	8.21E-05	0	0	1.31E-03	3.09E-03	1-hr and Annual	1.75E+02	2.00E-02	24-hr	2.20E-03	Yes
Nickel	7440-02-0	Yes	Yes	A	Yes	3.10E-04	1.36E-03	0	0	0	0	0	0	0	0	6.19E-03	1.55E-04	6.19E-03	1.11E-03	3.10E-03	7.74E-04	0	0	1.24E-02	3.40E-03	Annual	5.00E-01	--	year	6.20E-01	Yes
Selenium	7782-49-2	Yes	Yes	B	Yes	2.63E-05	1.15E-04	0	0	0	0	0	0	0	0	5.26E-04	1.31E-05	5.26E-04	9.46E-05	2.63E-04	6.57E-05	0	0	1.05E-03	2.89E-04	1-hr and Annual	1.75E+02	2.00E-02	24-hr	1.50E+00	No
Zinc	7440-66-6	No	No	--	No	3.94E-03	1.73E-02	0	0	0	0	0	0	0	0	7.88E-02	1.97E-03	7.88E-02	1.42E-02	3.94E-02	9.85E-03	0	0	1.58E-01	4.33E-02	--	--	--	--	--	No
Diesel engine exhaust, particulate	200	No	No	--	Yes	0	0	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.48E-02	2.17E-03	3.48E-02	2.17E-03	--	--	--	year	5.40E-01	Yes
[3] Total Dioxins/Furans (2,3,7,8 TCDD Eqv.)	136677-09-3	No	Yes	A	No	1.43E-08	6.25E-08	0	0	0	0	0	0	0	0	2.85E-07	7.13E-09	2.85E-07	5.13E-08	1.43E-07	3.57E-08	0	0	5.71E-07	1.57E-07	No SQER	--	--	--	--	Yes
[4] TAP Total Polycyclic Aromatic Hydrocarbons (TAP - PAH)	130498-29-2	Yes - PAH	Yes	A	No	2.75E-05	1.21E-04	0	0	0	0	0	0	0	0	5.51E-04	0	5.51E-04	9.92E-05	2.75E-04	6.89E-05	0	0	1.10E-03	2.89E-04	No SQER	--	--	--	--	Yes
HAP Total Polycyclic Aromatic Hydrocarbons (HAP - PAH)	--	Yes - PAH	No	--	No	1.17E-03	5.12E-03	0	0	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.34E-02	0	2.34E-02	4.21E-03	1.17E-02	2.92E-03	0	0	4.68E-02	1.23E-02	--	--	--	--	--	No
																								Total HAP (tpy)	**48.90**						
																								Maximum Single HAP (tpy)	**22.55**						

[1] The SQER for each TAP is obtained from the 1998 and 2019 WAC 173-460 TAP lists.

[2] Chromium III and II are conservatively assumed to each be equal to the total chromium emissions, since the oxidation state of the emitted chromium compounds is not known.

[3] Dioxin and furan emissions are quantified using a toxic equivalency (TEQ) factor and considered as one TAP under the 1998 rule. The sum of these pollutant emissions are compared to the ASIL in the 1998 TAP rule in accordance with WAC 173-460-050(4)(b) adopted by SWCAA. Under the 2019 TAP rule, dioxins and furans are considered separate pollutants. Emissions are calculated separately and compared to the 2019 TAP rule. Pollutants reported individually have not been adjusted to 2,3,7,8 TCDD Eqv.

[4] Polyaromatic hydrocarbon (PAH) emissions for TAP consideration are quantified as the following PAHs and are considered as one TAP equivalent in potency to benzo(a)pyrene: benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, indenol(1,2,3-cd)pyrene, benzo(a)pyrene. The sum of these pollutant emissions are then compared to the ASIL 1998 TAP rule in accordance with WAC 173-460-050(4)(c) adopted by SWCAA. Since the TAP equivalent potency is not provided, it is assumed that it equals 1.

Table C-3a. Biomass Rotary Dryer Operating Parameters

Parameter	Value	Units
Max Hourly Throughput	68.3	ODT/hr
Max Annual Throughput	496,040	ODT/yr
Maximum Heat Input	187.7	MMBtu/hr
Wood and Wood Residuals Heating Value[1]	17.48	MMBtu/ODT
Maximum Annual Operation	8,760	hr/yr

[1] Wood and wood residuals heating value provided in 40 CFR Appendix Table C-1 to Subpart C of Part 98.

Table C-3b. Biomass Rotary Dryer Potential Emissions - Criteria Pollutants

Pollutant	Maximum Hourly Emissions[1] (lb/hr)	Potential Annual Emissions (tpy)
PM	5.00	21.90
PM_{10}	5.00	21.90
$PM_{2.5}$	5.00	21.90
SO_2 [2]	4.69	20.55
NO_X	52.00	227.76
VOC	15.00	65.70
CO	42.00	183.96

[1] Hourly emission rates from the RTO stack are obtained from vendor guarantees provided by TSI on September 9th, 2022.

[2] SO_2 emissions estimated using AP-42 Table 1.6-2 for Wood Residue Combustion. Emission factor is given in lb/MMBtu and converted to lbs/hr using the maximum heat input of the furnace.

Table C-3c. Biomass Rotary Dryer Potential Emissions - GHG

Fuel	Wood Drying CO_2 Emission Factor [1] (lb/ODT)	CO_2 Emissions (tpy)
Wood & wood residuals	720	178,574

[1] Wood drying emission factors for CO_2 are from AP-42 Table 10.6.1-2.

Table C-3d. Biomass Rotary Dryer Potential Emissions - HAP/TAP

Pollutant	CAS #	HAP?	TAP?	Biomass Combustion Emission Factor[1] (lb/MMBtu)	ABE Stack Test Factors[2] (lb/ODT)	Maximum Hourly Emissions[3,4] (lb/hr)	Potential Annual Emissions[3,4] (tpy)
Acenaphthene	83-32-9	Yes - PAH	No	9.10E-07	--	8.54E-06	3.74E-05
Acenaphthylene	208-96-8	Yes - PAH	No	5.00E-06	--	4.69E-05	2.06E-04
Acetaldehyde	75-07-0	Yes	Yes	8.30E-04	8.29E-03	5.67E-01	2.06E+00
Acrolein	107-02-8	Yes	Yes	--	3.55E-03	2.43E-01	8.82E-01
Anthracene	120-12-7	Yes - PAH	No	3.00E-06	--	2.82E-05	1.23E-04
Benzo(a)anthracene	56-55-3	Yes - PAH	Yes	6.50E-08	--	6.10E-07	2.67E-06
Benzene	71-43-2	Yes	Yes	4.20E-03	--	3.94E-02	1.73E-01
Benzo(a)pyrene	50-32-8	Yes - PAH	Yes	2.60E-06	--	2.44E-05	1.07E-04
Benzo(b)fluoranthene	205-99-2	Yes - PAH	Yes	1.00E-07	--	9.39E-07	4.11E-06
Benzo(g,h,i)perylene	191-24-2	Yes - PAH	No	9.30E-08	--	8.73E-07	3.82E-06
Benzo(k)fluoranthene	207-08-9	Yes - PAH	Yes	3.60E-08	--	3.38E-07	1.48E-06
Chrysene	218-01-9	Yes - PAH	No	3.80E-08	--	3.57E-07	1.56E-06
Dibenzo(a,h)anthracene	53-70-3	Yes - PAH	Yes	9.10E-09	--	8.54E-08	3.74E-07
Fluoranthene	206-44-0	Yes - PAH	No	1.60E-06	--	1.50E-05	6.58E-05
Fluorene	86-73-7	Yes - PAH	No	3.40E-06	--	3.19E-05	1.40E-04
Formaldehyde	50-00-0	Yes	Yes	4.40E-03	2.09E-02	1.43E+00	5.17E+00
Hydrochloric Acid	7647-01-0	Yes	Yes	--	2.61E-03	1.78E-01	6.46E-01
Indeno(1,2,3,c,d)pyrene	193-39-5	Yes - PAH	Yes	8.70E-08	--	8.16E-07	3.58E-06
Methanol	67-56-1	Yes	Yes	--	3.74E-02	2.56E+00	9.29E+00
Naphthalene	91-20-3	Yes - PAH	Yes	9.70E-05	--	9.10E-04	3.99E-03
Octachlorodibenzo-p-dioxins (2,3,7,8 TCDD Eqv.)[5]	3268-87-9	No	No	6.60E-08	--	1.86E-10	8.14E-10
Pentachlorodibenzo-p-dioxins (2,3,7,8 TCDD Eqv.)[5]	40321-76-4	No	No	1.50E-09	--	1.41E-08	6.17E-08
Phenanthrene	85-01-8	Yes - PAH	No	7.00E-06	--	6.57E-05	2.88E-04
Phenol	108-95-2	Yes	Yes	--	1.61E-02	1.10E+00	4.00E+00
Propionaldehyde	123-38-6	Yes	Yes	--	2.37E-03	1.62E-01	5.88E-01
Pyrene	129-00-0	Yes - PAH	No	3.70E-06	--	3.47E-05	1.52E-04
Arsenic	7440-38-2	Yes	Yes	2.20E-05	--	2.06E-04	9.04E-04
Beryllium	7440-41-7	Yes	Yes	1.10E-06	--	1.03E-05	4.52E-05
Cadmium	7440-43-9	Yes	Yes	4.10E-06	--	3.85E-05	1.69E-04
Chromium, Total	7440-47-3	Yes	Yes	2.10E-05	--	1.97E-04	8.63E-04
Chromium, Hexavalent[6]	18540-29-9	No	Yes	3.50E-06	--	3.28E-05	1.44E-04
Copper	7440-50-8	No	Yes	4.90E-05	--	4.60E-04	2.01E-03
Manganese	7439-96-5	Yes	Yes	1.60E-03	--	1.50E-02	6.58E-02
Mercury	7439-97-6	Yes	Yes	3.50E-06	--	6.57E-04	2.88E-03
Nickel	7440-02-0	Yes	Yes	3.30E-05	--	3.10E-04	1.36E-03
Selenium	7782-49-2	Yes	Yes	2.80E-06	--	2.63E-05	1.15E-04
Zinc	7440-66-6	No	No	4.20E-04	--	3.94E-03	1.73E-02
						Total HAP	**22.88**
						Maximum Individual HAP	**9.29**

[1] Emission factors for biomass (wood residue) combustion are uncontrolled and from AP-42, Section 1.6 (Wood Residue Combustion), Tables 1.6-3 and 1.6-4. Pollutants with an emission factor rating of C, D, or E are not included.

[2] Emission factors obtained from Drax ABE facility in Gloster, MS stack testing. Maximum emission factors in lbs/ODT from 2018 and 2021 stack testing. A 25% safety factor has been included for conservatism.

[3] Organic TAP are controlled by RTO. Control efficiency is provided by LDX Solutions for VOC compounds as: 95%

[4] TAP emitted as PM are controlled by WESP. A minimum control efficiency according to an EPA Air Pollution Control Technology Fact Sheet on WESP is: 95%

Because mercury is a liquid at ambient temperature, it is not emitted in the form of PM. Therefore, it is uncontrolled.

[5] Dioxin and furan emissions apply a toxic equivalency (TEQ) factor obtained from the 72 FR 26545 in accordance with the 1998 TAP rule WAC 173-460-050(4)(b) adopted by SWCAA. Emissions shown in this table are expressed as an equivalent emissions of 2,3,7,8 TCDD. https://www.govinfo.gov/content/pkg/FR-2007-05-10/pdf/E7-9015.pdf

Octachlorodibenzo-p-dioxins TEQ:	0.0003
Pentachlorodibenzo-p-dioxins TEQ:	1

[6] Because the emission factor for "Chromium, Total" has an "A" rating and it is likely that a portion is in the form of hexavalent chromium, it conservative to use the emission factor for "Chromium, Hexavalent" even though it has a "C" rating.

Table C-4a. RTO Burner Operating Parameters

Parameter		Units
Unit Heat Input	8.8	MMBtu/hr
Natural Gas Heating Value[1]	1,020	MMBtu/MMscf
Annual Operation	8,760	hr/yr
Potential Annual Fuel Usage[2]	75.6	MMscf/yr

[1] Natural Gas HHV is the average from the range listed in AP-42, Section 1.4.

[2] Potential Annual Fuel Usage calculated as follows:
Annual Fuel Usage (MMscf/yr) = Heat Input (MMBtu/hr) / Natural Gas HHV (MMBtu/MMscf) x Annual Operation (hr/yr)

Table C-4b. RTO Potential Emissions - Criteria Pollutants

Pollutant[1]	Natural Gas Uncontrolled Emission Factor (lb/MMscf)	Maximum Hourly Emissions (lb/hr)	Potential Annual Emissions (tpy)
Total PM	--	--	--
PM_{10}	--	--	--
$PM_{2.5}$	--	--	--
SO_2	0.6	5.18E-03	2.27E-02
NO_X	--	--	--
VOC	--	--	--
CO	--	--	--
CH_4	2.3	1.98E-02	8.69E-02
N_2O	2.2	1.90E-02	8.31E-02
CO_2	120,000	1035	4535
CO_2e[2]	120,713	1041	4562

[1] Uncontrolled emission factors for natural gas combustion from AP-42, Section 1.4 - Natural Gas Combustion, Table 1.4-1, 1.4-2, 1.4-3, and 1.4-4. Emissions for CO, NO_X, VOC, and PM from the RTO are included in the dryer calculations.

[2] Global warming potential (GWP) for CH_4 is 25 and N_2O is 298 for estimating CO_2e emissions (40 CFR 98, Subpart A, Table A-1, effective January 1, 2014).

Table C-4c. RTO Potential Emissions - HAP/TAP

Pollutant	CAS #	HAP?	TAP?	Natural Gas Uncontrolled Emission Factor[1] (lb/MMscf)	Maximum Hourly Emissions [2] (lb/hr)	Potential Annual Emissions [2] (tpy)
Benzene	71-43-2	Yes	Yes	2.10E-03	1.81E-05	7.94E-05
Formaldehyde	50-00-0	Yes	Yes	7.50E-02	6.47E-04	2.83E-03
					Total HAP	**2.91E-03**
					Maximum Individual HAP	**2.83E-03**

[1] Uncontrolled emission factors for natural gas combustion from AP-42, Section 1.4 - Natural Gas Combustion, Table 1.4-1, 1.4-2, 1.4-3, and 1.4-4. Pollutants with an emission factor rating of C, D, or E are not included.

Table C-5a. RCO Burner Operating Parameters

Parameter		Units
Unit Heat Input	2.2	MMBtu/hr
Natural Gas Heating Value[1]	1,020	MMBtu/MMscf
Annual Operation	8,760	hr/yr
Potential Annual Fuel Usage[2]	18.9	MMscf/yr

[1] Natural Gas HHV is the average from the range listed in AP-42, Section 1.4.

[2] Potential Annual Fuel Usage calculated as follows:
Annual Fuel Usage (MMscf/yr) = Heat Input (MMBtu/hr) / Natural Gas HHV (MMBtu/MMscf) x Number of Burners x Annual Operation (hr/yr)

Table C-5b. RCO Potential Emissions - Criteria Pollutants

Pollutant	Natural Gas Uncontrolled Emission Factor[1] (lb/MMscf)	Maximum Hourly Emissions (lb/hr)	Potential Annual Emissions (tpy)
Total PM	7.6	0.02	0.07
PM_{10}	7.6	0.02	0.07
$PM_{2.5}$	7.6	0.02	0.07
SO_2	0.6	1.29E-03	5.67E-03
NO_X	100	0.22	0.94
VOC	5.5	0.01	0.05
CO	84	0.18	0.79
CH_4	2.3	4.96E-03	0.02
N_2O	2.2	4.75E-03	0.02
CO_2	120,000	259	1134
CO_2e[2]	120,713	260	1140

[1] PM is equal to the sum of PM (condensable) and PM (filterable). PM_{10} and $PM_{2.5}$ are conservatively assumed to be equivalent to PM.

[2] Global warming potential (GWP) for CH_4 is 25 and N_2O is 298 for estimating CO_2e emissions (40 CFR 98, Subpart A, Table A-1, effective January 1, 2014).

Table C-5c. RCO Potential Emissions - HAP/TAP

Pollutant	CAS #	HAP?	TAP?	Natural Gas Uncontrolled Emission Factor[1] (lb/MMscf)	Maximum Hourly Emissions [2] (lb/hr)	Potential Annual Emissions [2] (tpy)
Benzene	71-43-2	Yes	Yes	2.10E-03	4.53E-06	1.98E-05
Formaldehyde	50-00-0	Yes	Yes	7.50E-02	1.62E-04	7.09E-04
					Total HAP	**7.28E-04**
					Maximum Individual HAP	**7.09E-04**

[1] Uncontrolled emission factors for natural gas combustion from AP-42, Section 1.4 - Natural Gas Combustion, Table 1.4-1, 1.4-2, 1.4-3, and 1.4-4. Pollutants with an emission factor rating of C, D, or E are not included.

Table C-6a. Hammermill Potential Emissions - VOC

EU ID	Emission Unit	Control Device	Potential Hourly Throughput (ODT/hr)	Potential Annual Throughput (ODT/yr)	Controlled VOC Emission Factor[1] (lb/ODT)	Potential Controlled VOC Emissions[2] (tpy)
HM1	Hammermill No. 1	RCO	82.67	496,040	7.09E-02	17.57
HM2	Hammermill No. 2					
HM3	Hammermill No. 3					
HM4	Hammermill No. 4					
					Total Emissions	**17.57**

[1] The hammermill VOC emission factor is the average value from 2013/2014 engineering testing performed on the Dry Classizizer units at the Pinnacle Aliceville facility (formerly Westervelt Aliceville). A 25% safety factor has been included for conservatism.

[2] Potential Emissions (tpy) = Emission Factor (lb/short ton) x Potential Annual Throughput (tpy) / 2000 (lb/short ton)

Table C-6b. Hammermill Potential Emissions - PM

EU ID	Emission Unit	Control Device	Potential Operation[1]	Exit Temperature	Exhaust Flow Rate[2]		Loading Rate[3]	Total PM[4]		Total PM_{10}[4,5]		Total $PM_{2.5}$[4,5]	
			(hr/yr)	(°F)	(acfm)	(scfm)	(gr./dscf)	(lb/hr)	(tpy)	(lb/hr)	(tpy)	(lb/hr)	(tpy)
HM1	Hammermill No. 1	Baghouse	8,760	122	44,200	40,074	0.005	1.72	7.52	1.72	7.52	1.72	7.52
HM2	Hammermill No. 2												
HM3	Hammermill No. 3												
HM4	Hammermill No. 4												
							Total Emissions	**1.72**	**7.52**	**1.72**	**7.52**	**1.72**	**7.52**

[1] Potential operation assumed to be continuous.

[2] Exhaust flow rate (scfm) estimated for all hammermills. Exhaust flow converted to acfm assuming 50°C exhaust temperatures at 1 atm, with standard temperature of 68 °F.

[3] The grain loading rate is based on the BACT determination for dust collectors.

[4] Emissions of PM and PM_{10} are assumed to be equal to emissions of $PM_{2.5}$. These emissions are included as a conservative measure, as all of the particulate matter emitted is expected to be less than 2.5 microns.

[5] Potential hourly PM emissions (lb/hr) = Exhaust Grain Loading Rate (gr./dscf) x Exhaust Air Flow Rate (dscf/min) x (60 min/hr) x (lb/7,000 gr.)

Table C-6c. Hammermill Potential Emissions - HAP/TAP

Pollutant	CAS #	HAP?	TAP?	ABE Stack Test Factors[1] (lb/ODT)	Maximum Hourly Emissions (lb/hr)	Potential Annual Emissions (tpy)
Acetaldehyde	75-07-0	Yes	Yes	2.18E-03	1.80E-01	5.41E-01
Acrolein	107-02-8	Yes	Yes	8.18E-04	6.76E-02	2.03E-01
Formaldehyde	50-00-0	Yes	Yes	2.09E-03	1.73E-01	5.18E-01
Hydrochloric Acid	7647-01-0	Yes	Yes	4.54E-04	3.76E-02	1.13E-01
Methanol	67-56-1	Yes	Yes	2.42E-02	2.00E+00	5.99E+00
Phenol	108-95-2	Yes	Yes	1.31E-02	1.08E+00	3.24E+00
Propionaldehyde	123-38-6	Yes	Yes	2.00E-03	1.65E-01	4.96E-01
					Total HAP	**11.11**
					Maximum Individual HAP	**5.99**

[1] Emission factors obtained from the Drax facility in Gloster, MS (ABE) stack testing. Maximum emission factors in lbs/ODT obtained from 2018 and 2021 stack testing. The ABE facility routes emissions from both the hammermill and pelletizer to the RCO similar to the proposed Longview facility. The emission factors are divided by 2 to represent half of the RCO emissions for each piece of equipment. A 25% safety factor has been included for conservatism.

Table C-7a. Pelletizing Potential Emissions - VOC

EU ID	Emission Unit	Control Device	Potential Hourly Pellet Throughput (ODT/hr)	Potential Annual Pellet Throughput (ODT/yr)	Controlled VOC Emission Factor[1] (lb/ODT)	Potential Controlled VOC Emissions[2] (tpy)
PC1	Pelletizer No. 1	RCO	82.45	496,040	7.09E-02	17.57
PC2	Pelletizer No. 2					
PC3	Pelletizer No. 3					
PC4	Pelletizer No. 4					
PC5	Pelletizer No. 5					
PC6	Pelletizer No. 6					
PC7	Pelletizer No. 7					
PC8	Pelletizer No. 8					
PC9	Pelletizer No. 9					
PC10	Pelletizer No. 10					
PC11	Pelletizer No. 11					
					Total Emissions	**17.57**

[1] The pellet cooler VOC emission factor is the average value from 2013/2014 engineering testing performed on the Dry Classizer units at the Pinnacle Aliceville facility (formerly Westervelt Aliceville). A 25% safety factor has been included for conservatism.

[2] Potential Emissions (tpy) = Emission Factor (lb/short ton) x Potential Annual Throughput (tpy) / 2000 (lb/short ton)

Table C-7b. Pelletizing Potential Emissions - PM

EU ID	Emission Unit	Control Device	Potential Operation[1] (hr/yr)	Exit Temperature (°F)	Exhaust Flow Rate[2] (acfm)	Exhaust Flow Rate[2] (scfm)	Loading Rate[3] (gr./dscf)	Total PM[4,5] (lb/hr)	Total PM[4,5] (tpy)	Total PM_{10}[4,5] (lb/hr)	Total PM_{10}[4,5] (tpy)	Total $PM_{2.5}$[4,5] (lb/hr)	Total $PM_{2.5}$[4,5] (tpy)
PC1	Pelletizer No. 1	Baghouse	8,760	122	76,000	68,905	0.005	2.95	12.93	2.95	12.93	2.95	12.93
PC2	Pelletizer No. 2												
PC3	Pelletizer No. 3												
PC4	Pelletizer No. 4												
PC5	Pelletizer No. 5												
PC6	Pelletizer No. 6												
PC7	Pelletizer No. 7												
PC8	Pelletizer No. 8												
PC9	Pelletizer No. 9												
PC10	Pelletizer No. 10												
PC11	Pelletizer No. 11												
							Total Emissions	**2.95**	**12.93**	**2.95**	**12.93**	**2.95**	**12.93**

[1] Potential operation assumed to be continuous.

[2] Exhaust flow rate (scfm) estimated for all pellet coolers. Exhaust flow converted to acfm assuming 50°C exhaust temperatures at 1 atm, with standard temperature of 68 °F.

[3] The grain loading rate is based on the BACT determination for dust collectors.

[4] Emissions of PM and PM_{10} are assumed to be equal to emissions of $PM_{2.5}$. These emissions are included as a conservative measure, as all of the particulate matter emitted is expected to be less than 2.5 microns.

[5] Potential hourly PM emissions (lb/hr) = Exhaust Grain Loading Rate (gr./dscf) x Exhaust Air Flow Rate (dscf/min) x (60 min/hr) x (lb/7,000 gr.)

Table C-7c. Hammermill Potential Emissions - HAP/TAP

Pollutant	CAS #	HAP?	TAP?	ABE Stack Test Factors[1] (lb/ODT)	Maximum Hourly Emissions (lb/hr)	Potential Annual Emissions (tpy)
Acetaldehyde	75-07-0	Yes	Yes	2.18E-03	1.80E-01	5.41E-01
Acrolein	107-02-8	Yes	Yes	8.18E-04	6.74E-02	2.03E-01
Formaldehyde	50-00-0	Yes	Yes	2.09E-03	1.72E-01	5.18E-01
Hydrochloric Acid	7647-01-0	Yes	Yes	4.54E-04	3.75E-02	1.13E-01
Methanol	67-56-1	Yes	Yes	2.42E-02	1.99E+00	5.99E+00
Phenol	108-95-2	Yes	Yes	1.31E-02	1.08E+00	3.24E+00
Propionaldehyde	123-38-6	Yes	Yes	2.00E-03	1.65E-01	4.96E-01
					Total HAP	**11.11**
					Maximum Individual HAP	**5.99**

[1] Emission factors obtained from the Drax facility in Gloster, MS (ABE) stack testing. Maximum emission factors in lbs/ODT obtained from 2018 and 2021 stack testing. The ABE facility routes emissions from both the hammermill and pelletizer to the RCO similar to the proposed Longview facility. The emission factors are divided by 2 to represent half of the RCO emissions for each piece of equipment. A 25% safety factor has been included for conservatism.

Table C-8. Miscellaneous Sources Potential Emissions - PM

EU ID	Emission Unit[1]	Potential Annual Throughput (ODT/yr)	Emission Factor[2,3] PM (lb/ton)	PM_{10} (lb/ton)	$PM_{2.5}$ (lb/ton)	Potential Emissions PM (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)
BIO	Biosizer/Scalper	496,040	1.1E-05	5.1E-06	7.8E-07	5.37E-03	2.54E-03	3.85E-04
DCS	Dry Chip Storage Tent	496,040	2.1E-04	1.0E-04	1.5E-05	5.56E-02	2.63E-02	3.98E-03
PSS1	Pellet Storage Silo 1	248,020	2.7E-04	1.3E-04	1.9E-05	3.55E-02	1.68E-02	2.54E-03
PSS2	Pellet Storage Silo 2	248,020	2.7E-04	1.3E-04	1.9E-05	3.55E-02	1.68E-02	2.54E-03
SLS	Ship Loadout System	496,040	2.7E-04	1.3E-04	1.9E-05	7.10E-02	3.35E-02	5.07E-03

[1] Total throughput at the facility is quantified in ODT/yr. To represent as-processed throughput weight, the value is adjusted based on moisture content specific to the process associated with the emission unit. All throughput will either go through the biosizer or a scalper so emissions from these process units are only quantified once.

[2] Emissions calculated using emission factor determined according to AP-42 Section 13.2.4 for aggregate handling and storage piles.

E (lb/ton) = $k\ (0.0032) \times (U/5)^{1.3}/(M/2)^{1.4}$

0.74 = k, PM size multiplier

0.35 = k, PM_{10} size multiplier

0.053 = k, $PM_{2.5}$ size multiplier

2.54 = U, mean wind speed (m/s) (average from 2007-2015) in Longview

50 = M, estimate for moisture content (%) of incoming material as described in manufacturer's proposal for RTO operation

6 = M, estimate for moisture content (%) of dry chips

5 = M, estimate for moisture content (%) of dry, finished product

[3] The VOC emission factor for chip storage in EPA AP-42 10.6.3, Table 10.6.3-7 is listed as "no data available"; therefore emissions are not quantified.

Table C-9. Paved Road Potential Emissions - PM

Paved Truck Route	PM Emission Factor, E [1] (lb/VMT)	PM_{10} Emission Factor, E [1] (lb/VMT)	$PM_{2.5}$ Emission Factor, E [1] (lb/VMT)	Maximum Loads Per Hour [2]	Maximum Loads Per Year [2]	Truck Route Maximum Round Trip Distance (mi)	Vehicle Miles Traveled per Hour (VMT/hr)	Vehicle Miles Traveled per Year (VMT/yr)	PM Emissions [3] (tpy)	PM_{10} Emissions [3] (tpy)	$PM_{2.5}$ Emissions [3] (tpy)
Between wet material stockpiles and process drop point	0.25	0.049	0.012	24.8	180,000	0.124	3.1	22,369	2.39	0.48	0.12

[1] Emission factor E is calculated according to AP-42 Section 13.2.1 for emissions from paved roads, equation 1:

E (lbs/VMT) = Paved Road Emission Factor, [$k * (sL)^{0.91} * (W)^{1.02}$]

0.011 = k, PM size multiplier (lb/VMT) from AP-42 Table 13.2.1-1.

0.0022 = k, PM_{10} size multiplier (lb/VMT) from AP-42 Table 13.2.1-1.

0.00054 = k, $PM_{2.5}$ size multiplier (lb/VMT) from AP-42 Table 13.2.1-1.

1.1 = sL, roadway surface silt loading (g/m^2) AP-42 13.2.1, Table 13-2.1-3. The silt loading value for corn wet mills is used because the wet material stockpile is expected to store materials with a similar texture and moisture content.

19.26 = W, average truck weight (tons)

[2] Vehicles per hour and vehicles per year are based on truck capacity and pile throughput values:

Truck Capacity: 5.51 tons

Max Hourly Throughput: 137 tons/hr

Max Annual Throughput: 992,080 tons/yr

[3] Emissions account for natural mitigation due to precipitation according to AP-42 Section 13.2.1 equation 2:

Annual emissions (tpy) = E * (1-P/4N)*[VMT/yr]/[lb/ton]

185.8 = P, mean number of days per year with measurable precipitation for Longview station, NOAA National Centers for Environmental Information 1981-2010 Climate Normals data

365 = N, number of days in period for annual rainfall mitigation effect

[4] Truck weight and vehicle capacity were provided to by Drax to Trinity via email on March 6, 2020.

Truck Weight: 33000 lb

Vehicle Capacity: 5 ODMT

Table C-10a. Material Handling Potential Emissions - PM

Pile	Throughput [1] (tons/hr)	(tons/yr)	PM Emissions [2] (lb/hr)	(tpy)	PM_{10} Emissions [2] (lb/hr)	(tpy)	$PM_{2.5}$ Emissions [2] (lb/hr)	(tpy)
Wet Material Stockpiles	137	992,080	1.48E-03	5.37E-03	7.00E-04	2.54E-03	1.06E-04	3.85E-04

[1] Maximum pile throughput is based on a total pellet production rate of 62 metric tonnes per hour and 450,000 metric tonnes per year, scaled by a factor of 2 to account for the additional weight of the material being stored wet.

[2] Emissions calculated using emission factor determined according to AP-42 Section 13.2.4 for aggregate handling and storage piles.

$$E\ (\text{lb/VMT}) = k\ (0.0032) \times (U/5)^{1.3}/(M/2)^{1.4}$$

0.74 = k, PM size multiplier

0.35 = k, PM_{10} size multiplier

0.053 = k, $PM_{2.5}$ size multiplier

2.54 = U, mean wind speed (m/s) (average from 2007-2015) in Longview

50 = M, estimate for moisture content (%) of incoming material as described in manufacturer's proposal for RTO operation

Table C-10b. Pile Wind Erosion Potential Emissions - PM

Pile	Area [1] (acres)	PM Emissions [2] (lb/hr)	(tpy)	PM_{10} Emissions [3] (lb/hr)	(tpy)	$PM_{2.5}$ Emissions [3] (lb/hr)	(tpy)
Wet Material Stockpiles	2.52	0.08	0.37	0.040	0.18	0.0061	0.027

[1] The wet material stockpiles are located on the north side of the facility in a conical shape. There will be two wet fiber storage piles and one hog storage pile. The three piles are expected to have similar dimensions. The pile diameters and heights were provided by Drax in a call on 3/7/2022.

[2] PM Emissions are calculated using emission factors determined according to Equation 2-12 from the EPA document "Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures" dated 9/1992.

$$e_{TSP}\ (\text{lb/acre-day}) = 1.7 * (s/1.5) * [\ (365-p) / 235\ ] * (f/15)$$

1 = s, silt content

185.8 = p, number of days with ≥ 0.01 in. precipitation per year

14.01 = f, percentage of time that the unobstructed wind speed exceeds 5.4 m/s (12 mph) at the mean pile height

[3] PM_{10} and $PM_{2.5}$ emissions are determined based on PM emissions using the ratios of the particle size multipliers for each particle size provided for Equation 1 in AP-42 Section 13.2.4.

Table C-12. Truck Tipping Potential Emissions - PM

EU ID	Emission Unit	Control Device	Potential Operation[1] (hr/yr)	Exit Temperature (°F)	Exhaust Flow Rate[2] (acfm)	Exhaust Flow Rate[2] (scfm)	Loading Rate[3] (gr./dscf)	Total PM[4] (lb/hr)	Total PM[4] (tpy)	Total PM_{10}[4,5] (lb/hr)	Total PM_{10}[4,5] (tpy)	Total $PM_{2.5}$[4,5] (lb/hr)	Total $PM_{2.5}$[4,5] (tpy)
BAG2	Truck Tipper	Baghouse	8,760	150	27,700	23,961	0.002	0.41	1.80	0.41	1.80	0.41	1.80
							Total Emissions	**0.41**	**1.80**	**0.41**	**1.80**	**0.41**	**1.80**

[1] Potential operation assumed to be continuous.

[2] Exhaust flow converted to scfm assuming 150°F exhaust temperatures at 1 atm, with standard temperature of 68°F.

[3] Exit temperature, exhaust flow rate, and loading rate obtained from vendor guarantee.

[4] Emissions of PM and PM_{10} are assumed to be equal to emissions of $PM_{2.5}$. These emissions are included as a conservative measure, as all of the particulate matter emitted is expected to be less than 2.5 microns.

[5] Potential hourly PM emissions (lb/hr) = Exhaust Grain Loading Rate (gr/dscf) x Exhaust Air Flow Rate (dscf/min) x (60 min/hr) x (lb/7,000 gr.)

Table C-11a. ULSD-Fired Emergency Engines Operating Parameters

EU ID	Emission Unit	Potential Operation (hr/yr)	Rated Engine Capacity (bhp)	(bkw)
ENG1	625 kW Emergency Generator	125	838	625
FWP1	164 kW Fire Pump Engine	125	220	164

Table C-11b. ULSD-Fired Emergency Engines Potential Emissions - Criteria Pollutants

Pollutant	Diesel Industrial Engines AP-42 Emission Factor[1] (lb/MMBtu)	Large Stationary Diesel Engines AP-42 Emission Factor[1] (lb/MMBtu)	FWP1 Emissions[2,3,4]		ENG1 Emissions[2,3,4]	
			(lb/hr)	(tpy)	(lb/hr)	(tpy)
Total PM	--	--	7.23E-03	4.52E-04	0.03	1.72E-03
Total PM_{10}	--	--	7.23E-03	4.52E-04	0.03	1.72E-03
Total $PM_{2.5}$	--	--	7.23E-03	4.52E-04	0.03	1.72E-03
SO_2	0.29	1.52E-03	0.45	0.03	0.01	5.55E-04
NO_X	4.41	3.20	6.79	0.42	18.77	1.17
VOC	0.36	0.09	0.55	0.03	0.53	0.03
CO	0.95	0.85	1.46	0.09	4.99	0.31
CO_2e[5]	165.20	165.60	254.41	15.90	971.39	60.71

[1] Emission factors for diesel industrial engines from AP-42, Table 3.3-1. Emission factors for large stationary diesel engines from AP-42, Table 3.4-1 and Table 3.4-2. HAP/TAP Pollutants with an emission factor rating of C, D, or E are not included.

[2] PM emissions for both units are estimated using Tier II EPA standards (0.20 g/kW-hr) for nonroad compression-ignition engines. Factors are given in units of g/kW-hr and are converted to lb/hr.

[3] An example of annual emissions calculations are shown below:

Emission Factor (lb/MMBtu) x Fuel Factor (MMBtu/bhp-hr) x Rated Capacity (bhp) x Annual Operation (hr/yr) / 2,000 (lb/ton)

Fuel Factor (MMBtu/bhp-hr) = 0.007

[4] Diesel particulate filters will be added to each emergency engine and will provide the following control efficiency for particulate matter: 90%

[5] CO_2 and CH_4 emission factors are from AP-42, Table 3.3-1. N_2O emission factor is from 40 CFR 98, Subpart C, Table C-2. Global warming potential (GWP) for CH_4 is 25 and N_2O is 298 for estimating CO_2e emissions (40 CFR 98, Subpart A, Table A-1).

Table C-13a. Biomass Rotary Dryer Abort Parameters

Parameter	Value	Units
Max Hourly Throughput	68.3	ODT/hr
Maximum Heat Input[1]	187.7	MMBtu/hr
Wood and Wood Residuals Heating Value[2]	17.48	MMBtu/ODT
Maximum Annual Operation	50	hr/yr

[1] Dryer abort heat input is assumed to be 100% of the maximum heat input for the unit.

[2] Wood and wood residuals heating value provided in 40 CFR Appendix Table C-1 to Subpart C of Part 98.

Table C-13b. Biomass Rotary Dryer Abort Potential Emissions - Criteria Pollutants

Pollutant	Maximum Hourly Emissions[1] (lb/hr)	Potential Annual Emissions (tpy)
PM	100.00	2.50
PM_{10}	100.00	2.50
$PM_{2.5}$	100.00	2.50
SO_2 [2]	4.69	0.12
NO_X	52.00	1.30
VOC	300.00	7.50
CO	42.00	1.05

[1] Hourly emission rates from the RTO stack are obtained from vendor guarantees provided by TSI on September 9th, 2022. Uncontrolled emissions for PM and VOC are backcalculated using the control efficiencies of the WESP and RTO provided by TSI.

WESP PM control efficiency:	95%
RTO VOC control efficiency:	95%

[2] SO_2 emissions estimated using AP-42 Table 1.6-2 for Wood Residue Combustion. Emission factor is given in lb/MMBtu and converted to lbs/hr using the maximum heat input of the furnace.

Table C-13c. Biomass Rotary Dryer Abort Potential Emissions - GHG

Fuel	Wood Drying CO_2 Emission Factor [1] (lb/ODT)	CO_2 Emissions (tpy)
Wood & wood residuals	720	1,230

[1] Wood drying emission factors for CO_2 are from AP-42 Table 10.6.1-2.

Table C-13d. Biomass Rotary Dryer Abort Potential Emissions - HAP/TAP

Pollutant	CAS #	HAP?	TAP?	Biomass Combustion Emission Factor[1] (lb/MMBtu)	ABE Stack Test Factors[2] (lb/ODT)	Maximum Hourly Emissions (lb/hr)	Potential Annual Emissions (tpy)
Acenaphthene	83-32-9	Yes - PAH	No	9.10E-07	--	1.71E-04	4.27E-06
Acenaphthylene	208-96-8	Yes - PAH	No	5.00E-06	--	9.39E-04	2.35E-05
Acetaldehyde	75-07-0	Yes	Yes	8.30E-04	1.66E-01	1.13E+01	2.83E-01
Acrolein	107-02-8	Yes	Yes	--	7.11E-02	4.86E+00	1.21E-01
Anthracene	120-12-7	Yes - PAH	No	3.00E-06	--	5.63E-04	1.41E-05
Benzo(a)anthracene	56-55-3	Yes - PAH	Yes	6.50E-08	--	1.22E-05	3.05E-07
Benzene	71-43-2	Yes	Yes	4.20E-03	--	7.88E-01	1.97E-02
Benzo(a)pyrene	50-32-8	Yes - PAH	Yes	2.60E-06	--	4.88E-04	1.22E-05
Benzo(b)fluoranthene	205-99-2	Yes - PAH	Yes	1.00E-07	--	1.88E-05	4.69E-07
Benzo(g,h,i)perylene	191-24-2	Yes - PAH	No	9.30E-08	--	1.75E-05	4.36E-07
Benzo(k)fluoranthene	207-08-9	Yes - PAH	Yes	3.60E-08	--	6.76E-06	1.69E-07
Chrysene	218-01-9	Yes - PAH	No	3.80E-08	--	7.13E-06	1.78E-07
Dibenzo(a,h)anthracene	53-70-3	Yes - PAH	Yes	9.10E-09	--	1.71E-06	4.27E-08
Fluoranthene	206-44-0	Yes - PAH	No	1.60E-06	--	3.00E-04	7.51E-06
Fluorene	86-73-7	Yes - PAH	No	3.40E-06	--	6.38E-04	1.60E-05
Formaldehyde	50-00-0	Yes	Yes	4.40E-03	4.17E-01	2.85E+01	7.13E-01
Hydrochloric Acid	7647-01-0	Yes	Yes	--	5.21E-02	3.56E+00	8.91E-02
Indeno(1,2,3,c,d)pyrene	193-39-5	Yes - PAH	Yes	8.70E-08	--	1.63E-05	4.08E-07
Methanol	67-56-1	Yes	Yes	--	7.49E-01	5.12E+01	1.28E+00
Naphthalene	91-20-3	Yes - PAH	Yes	9.70E-05	--	1.82E-02	4.55E-04
Octachlorodibenzo-p-dioxins (2,3,7,8 TCDD Eqv.)[3]	3268-87-9	No	No	6.60E-08	--	3.72E-09	9.29E-11
Pentachlorodibenzo-p-dioxins (2,3,7,8 TCDD Eqv.)[3]	40321-76-4	No	No	1.50E-09	--	2.82E-07	7.04E-09
Phenanthrene	85-01-8	Yes - PAH	No	7.00E-06	--	1.31E-03	3.28E-05
Phenol	108-95-2	Yes	Yes	--	3.22E-01	2.20E+01	5.51E-01
Propionaldehyde	123-38-6	Yes	Yes	--	4.74E-02	3.24E+00	8.10E-02
Pyrene	129-00-0	Yes - PAH	No	3.70E-06	--	6.94E-04	1.74E-05
Arsenic	7440-38-2	Yes	Yes	2.20E-05	--	4.13E-03	1.03E-04
Beryllium	7440-41-7	Yes	Yes	1.10E-06	--	2.06E-04	5.16E-06
Cadmium	7440-43-9	Yes	Yes	4.10E-06	--	7.70E-04	1.92E-05
Chromium, Total	7440-47-3	Yes	Yes	2.10E-05	--	3.94E-03	9.85E-05
Chromium, Hexavalent[4]	18540-29-9	No	Yes	3.50E-06	--	6.57E-04	1.64E-05
Copper	7440-50-8	No	Yes	4.90E-05	--	9.20E-03	2.30E-04
Manganese	7439-96-5	Yes	Yes	1.60E-03	--	3.00E-01	7.51E-03
Mercury	7439-97-6	Yes	Yes	3.50E-06	--	6.57E-04	1.64E-05
Nickel	7440-02-0	Yes	Yes	3.30E-05	--	6.19E-03	1.55E-04
Selenium	7782-49-2	Yes	Yes	2.80E-06	--	5.26E-04	1.31E-05
Zinc	7440-66-6	No	No	4.20E-04	--	7.88E-02	1.97E-03
						Total HAP	**3.15**
						Maximum Individual HAP	**1.28**

[1] Emission factors for biomass (wood residue) combustion are uncontrolled and from AP-42, Section 1.6 (Wood Residue Combustion), Tables 1.6-3 and 1.6-4. Pollutants with an emission factor rating of C, D, or E are not included.

[2] Emission factors obtained from Drax ABE facility in Gloster, MS stack testing. Maximum emission factors in lbs/ODT from 2018 and 2021 stack testing. A 25% safety factor has been included for conservatism. Uncontrolled TAP emissions in the form of VOC are backcalculated using the control efficiencies of the RTO provided by TSI.

Control efficiency is provided by LDX Solutions for VOC compounds as: 95%

[3] Dioxin and furan emissions apply a toxic equivalency (TEQ) factor obtained from the 72 FR 26545 in accordance with the 1998 TAP rule WAC 173-460-050(4)(b) adopted by SWCAA. Emissions shown in this table are expressed as an equivalent emissions of 2,3,7,8 TCDD. https://www.govinfo.gov/content/pkg/FR-2007-05-10/pdf/E7-9015.pdf

Octachlorodibenzo-p-dioxins TEQ: 0.0003

Pentachlorodibenzo-p-dioxins TEQ: 1

[4] Because the emission factor for "Chromium, Total" has an "A" rating and it is likely that a portion is in the form of hexavalent chromium, it conservative to use the emission factor for "Chromium, Hexavalent" even though it has a "C" rating.

Table C-14a. Biomass Furnace Abort Parameters

Parameter	Value	Units
Maximum Heat Input[1]	187.7	MMBtu/hr
Maximum Annual Operation	360	hr/yr

[1] Furnace abort heat input is assumed to be 100% of the maximum heat input for the unit.

Table C-14b. Biomass Furnace Abort Potential Emissions - Criteria Pollutants

Pollutant	Emission Factors[1] (lb/MMBtu)	Maximum Hourly Emissions (lb/hr)	Potential Annual Emissions (tpy)
CO	0.60	112.62	20.27
NO_X	0.22	41.29	7.43
VOC	0.02	3.19	5.74E-01
Filterable PM	0.56	105.11	18.92
Condensable PM	0.02	3.19	5.74E-01
Total PM	0.58	108.30	19.49
Total PM_{10}	0.52	97.04	17.47
Total $PM_{2.5}$	0.45	83.90	15.10
SO_2	0.03	4.69	8.45E-01
Lead	4.80E-05	9.01E-03	1.62E-03
CH_4	0.02	3.94	7.10E-01
N_2O	0.01	2.44	4.39E-01
CO_2	195.00	36,602	6588.27
CO_2e[2]	199.40	37,427	6736.89

[1] Emission factors from AP-42 Section 1.6 (Wood Residue Combustion), Tables 1.6-1 through 1.6-4 (09/03).

[2] Global warming potential (GWP) for CH_4 is 25 and N_2O is 298 for estimating CO_2e emissions (40 CFR 98, Subpart A, Table A-1, effective January 1, 2014).

Table C-14c. Biomass Furnace Abort Potential Emissions - HAP/TAP

Pollutant	CAS #	HAP?	TAP?	Biomass Combustion Emission Factor[1] (lb/MMBtu)	Maximum Hourly Emissions (lb/hr)	Potential Annual Emissions (tpy)
Acenaphthene	83-32-9	Yes - PAH	No	9.10E-07	1.71E-04	3.07E-05
Acenaphthylene	208-96-8	Yes - PAH	No	5.00E-06	9.39E-04	1.69E-04
Acetaldehyde	75-07-0	Yes	Yes	8.30E-04	1.56E-01	2.80E-02
Anthracene	120-12-7	Yes - PAH	No	3.00E-06	5.63E-04	1.01E-04
Benzo(a)anthracene	56-55-3	Yes - PAH	Yes	6.50E-08	1.22E-05	2.20E-06
Benzene	71-43-2	Yes	Yes	4.20E-03	7.88E-01	1.42E-01
Benzo(a)pyrene	50-32-8	Yes - PAH	Yes	2.60E-06	4.88E-04	8.78E-05
Benzo(b)fluoranthene	205-99-2	Yes - PAH	Yes	1.00E-07	1.88E-05	3.38E-06
Benzo(g,h,i)perylene	191-24-2	Yes - PAH	No	9.30E-08	1.75E-05	3.14E-06
Benzo(k)fluoranthene	207-08-9	Yes - PAH	Yes	3.60E-08	6.76E-06	1.22E-06
Chrysene	218-01-9	Yes - PAH	No	3.80E-08	7.13E-06	1.28E-06
Dibenzo(a,h)anthracene	53-70-3	Yes - PAH	Yes	9.10E-09	1.71E-06	3.07E-07
Fluoranthene	206-44-0	Yes - PAH	No	1.60E-06	3.00E-04	5.41E-05
Fluorene	86-73-7	Yes - PAH	No	3.40E-06	6.38E-04	1.15E-04
Formaldehyde	50-00-0	Yes	Yes	4.40E-03	8.26E-01	1.49E-01
Indeno(1,2,3,c,d)pyrene	193-39-5	Yes - PAH	Yes	8.70E-08	1.63E-05	2.94E-06
Naphthalene	91-20-3	Yes - PAH	Yes	9.70E-05	1.82E-02	3.28E-03
Octachlorodibenzo-p-dioxins (2,3,7,8 TCDD Eqv.)[2]	3268-87-9	No	No	6.60E-08	3.72E-09	6.69E-10
Pentachlorodibenzo-p-dioxins (2,3,7,8 TCDD Eqv.)[2]	40321-76-4	No	No	1.50E-09	2.82E-07	5.07E-08
Phenanthrene	85-01-8	Yes - PAH	No	7.00E-06	1.31E-03	2.37E-04
Pyrene	129-00-0	Yes - PAH	No	3.70E-06	6.94E-04	1.25E-04
Arsenic	7440-38-2	Yes	Yes	2.20E-05	4.13E-03	7.43E-04
Beryllium	7440-41-7	Yes	Yes	1.10E-06	2.06E-04	3.72E-05
Cadmium	7440-43-9	Yes	Yes	4.10E-06	7.70E-04	1.39E-04
Chromium, Total	7440-47-3	Yes	Yes	2.10E-05	3.94E-03	7.10E-04
Chromium, Hexavalent[3]	18540-29-9	No	Yes	3.50E-06	6.57E-04	1.18E-04
Copper	7440-50-8	No	Yes	4.90E-05	9.20E-03	1.66E-03
Manganese	7439-96-5	Yes	Yes	1.60E-03	3.00E-01	5.41E-02
Mercury	7439-97-6	Yes	Yes	3.50E-06	6.57E-04	1.18E-04
Nickel	7440-02-0	Yes	Yes	3.30E-05	6.19E-03	1.11E-03
Selenium	7782-49-2	Yes	Yes	2.80E-06	5.26E-04	9.46E-05
Zinc	7440-66-6	No	No	4.20E-04	7.88E-02	1.42E-02
					Total HAP	**3.80E-01**
					Maximum Individual HAP	**1.49E-01**

1 Emission factors for biomass (wood residue) combustion are uncontrolled and from AP-42, Section 1.6 (Wood Residue Combustion), Tables 1.6-3 and 1.6-4. Pollutants with an emission factor rating of C, D, or E are not included.

2 Dioxin and furan emissions apply a toxic equivalency (TEQ) factor obtained from the 72 FR 26545 in accordance with the 1998 TAP rule WAC 173-460-050(4)(b) adopted by SWCAA. Emissions shown in this table are expressed as an equivalent emissions of 2,3,7,8 TCDD. https://www.govinfo.gov/content/pkg/FR-2007-05-10/pdf/E7-9015.pdf

Octachlorodibenzo-p-dioxins TEQ:	0.0003
Pentachlorodibenzo-p-dioxins TEQ:	1

3 Because the emission factor for "Chromium, Total" has an "A" rating and it is likely that a portion is in the form of hexavalent chromium, it conservative to use the emission factor for "Chromium, Hexavalent" even though it has a "C" rating.

Table C-15a. Biomass Furnace Idle Parameters

Parameter	Value	Units
Maximum Heat Input[1]	93.9	MMBtu/hr
Maximum Annual Operation	500	hr/yr

[1] Furnace abort heat input is assumed to be 50% of the maximum heat input for the unit based on operational data from other Drax facilities.

Table C-15b. Biomass Furnace Idle Potential Emissions - Criteria Pollutants

Pollutant	Emission Factors[1] (lb/MMBtu)	Maximum Hourly Emissions (lb/hr)	Potential Annual Emissions (tpy)
CO	0.60	56.31	14.08
NO_X	0.22	20.65	5.16
VOC	0.02	1.60	0.40
Filterable PM	0.56	52.56	13.14
Condensable PM	0.02	1.60	0.40
Total PM	0.58	54.15	13.54
Total PM_{10}	0.52	48.52	12.13
Total $PM_{2.5}$	0.45	41.95	10.49
SO_2	0.03	2.35	0.59
Lead	4.80E-05	4.50E-03	1.13E-03
CH_4	0.02	1.97	0.49
N_2O	0.01	1.22	0.31
CO_2	195.00	18,301	4575.19
CO_2e[2]	199.40	18,714	4678.40

[1] Emission factors from AP-42 Section 1.6 (Wood Residue Combustion), Tables 1.6-1 through 1.6-4 (09/03).

[2] Global warming potential (GWP) for CH_4 is 25 and N_2O is 298 for estimating CO_2e emissions (40 CFR 98, Subpart A, Table A-1, effective January 1, 2014).

Table C-15c. Biomass Furnace Idle Potential Emissions - HAP/TAP

Pollutant	CAS #	HAP?	TAP?	Biomass Combustion Emission Factor[1] (lb/MMBtu)	Maximum Hourly Emissions (lb/hr)	Potential Annual Emissions (tpy)
Acenaphthene	83-32-9	Yes - PAH	No	9.10E-07	8.54E-05	2.14E-05
Acenaphthylene	208-96-8	Yes - PAH	No	5.00E-06	4.69E-04	1.17E-04
Acetaldehyde	75-07-0	Yes	Yes	8.30E-04	7.79E-02	1.95E-02
Anthracene	120-12-7	Yes - PAH	No	3.00E-06	2.82E-04	7.04E-05
Benzo(a)anthracene	56-55-3	Yes - PAH	Yes	6.50E-08	6.10E-06	1.53E-06
Benzene	71-43-2	Yes	Yes	4.20E-03	3.94E-01	9.85E-02
Benzo(a)pyrene	50-32-8	Yes - PAH	Yes	2.60E-06	2.44E-04	6.10E-05
Benzo(b)fluoranthene	205-99-2	Yes - PAH	Yes	1.00E-07	9.39E-06	2.35E-06
Benzo(g,h,i)perylene	191-24-2	Yes - PAH	No	9.30E-08	8.73E-06	2.18E-06
Benzo(k)fluoranthene	207-08-9	Yes - PAH	Yes	3.60E-08	3.38E-06	8.45E-07
Chrysene	218-01-9	Yes - PAH	No	3.80E-08	3.57E-06	8.92E-07
Dibenzo(a,h)anthracene	53-70-3	Yes - PAH	Yes	9.10E-09	8.54E-07	2.14E-07
Fluoranthene	206-44-0	Yes - PAH	No	1.60E-06	1.50E-04	3.75E-05
Fluorene	86-73-7	Yes - PAH	No	3.40E-06	3.19E-04	7.98E-05
Formaldehyde	50-00-0	Yes	Yes	4.40E-03	4.13E-01	1.03E-01
Indeno(1,2,3,c,d)pyrene	193-39-5	Yes - PAH	Yes	8.70E-08	8.16E-06	2.04E-06
Naphthalene	91-20-3	Yes - PAH	Yes	9.70E-05	9.10E-03	2.28E-03
Octachlorodibenzo-p-dioxins (2,3,7,8 TCDD Eqv.)[2]	3268-87-9	No	No	6.60E-08	1.86E-09	4.65E-10
Pentachlorodibenzo-p-dioxins (2,3,7,8 TCDD Eqv.)[2]	40321-76-4	No	No	1.50E-09	1.41E-07	3.52E-08
Phenanthrene	85-01-8	Yes - PAH	No	7.00E-06	6.57E-04	1.64E-04
Pyrene	129-00-0	Yes - PAH	No	3.70E-06	3.47E-04	8.68E-05
Arsenic	7440-38-2	Yes	Yes	2.20E-05	2.06E-03	5.16E-04
Beryllium	7440-41-7	Yes	Yes	1.10E-06	1.03E-04	2.58E-05
Cadmium	7440-43-9	Yes	Yes	4.10E-06	3.85E-04	9.62E-05
Chromium, Total	7440-47-3	Yes	Yes	2.10E-05	1.97E-03	4.93E-04
Chromium, Hexavalent[3]	18540-29-9	No	Yes	3.50E-06	3.28E-04	8.21E-05
Copper	7440-50-8	No	Yes	4.90E-05	4.60E-03	1.15E-03
Manganese	7439-96-5	Yes	Yes	1.60E-03	1.50E-01	3.75E-02
Mercury	7439-97-6	Yes	Yes	3.50E-06	3.28E-04	8.21E-05
Nickel	7440-02-0	Yes	Yes	3.30E-05	3.10E-03	7.74E-04
Selenium	7782-49-2	Yes	Yes	2.80E-06	2.63E-04	6.57E-05
Zinc	7440-66-6	No	No	4.20E-04	3.94E-02	9.85E-03
					Total HAP	**2.64E-01**
					Maximum Individual HAP	**1.03E-01**

[1] Emission factors for biomass (wood residue) combustion are uncontrolled and from AP-42, Section 1.6 (Wood Residue Combustion), Tables 1.6-3 and 1.6-4. Pollutants with an emission factor rating of C, D, or E are not included.

[2] Dioxin and furan emissions apply a toxic equivalency (TEQ) factor obtained from the 72 FR 26545 in accordance with the 1998 TAP rule WAC 173-460-050(4)(b) adopted by SWCAA. Emissions shown in this table are expressed as an equivalent emissions of 2,3,7,8 TCDD. https://www.govinfo.gov/content/pkg/FR-2007-05-10/pdf/E7-9015.pdf

Octachlorodibenzo-p-dioxins TEQ:	0.0003
Pentachlorodibenzo-p-dioxins TEQ:	1

[3] Because the emission factor for "Chromium, Total" has an "A" rating and it is likely that a portion is in the form of hexavalent chromium, it conservative to use the emission factor for "Chromium, Hexavalent" even though it has a "C" rating.

Table C-16a. Criteria Pollutant Model Results - NAAQS Comparison

Pollutant	Averaging Period	Design Concentration	Modeled Concentration ($\mu g/m^3$)	Background Concentration ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Above NAAQS?
PM_{10}	24-hr	H2H	25.2	53.1	78	150	No
$PM_{2.5}$	24-hr	H8H	8.3	19.1	27.4	35	No
	annual	Average	1.3	6.2	7	12	No
SO_2	1-hr	H4H	16	14.2	31	196	No
NO_2	1-hr	H8H	100	20.6	120	188	No
	annual	Average	3.8	67.9	72	100	No
CO	1-hr	H2H	1,816	1,371	3,187	40,000	No
	8-hr	H2H	812	956	1,768	10,000	No

Table C-17a. TAP Pollutant Model Results - 1998 and 2019 ASIL Comparison

Model ID	Pollutant	CAS #	Averaging Period	ASIL (µg/m^3)		Results (µg/m^3)	Above ASIL?	
				1998	2019		1998	2019
Annual_1	Acetaldehyde	75-07-0	Annual	0.45	0.37	5.52E-02	No	No
Annual_2	Benzene	71-43-2	Annual	0.12	0.13	3.49E-03	No	No
Annual_3	Formaldehyde	50-00-0	Annual	7.70E-02	0.17	0.11	Yes	No
Annual_4	Arsenic	7440-38-2	Annual	2.30E-04	3.00E-04	1.83E-05	No	No
Annual_5	Beryllium	7440-41-7	Annual	4.20E-04	4.20E-04	9.13E-07	No	No
Annual_6	Cadmium	7440-43-9	Annual	5.60E-04	2.40E-04	3.41E-06	No	No
Annual_7	Chromium VI	18540-29-9	Annual	8.30E-05	4.00E-06	2.91E-06	No	No
Annual_8	Nickel	7440-02-0	Annual	2.10E-03	3.80E-03	2.74E-05	No	No
Annual_9	Total Dioxins/Furans (2,3,7,8 TCDD Eqv.)	136677-09-3	Annual	3.00E-08	--	1.26E-09	No	No
Annual_10	TAP Total Polycyclic Aromatic Hydrocarbons (TAP - PAH)	130498-29-2	Annual	4.80E-04	--	2.36E-06	No	No
Annual_11	Benzo(a)pyrene	50-32-8	Annual	4.80E-04	1.00E-03	2.16E-06	No	No
Annual_12	Naphthalene	91-20-3	Annual	--	0.03	8.07E-05	No	No
Annual_13	Pentachlorodibenzo-p-dioxins	40321-76-4	Annual	--	2.60E-08	1.24E-09	No	No
Annual_14	Diesel engine exhaust, particulate	200	Annual	--	0.0033	3.08E-03	No	No
24-hr_1	Propionaldehyde	123-38-6	24-hr	--	8.0	0.26	No	No
24-hr_2	Acrolein	107-02-8	24-hr	0.02	0.35	0.31	Yes	No
24-hr_3	Hydrochloric Acid	7647-01-0	24-hr	7.0	9.0	0.22	No	No
24-hr_4	Manganese	7439-96-5	24-hr	0.40	0.30	0.09	No	No
24-hr_5	Phenol	108-95-2	24-hr	63	200	1.72	No	No
24-hr_6	Methanol	67-56-1	24-hr	870	20,000	3.29	No	No
24-hr_7	Mercury	7439-97-6	24-hr	0.33	0.03	2.01E-04	No	No
24-hr_8	Chromium III	16065-83-1	24-hr	--	0.10	1.21E-03	No	No

Acetaldehyde			
Description	ABE Stack Test 11/28/2018	ABE Stack Test 7/13/21	Maximum Results
Regenerative Thermal Oxidizer		0.350	0.350

Formaldehyde			
Description	ABE Stack Test 11/28/2018	ABE Stack Test 7/13/21	Maximum Results
Regenerative Thermal Oxidizer	0.5575	0.880	0.880

Hydrochloric acid			
Description	ABE Stack Test 11/28/2018	ABE Stack Test 7/13/21	Maximum Results
Regenerative Thermal Oxidizer		0.110	0.110

Methanol			
Description	ABE Stack Test 11/28/2018	ABE Stack Test 7/13/21	Maximum Results
Regenerative Thermal Oxidizer		1.580	1.580

Stack Test Emissions				
Pollutants	ABE			
	RTO			
	°F	lb/hr	ODT/hr	lb/ODT
Acetaldehyde	1,676	0.350	52.75	6.64E-03
Acrolein	1,676	0.150	52.75	2.84E-03
Formaldehyde	1,676	0.880	52.75	1.67E-02
Hydrochloric acid	1,676	0.110	52.75	2.09E-03
Methanol	1,676	1.580	52.75	3.00E-02
Phenol	1,676	0.680	52.75	1.29E-02
Propionaldehyde	1,676	0.100	52.75	1.90E-03

ATTACHMENT 3

Dryer Vendor Guarantee Letter

Drax
Monticello, Washington State

September 9th, 2022

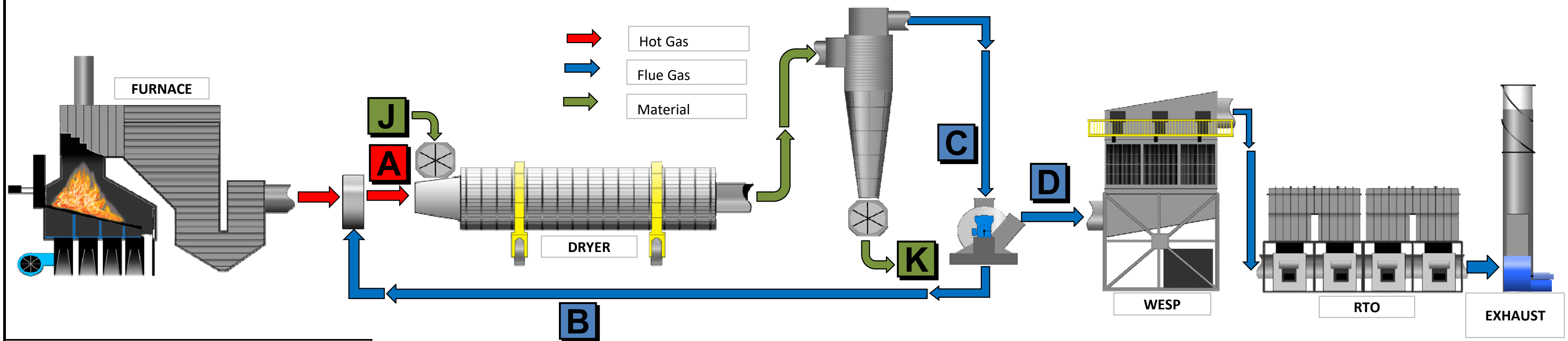
RE: Dryer Island Equipment Emissions

Drax will build a Pellet Plant located in Monticello, Washington State. The Pellet Plant will require a Dryer Island to dry wet-woody-biomass. The TSI Dryer Island consists of four (4) major pieces of equipment:

1) The Heat Energy System that burns wet-woody-biomass to generate heat for the Dryer System for the purpose of evaporating water from the wet-woody-biomass
   a. During the combustion process the Heat Energy System will generate primarily 'fuel-bound' NOx; fuel-bound NOx is generated from nitrogen that is present in the fuel itself
   b. The Heat Energy System will not generate much thermal NOx; thermal NOx is generated when heat within the system exceeds 2100°F and nitrogen from combustion air itself starts to turn into NOx
      i. The Heat Energy System will not exceed 1850°F operating temperature and thus generating thermal NOx to any meaningful levels will not occur
   c. A Heat Energy System that does not generate thermal NOx is considered a low-NOx Burner, since only NOx generated is from the fuel itself, which is inevitable; the only possible control a Burner has to control NOx is to control amount of thermal NOx
2) Before the Dryer Island can be started and run the WESP & the RTO must be available
   a. Therefore, the WESP & the RTO are always running when Dryer Island is starting up and flue gasses from the Dryer Island are cleaned from Particulate and VOCs prior to being exhausted to atmosphere
3) During shutdown of the Dryer Island the WESP and the RTO are running and still cleaning the flue gas from the Particulate and the VOCs prior to being exhausted to atmosphere
4) If during Dryer Island operations there is an upset operating condition the system will abort gasses to atmosphere via the Furnace Abort Stack and the Dryer System Abort Stack
   a. During this time feed to the Furnace and the Dryer System is stopped; therefore, the Furnace combustion is aborted and the Dryer System operations are slowly brought to a stop by aborting material to the Fire Dump

Best Regards,

Zlatko Savovic
Sales Director and Mechanical Engineer
TSI,Inc.
(425) 239-7490
zsavovic@tsi-inc.net



BTU/hr (sensible)	169,691,360
BTU/hr (HHV)	233,048,583
Fuel moisture conent	50.0
Fuel mt/hr (bone dry)	12.58
Fuel HHV (BTU/lb)	8,400

GAS FLOW EACH DRYER					
UNITS	A	B	C	D	E
ACFM	402,774	66,346	238,018	171,673	0
LBS/CUFT	0.023	0.049	0.049	0.049	
LBS/HR	548,749	193,614	694,599	500,986	
TEMP ^{o}C	621	113	116	113	

MATERIAL FLOW EACH DRYER		
UNITS	J	K
WET KG/HR	110,401	60,000
MC %WB	50.0	8.0
MC % DB	100.0	8.7
Metric Tons/Hr @ 6% mc wwb		60.00

TSI Single-Pass Recycle Dryer System

tsi
Lynnwood, Washington, 98036
425-771-1190

A PROPOSAL TO PROVIDE A

DRYER ISLAND & RCO

FOR

drax

Location: Monticello, Washington State

tsi

Responsible Innovation

Budget Proposal # 220906

Submitted September 6th, 2022

20818 44th Ave West, Ste 201
Lynnwood, WA 98036
United States of America

Contact:
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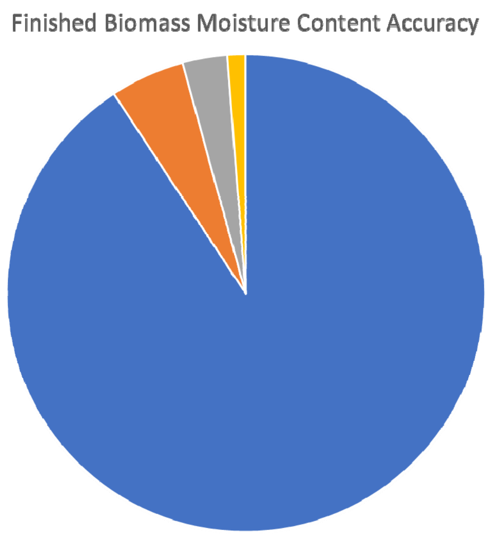
CONTENTS

PROJECT REQUIREMENTS

- **Site Information**
  - Location: Washington State
  - Maximum Ambient Temperature (°F): 120
  - Minimum Ambient Temperature (°F): 20
  - Design based on Average Ambient Temperature (°F): 60
  - Site elevation above sea level: ≤50 feet

- **Dryer Island Design Conditions**
  - Incoming Biomass Moisture Content wet-weight-basis: ≤50.0%
  - Finished Biomass Moisture Content wet-weight-basis: 6.0%
    - 90% within ±1.0% of the target range
    - 95% within ±2.0% of the target range
    - 98% within ±3.0% of the target range
    - Below is a pie-chart representation of finished biomass moisture content characteristics



  - Wet-Woody-Biomass: 80% sawdust/shavings with up to 20% chips
    - Chips characteristics:
      - 100% will pass ¾" square mesh screen
  - Chip Density: 18 to 22 lbs/cuft (wet)
    - TSI estimates this density; density to be verified prior to project start and if needed a price adjustment will be made
    - Prior to order the Buyer needs to supply TSI with a 5-gallon sample for laboratory testing to be performed by TSI
  - Fuel Density: 12 to 22 lbs/cuft (OD)
    - TSI estimates this density; density to be verified prior to project start and if needed a price adjustment will be made
    - Prior to order the Buyer needs to supply TSI with a 5-gallon sample

        for laboratory testing to be performed by TSI
    - Fuel Moisture Content wet weight-basis: 40% to 50%
    - Fuel Higher Heating Value: 7,800 Btu/lb to 8,600 Btu/lb
    - Fuel required sizing:
        - 100% <6”
        - 90% <4”
        - 70% >2”
        - 25% <1”
        - 15% <1/2”
    - Species: 100% Softwoods, 100% Hardwoods, and any mix in-between
    - RTO Gas Pressure required (psig): 20 to 40
        - Minimum 15 psig at full flow

- **Regenerative Catalytic Oxidizer (RCO) Design Conditions**
    - There are two (2) options offered:
        - ≤120,000 ACFM
            - VOC (lbs/hr): 260
        - ≤76,500 ACFM
            - VOC (lbs/hr): 220
    - Temperature (°F): 120
    - Particulate (mg/Nm3): ≤115
    - Humidity (% by volume): ≥5
    - RCO Gas Pressure required (psig): 20 to 40
        - Minimum 15 psig at full flow

Client: Drax **Location: Monticello, WA**

Design Parameters:	Finished MC	Elevation	Chip Size
	6% ±1%	≤50'	≤3/8"

PRODUCTION MATRIX (dried metric tons/hr @ 6% moisture content wet-weight-basis)						
Infeed Moisture wet-weight-basis	Ambient Temperature					
	35°F	45°F	55°F	65°F	75°F	85°F
55%	48.2	49	49.7	50.7	51.1	51.4
50%	59.3	59.9	61	62.2	62.7	63
45%	72	72	72	72	72	72

Fuel Conditions for above noted calculations	
FUEL: (DRY %)	WOOD
CARBON %	49.48
HYDROGEN %	5.83
OXYGEN %	41.89
NITROGEN %	0.20
SULPHUR %	0.00
ASH %	2.60
TOTAL: (100)	100.00
FUEL HHV dry	8,400
FUEL MC %	50.00

EQUIPMENT SPECIFICATION – DRYER ISLAND

- **Heat Energy System**
  - Quantity: One (1)
  - Size: **80m2 Grate**
  - Fuel Moisture (wet-weight-basis): 35% minimum to 55% maximum
  - Number of Combustion Chambers: Two (2) - primary & secondary
  - Number of Wet-Ash Conveyors: Two (2)
  - Metering Bin capacity: Twenty (20) minutes
  - Abort Stack: included
  - Control Devices: Included
  - Deluge Nozzles: Included
  - Drives: Direct-coupled
  - Structural Steel support & access: Included
  - Structural Steel support & access finish: Painted
  - Scope of supply start: Metering Bin
    - Buyer responsible for feeding fuel into the Metering Bin
  - Scope of supply end: Wet Ash Conveyor discharge
    - Buyer responsible for supplying ash bin

- **Dryer System**
  - Quantity: One (1)
  - Dryer Drum Size: **Ø23' by 100' long** (nominal)
    - The Dryer Drum comprises nine (9) 10' long sections that are bolted together
    - Inlet to Outlet Seal nominal length is 100'
  - Hot Gas Isolation Gate: Included
  - Blending Duct Isolation Gate: Included
  - Metering Bin capacity: Forty-five (45) minutes
  - Infeed Airlock type: Feeder type (knife tipped)
  - Cyclone Airlock type: Feeder type (knife tipped)
  - Quantity of Cyclones: Two (2)
  - Cyclone Construction: ½" thick T1 for body/cone & 3/16" thick for hood
  - Quantity of Cyclone Airlocks: two (2)
  - Ductwork Expansion Joints: corrugated Stainless-Steel
  - Double-Ductwork: Included
    - Primary Double-Duct Heat Source: Air-Air Heat Exchanger
    - Backup Double-Duct Heat Source: Electrical Heater
  - ID Fan: 900 RPM
    - 900 RPM ID Fan provides for lower noise and is less susceptible to vibrations
    - Lower wear and maintenance
    - Materials of construction: Stainless-Steel for housing with Carbon-Steel external stiffeners; Carbon-Steel for shaft & wheel
  - ID Fan Expansion Joints: corrugated Stainless-Steel
  - Abort Stack: Included
  - Control Devices: Included
  - Explosion Panels: Included (NFPA certified)
  - Deluge Nozzles: Included

- Drives: Direct-coupled
- Structural Steel support & access: Included
- Structural Steel support & access finish: Painted
- Scope of supply start: Metering Bin
  - Buyer responsible for feeding chips into the Metering Bin
- Scope of supply end: Collection Screw
  - Buyer responsible for receiving dried chips from the Collection Screw

- **WESP**
  - Quantity: One (1)
  - Number of Ø10" tubes: **936**
  - Number of Fields: Four (4)
  - Centrifuge: included
  - Control Devices: Included
  - Drives: Direct-coupled
  - Structural Steel support & access: Included
  - Structural Steel support & access finish: Painted
  - Scope of supply start: Quench-Duct
    - Quench-Duct connects to the Dryer System's Abort Stack
  - Scope of supply end: Centrifuge
    - Buyer responsible for receiving 'sludge' from the Centrifuge

- **RTO**
  - Quantity: One (1)
  - Four (4) CAN RTO
    - **Each CAN measures 11' wide by 34' long by 8' tall**
  - Number of Combustion Chambers: Two (2)
  - Heat Recovery Media and Internal Refractory quantities (total ft3):
    - Saddle Lexco: 1,320
    - Corpac (Flexo type-28): 2,640
    - Monolith LA10-32: 2,640
    - Monolith NT40: 2,640
    - Internal Refractory: 6,200
  - Projected Gas Consumption: 8.8 mmBTU/hr
    - Projected gas consumption is based on following emissions entering the RTO:
      - − VOC (lbs/hr): ≥350
      - − CO (lbs/hr): ≥100
      - − HAPs (lbs/hr): ≥100
      - − Condensable PM (lbs/hr): ≥200
  - FD Fan: 900 RPM
    - 900 RPM ID Fan provides for lower noise and is less susceptible to vibrations
    - Lower wear and maintenance
    - Stainless-Steel construction
  - Control Devices: Included
  - Drives: Direct-coupled
  - Structural Steel support & access: Included
  - Structural Steel support & access finish: Painted

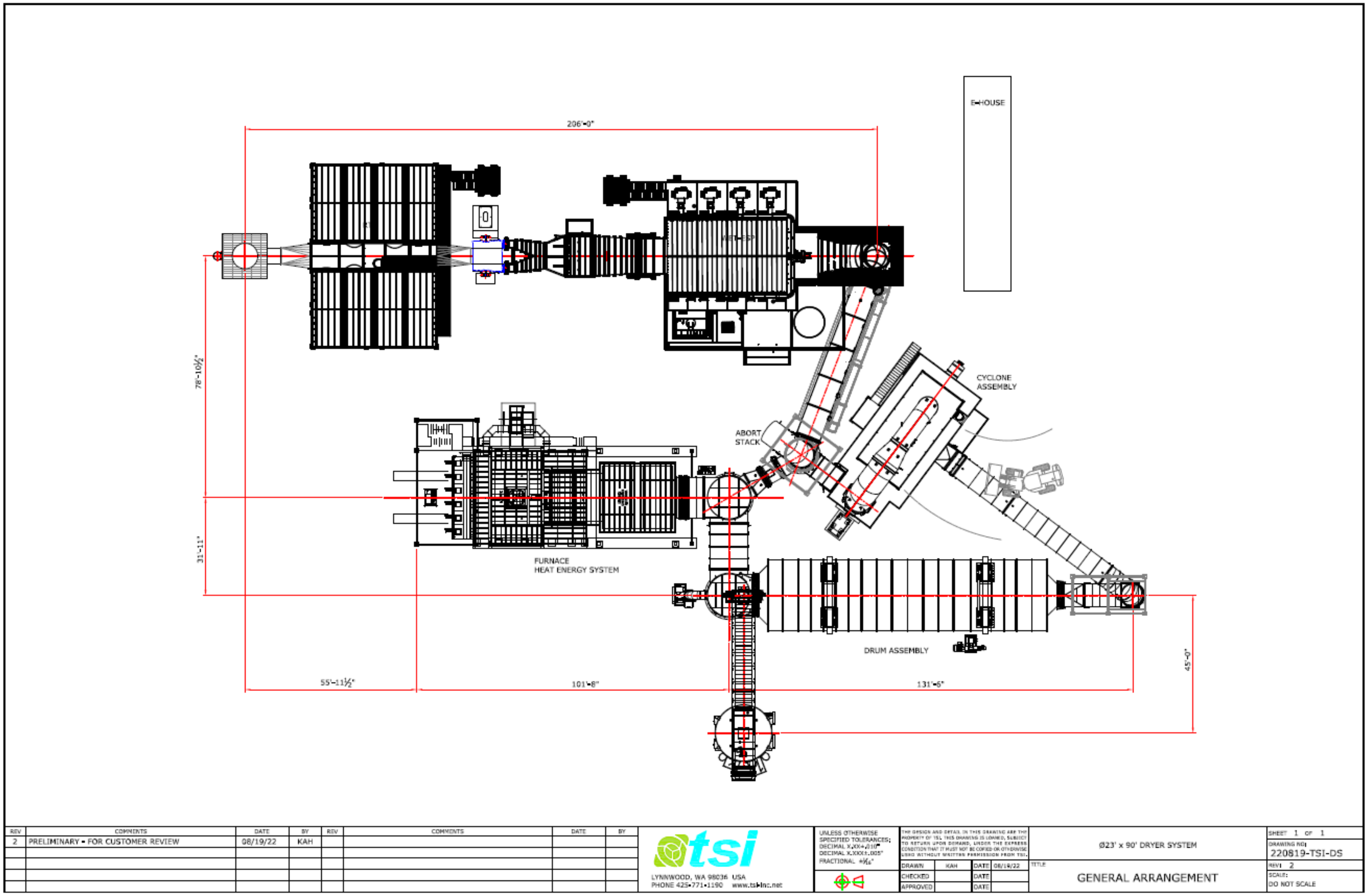
- Scope of supply start: Mist Eliminator Chamber
    - WESP discharge duct connects to the Mist Eliminator Chamber
- Scope of supply end: Exhaust Stack
    - Flue gas is exhausted to atmosphere via the Exhaust Stack
    - Height (ft): sixty (60)
    - Diameter (in): 90

EQUIPMENT SPECIFICATION – 120,000 ACFM RCO

- Four (4) CAN RCO
- **Each CAN measures 11' wide by 26' long by 8' tall**
- Number of Combustion Chambers: Two (2)
- Heat Recovery Media and Internal Refractory quantities (total ft3):
    - Saddle Lexco: 1,000
    - Corpac (Flexo type-28): 2,000
    - Monolith LA10-32: 2,000
    - Monolith NT40: 2,000
    - Catalyst (6x6x4 blocks): 4,200
    - Internal Refractory: 5,400
- Projected Gas Consumption: 2.2 mmBTU/hr
    - Projected gas consumption is based on the following emissions entering the RTO:
        - VOC (lbs/hr): ≥260
        - Condensable PM (mg/Nm3): ≥115
- FD Fan: 900 RPM
    - 900 RPM ID Fan provides for lower noise and is less susceptible to vibrations
    - Lower wear and maintenance
    - Stainless-Steel construction
- Control Devices: Included
- Drives: Direct-coupled
- Structural Steel support & access: Included
- Structural Steel support & access finish: Painted
- Scope of supply start: Quench-Duct
    - Buyer responsible to connect Pelletizing Island flue gas to the Quench-Duct
    - Quench-Duct total length included (ft): 50
- Scope of supply end: Exhaust Stack
    - Flue gas is exhausted to atmosphere via the Exhaust Stack
    - Height (ft): sixty (60)
    - Diameter (in): 72

EQUIPMENT SPECIFICATION – 76,500 ACFM RCO (option)

- Two (2) CAN RCO
- **Each CAN measures 11’ wide by 33’ long by 8’ tall**
- Number of Combustion Chambers: One (1)
- Heat Recovery Media and Internal Refractory quantities (total ft3):
    - Saddle Lexco: 640
    - Corpac (Flexo type-28): 1,280
    - Monolith LA10-32: 1,280
    - Monolith NT40: 1,280
    - Catalyst (6x6x4 blocks): 2,688
    - Internal Refractory: 3,200
- Projected Gas Consumption: 0.7 mmBTU/hr
    - Projected gas consumption is based on the following emissions entering the RTO:
        - VOC (lbs/hr): ≥220
        - Condensable PM (mg/Nm3): ≥115
- FD Fan: 900 RPM
    - 900 RPM ID Fan provides for lower noise and is less susceptible to vibrations
    - Lower wear and maintenance
    - Stainless-Steel construction
- Control Devices: Included
- Drives: Direct-coupled
- Scope of supply start: Quench-Duct
    - Buyer responsible to connect Pelletizing Island flue gas to the Quench-Duct
    - Quench-Duct total length included (ft): 50
- Scope of supply end: Exhaust Stack
    - Flue gas is exhausted to atmosphere via the Exhaust Stack
    - Height (ft): sixty (60)
    - Diameter (in): 60



DRYER ISLAND PRELIMINARY LAYOUT

EMISSIONS

- **Dryer Island**
  - Total Particulate (PM) (lbs/hr): ≤15 lbs/hr
  - Volatile Organic Compounds (VOC) (lbs/hr): ≤15 lbs/hr
  - Carbon Monoxide (CO) (lbs/hr): ≤42 lbs/hr
  - Nitrogen Oxide (NOx) (lbs/hr): ≤52 lbs/hr

- **RCO – 120,000 ACFM**
  - Total Particulate (PM) (lbs/hr): ≤14 lbs/hr
  - Volatile Organic Compounds (VOC) (lbs/hr): ≤13 lbs/hr or ≥95% destruction efficiency
  - Carbon Monoxide (CO) (lbs/hr): ≤14 lbs/hr
  - Nitrogen Oxide (NOx) (lbs/hr): ≤5 lbs/hr

- **RCO – 76,500 ACFM** (option instead of the 120,000 ACFM RCO)
  - Total Particulate (PM) (lbs/hr): ≤11 lbs/hr
  - Volatile Organic Compounds (VOC) (lbs/hr): ≤11 lbs/hr or ≥95% destruction efficiency
  - Carbon Monoxide (CO) (lbs/hr): ≤12 lbs/hr
  - Nitrogen Oxide (NOx) (lbs/hr): ≤4 lbs/hr

Notes:

- *Show above are projected emissions from the Dryer Island RTO Exhaust Stack*
- *Emissions measured via USEPA approved testing methods; emissions based on above noted design criteria & guaranteed production rates*
- *NOx emissions for Dryer Island are based on fuel nitrogen level at 0.22% bone dry basis*
  - *Higher nitrogen content within fuel will result in higher NOx emissions*

PROPOSAL SUMMARY

This Proposal is for a complete Dryer Island. The Dryer Island consists of one (1) Heat Energy System, one (1) Dyer System, one (1) Wet Electrostatic Precipitator (WESP), and one (1) Regenerative Thermal Oxidizer (RTO).

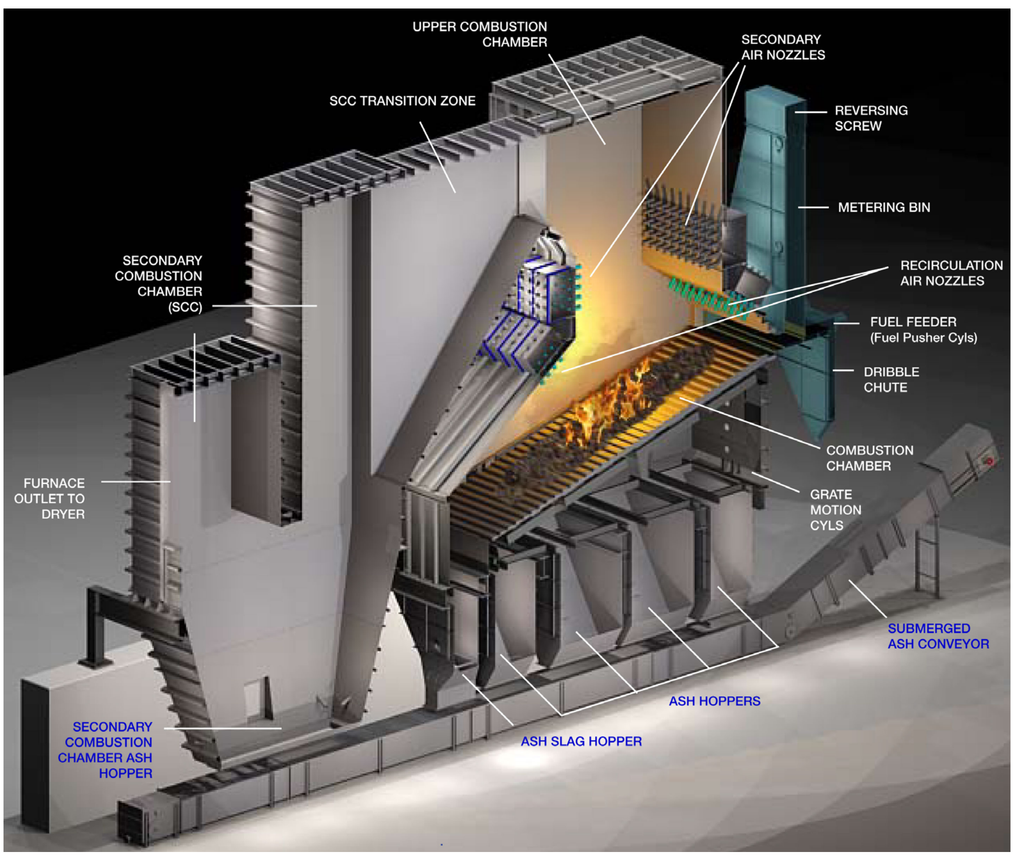
This Proposal also offers a Regenerative Catalytic Oxidizer (RCO) with a Disengagement Chamber located ahead of the RCO. The RCO treats flue gas from the Buyer's Pelletizing Island.

The following pages describe the purpose and operations of each unit.

Heat Energy System

The Heat Energy System receives wet fuel (bark or chips), combusts that fuel in an efficient manner, and delivers products of combustion to the Dryer System for purpose of drying wet-woody-biomass.

TSI Heat Energy System mechanical scope of supply begins immediately after the Buyer's fuel infeed conveyor to the Metering Bin. The bottom of the Metering Bin has hydraulic ram pushers that push fuel one the reciprocating grates, which are housed within the Primary Combustion Chamber. There are 4-zones of moving reciprocating grates. The 1st zone dries fuel to point of combustion; the 2nd and 3rd zones begin combustion; the 4th zone oscillates slowest to burn off most of the carbon before inorganics like ash and slag are discharged into the Wet Ash Conveyor. The Wet Ash Conveyor is sub-merged in water and provides an affective airlock that prevents ambient air leaking into the Heat Energy System. The Wet Ash Conveyor conveys ash and slag to a bin or bunker, provided by the Buyer, that is accessible via mobile equipment for periodic removal from the plant site. There are two combustion fans: the Primary Fan starts combustion and prevents grates from over-heating, while Secondary Fan completes combustion process in the Upper Combustion Chamber. Hot gas from the Upper Combustion Chamber enters the Secondary Combustion Chamber designed with a downward U-turn that will remove significant amount of fly ash and sparks from the gas stream prior to entry into the Dryer System. An Emergency Stack, which vents gases during upset conditions to atmosphere, is located on top of the Upper Combustion Chamber. The Combustion Chambers are lined with refractory and insulation materials.



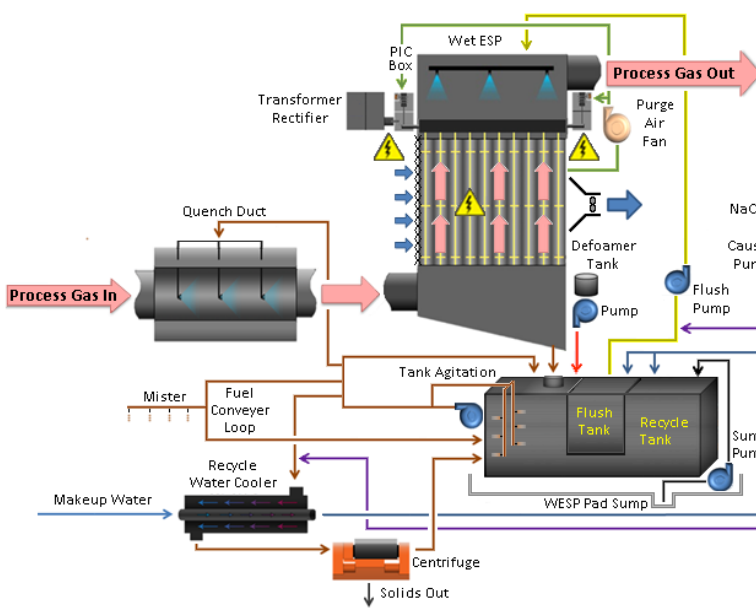
Dryer System

The Dryer System dries wet-woody-biomass to the moisture content required by the Buyer. TSI Dryer System mechanical scope of supply begins immediately after the Buyer's infeed to the Metering Bin. The Metering Bin stores and meters wet-material into the Dryer Drum via Infeed Airlock and Inlet Fitting. Hot Gas Ductwork connects the Heat Energy System to the Dryer System. Within the Hot Gas Ductwork are the Hot Gas Isolation Gate, the Dilution Bustle, and the Inlet Fitting. The Hot Gas Ductwork is lined with refractory and insulation materials. The Inlet Fitting processes mixed gas from the Dilution Bustle and the wet-woody-biomass into the Dryer Drum. The Dryer Drum is a 'convection-type' single-pass unit that is responsible for distributing and classifying each biomass particle to allow for its efficient drying. This is accomplished with utilization of a complex 'flighting system' within the Dryer Drum that has been perfected to an advanced stage. The Dryer Drum dries wet-woody-biomass to the required moisture content and exhausts flue-gas and dried biomass into the Material Duct. As dried biomass exits the Dryer Drum it is pneumatically conveyed via the Material Duct into the High Efficiency Cyclone(s). The High Efficiency Cyclone(s) removes dried biomass from the flue-gas stream, discharges dried biomass into Cyclone Airlock(s), and exhausts flue-gas stream out the top and into the Gas Duct towards the Induced Draft Fan (ID Fan). Dried biomass from the Cyclone Airlock(s) is received by the Collection Screw, which under normal operating conditions conveys dried biomass to the Buyer; during upset operating conditions the Collection Screw reverses direction and dumps material into the Buyer's Fire Dump. The ID Fan flow is controlled by a Variable Frequency Drive, which is governed by the pressure differential reading across the High Efficiency Cyclone(s). The temperature control at the outlet of the Drum is controlled by the Dilution Damper and this control loop ensures proper moisture content of the biomass. TSI Dryer Systems are equipped with advanced spark detects, temperature elements, and strategically positioned water deluge nozzles to enable water delivery throughout the system with and without the ID Fan running.

Wet Electrostatic Precipitator

The Wet Electrostatic Precipitator (WESP) removes particulate from the gas stream before the gas stream enters the Regenerative Thermal Oxidizer (RTO). There are two (2) types of particulates: the filterable ('front-half') particulate and condensable ('back-half') particulate. The WESP will remove ≥95% of the front-half particulate as well as any back-half particulate that condenses from the gas stream and into a water particle at temperature of 160°F to 180°F. Back-half particulate that doesn't condense will pass thru the WESP and burn-off within the RTO's combustion chamber.

Dryer flue-gas enters the WESP through the Quench-Duct, which includes recirculated water sprays that saturate the gas stream and condense some of the vaporous particulate. It also serves as a pre-filter by scrubbing out larger particulate and fiber carryover. The gas stream enters the bottom of the WESP through a common plenum and travels upward into parallel tube bundles. Each tube bundle is an array of Stainless-Steel collection tubes that have high voltage discharge electrodes suspended within them. The electrodes have a series of discs that create an intense electric field (Corona) when high voltage is applied. As the gas stream passes between the collection tubes and the discharge electrode, the suspended particles become negatively charged and are driven towards the grounded collection tube (precipitation). Each tube bundle is periodically and independently flushed with a dilute caustic solution to remove the particulate from the collection tube wall. The spent flush water flows by gravity into the recycle system via the recycle tank located underneath the WESP. This serves to make up the majority of the water that is evaporated in the quench duct. A portion of the recycle water is processed through a centrifuge to remove suspended solids. The solids are collected in a tote (by Buyer) for disposal (this is a non-toxic discharge that can be sent to a regular land fill). The collection tube walls stay wet, which aids in the cleaning process, by drawing ambient air across the exterior surface with small fans. This air cools the collection tubes and promotes condensation from the saturated gas stream on the inner surface. This condensation makes up the remainder of the balance of water evaporated in the quench duct. As the cleaned gas exits the tube bundle it passes through the electrode suspension grid into a common plenum and is then ducted down to grade level where it is directed to the RTO. The electrode grid is charged by a high voltage transformer rectifier and is suspended at external insulator boxes. The insulator boxes are purged using warm air from the tube bundle cooling air, thus keep the insulator dry and improving overall performance.



Regenerative Thermal Oxidizer

The Regenerative Thermal Oxidizer (RTO) receives particulate cleansed flue-gas from the WESP and combusts the uncondensed back-half Particulate (BHP), Volatile Organic Compounds (VOCs), Hazardous Air Pollutants (HAPs), and Carbon Monoxide (CO).

Cleansed flue-gas from the WESP first passes through the Mist Eliminator Chamber, which removes free water droplets. The flue-gas is then routed through a common duct manifold and into two of four Diverter Valves. The Diverter Valves enable the system to regularly reverse gas flow, which in combination with the heat recovery Media, provides an affective energy saving system. Flue-gas exits the inlet Diverter Valves and travels upward into the Hoppers. The Hoppers distribute gas into the inlet Heat Recovery Chambers, which contain Ceramic Media. This Media, which was heated from discharge gasses during the previous valve cycle, preheat flue-gas to approximately 1400^{o}F before the flue-gas enters the Combustion Chamber. The Combustion Chamber is maintained at a temperature of 1500°F by a Gas Burner. Within the Combustion Chamber hydrocarbons are converted to CO_2 and H_2O. Flue-gas exits through opposing heat recovery chambers, where the Media now acts as a heat sink and absorbs the thermal energy, cooling it to within 75°F to 100°F of the RTO inlet temperature, before discharging flue-gas into the Exhaust Stack. The Ceramic Media comes in a variety of types and specific selection depends on the application. The Diverter Valves continually reverse airflow based on a pre-programmed timer. By reversing the flow, the inlet chambers become the outlet chambers and vice versa. The chambers that have been heated by the exhausting flue-gas become a pre-heating media for the incoming flue-gas; while the chambers that have just been cooled by the incoming flue-gas can again be reheated by the exhausting gas. This heat recovery cycle makes the RTO ≥95% thermally efficient. Flue-gas is pushed through the RTO by a Forced Draft Fan (FD Fan) located between the Mist Eliminator Chamber and the RTO.

Regenerative Catalytic Oxidizer

The Regenerative Catalytic Oxidizer (RCO) receives flue gas from the Buyer's Pelletizing Island, which is laden with Volatile Organic Compounds (VOCs) and Particulate Matter (PM), combusts the VOCs and PM and exhausts cleansed gas stream to the atmosphere via the Exhaust Stack.

The Buyer's Pelletizing Island flue gas enters the Quench Duct where a series of water nozzles sprays the gas stream with recycled water, thus reducing dust emissions entering the Disengagement Chamber upstream of the RCO. The Disengagement Chamber removes ≥90% of the water droplets and particulate 60 micron and larger. The water is collected in a recycle tank at Disengagement Chamber bottom, from where it is pumped back to the Quench Duct. A slip stream of about 50 GPM is diverted to a centrifuge for particulate removal. Cleansed flue-gas from the Disengagement Chamber is routed through a common duct manifold and into two of four Diverter Valves. The Diverter Valves enable the system to regularly reverse gas flow, which in combination with the heat recovery Media, provides an affective energy saving system. Flue-gas exits the inlet Diverter Valves and travels upward into the Hoppers. The Hoppers distribute gas into the inlet Heat Recovery Chambers, which contain Ceramic Media. This Media, which was heated from discharge gasses during the previous valve cycle, preheat flue-gas to approximately 800^{o}F before the flue-gas enters the Burner Chamber. The Burner Chamber is maintained at a temperature of 850°F by a Gas Burner. Within the Catalytic Media itself is where the hydrocarbons are converted to CO_2 and H_2O. Flue-gas exits through opposing heat recovery chambers, where the Media now acts as a heat sink and absorbs the thermal energy, cooling it to within 35°F to 50°F of the RCO inlet temperature, before discharging flue-gas into the Exhaust Stack. The Ceramic Media comes in a variety of types and specific selection depends on the application. The Diverter Valves continually reverse airflow based on a pre-programmed timer. By reversing the flow, the inlet chambers become the outlet chambers and vice versa. The chambers that have been heated by the exhausting flue-gas become a pre-heating media for the incoming flue-gas; while the chambers that have just been cooled by the incoming flue-gas can again be reheated by the exhausting gas. This heat recovery cycle makes the RCO ≥95% thermally efficient. Flue-gas is pushed through the RCO by a Forced Draft Fan (FD Fan) located between the Disengagement Chamber and the RCO.

ITEM 01ENGINEERING

TSI engineers will work closely with the Buyer's engineer to properly lay-out the equipment, and to ensure proper interface with the Buyer's equipment upstream & downstream of the Dryer Island. As part of the Engineering package the Buyer will receive the following documents:

- Layouts
    - Plan view
    - Elevation views
- Foundation Load Drawings
- Motor List
- Device List
- Motor Location Drawings
- Device Location Drawings
- Fire Detection & Suppression Drawings
- Instrument Air Requirements
- PID Drawings
- Functional Description

ITEM 02 HEAT ENERGY SYSTEM

Shown below and on following pages are some of the major individual components that make up the Heat Energy System.

Flop Gate

The Flop Gate isolates fuel infeed equipment, like the conveyors, from the potential Furnace back-fires. The Flop Gate also eliminates air leakage into the Furnace during normal and upset operating conditions. The Flop Gate is located on top of the Metering Bin and it only opens when the Metering Bin fuel level reaches low level sensor. The Flop Gate blocks air (oxygen) from getting inside the Metering Bin during fuel feed upsets or when shutting down a Furnace which contributes to fires. It is operated pneumatically via pneumatic cylinders.

Flop Gate located on top of the Reversing Screw; the Reversing Screw is located on top of the Metering Bin

Reversing Screw

The Reversing Screw is located directly above the Metering Bin and directs fuel to both sides of the Metering Bin, thus ensuring even fuel distribution within the Metering Bin. It provides for even fuel feed onto the reciprocating grates, which is critical to ensuring proper fuel combustion. The Reversing Screw reverses direction based on low level sensors located on both sides at the bottom of the Metering Bin.

Reversing Screw

Metering Bin

The Metering Bin consists of fuel feed pushers that push fuel onto the 1st zone of the reciprocating grates located within the Primary Combustion Chamber. The Metering Bin holds fuel evenly with even density achieved due to the above-mentioned Reversing Screw, thus covering the entire grate area with fuel at a controlled fuel bed level. The complete grate area forms an active drying and combustion area. A double alarm system (level control furnace and level control fuel feeders) warns the Operator in case of interruptions of fuel supply. A gate valve and sprinkler system are installed for prevention of back burning into the Metering Bin.

Metering Bin
(Shown with Reversing Screw & Flop Gate located directly above it)

Reciprocating Grate Combustion Chamber

The Combustion Chamber constructed of a robust steel frame structure with moving and stationary grate frames. Reciprocating grate bars are carried by moving support frames. Stationary grate bars are supported by the structure frame. The reciprocating grate frames and grate bars are supported on ball bearings. There are four (4) zones of moving grates within the Furnace. Grates are fabricated from high heat resistant steel ASTM A297, Grade HD. Grates modulate from 10% to 100% and the Furnace has a 1:4 turndown ratio.

The grate bars are of high heat resistant alloy with cooling fins to prevent overheating; water cooling is not required. The grate bars are overlapping, thus preventing through fall of unburned fuel. A hydraulic power pack with pump operates the fuel feeders and grates.

The primary combustion air enters the fuel bed from the under-fire air zone through slots between the grate bars. The sides of the grate's assembly are cast steel side bars to protect the refractory of the furnace from abrasion by the moving grate bars.

The reciprocating grate bars are activated by hydraulic cylinders. The relative movement between stationary and moving grate bars causes the fuel to continually turn and convey along the grate to enhance the combustion process.

Complete Heat Energy System
(note: some items shown may not reflect actual that are offered within this Proposal)

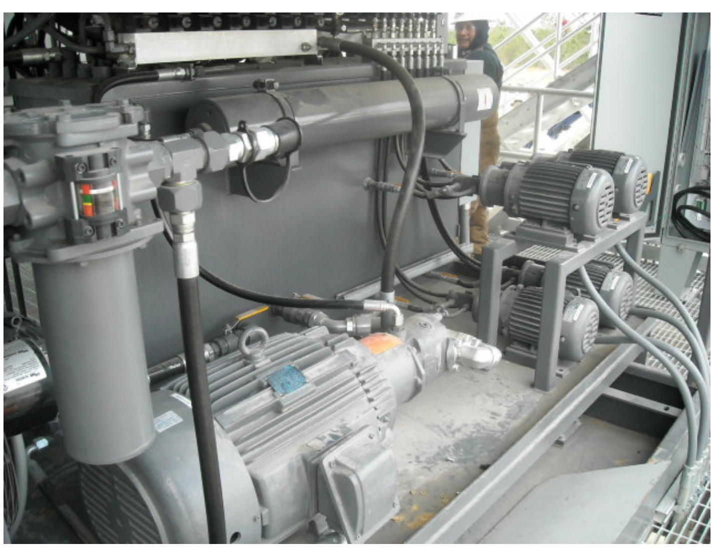
Hydraulic Power Pack

Hydraulics for ram feeder, shut off slide, grate cylinders, and the last grate section. Hydraulic Power Pack unit complete with one high-capacity hydraulic pump, complete with coupling, guard, three 4-way directional solenoid valves, tank trim, all components pre-piped, and mounted on a rigid tank.

Hydraulic Power Pack

Hydraulic Displacement Pumps

Hydraulic Displacement Pumps operate all four (4) grate sections of the Furnace and control the speed of the strokes based on firing rate and controlling the speed of the pumps. Each pump motor requires a variable frequency drive.



Hydraulic Displacement Pumps

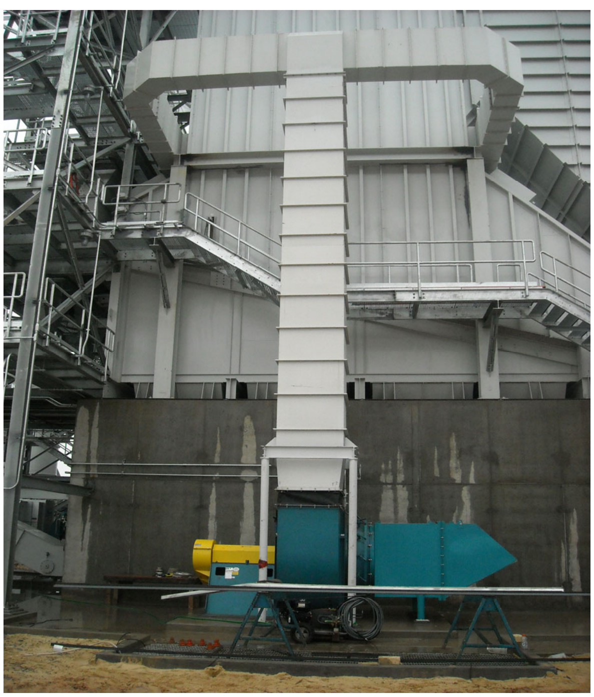
Primary Air Fan

Forced draft fan with flanged inlet and outlet, inlet vane control damper, electric actuator with linkage and mounting bracket. The Primary Air Fan provides the primary combustion air into the under-fire air zones. Air is fed from under the grate bars and is controllable in each of the four sections.

Primary Air Fan (Under-fire Air)

Secondary Air Fan

Secondary Air Fan is a forced draft fan with flanged inlet and outlet, inlet vane control damper, electric actuator with linkage and mounting bracket. The Secondary Air Fan feeds the air over the fuel pile for complete combustion of fuel.



Secondary Air Fan (Over-fire Air)

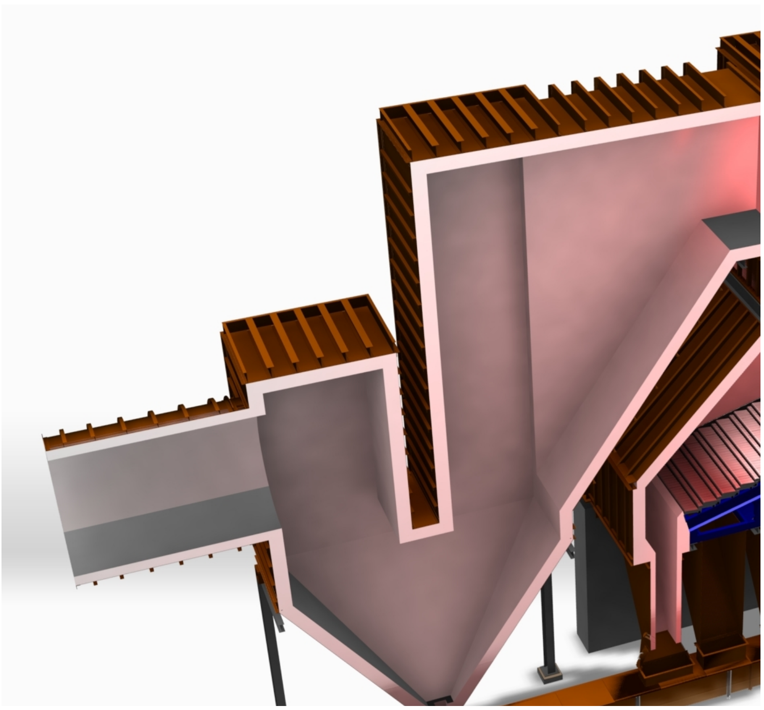
Casing and Combustion Air Ducts

Carbon-Steel construction for the complete chamber with external stiffening beams. Ducting for the Primary and Secondary Air Fans from the fans to the Furnace air boxes and headers.

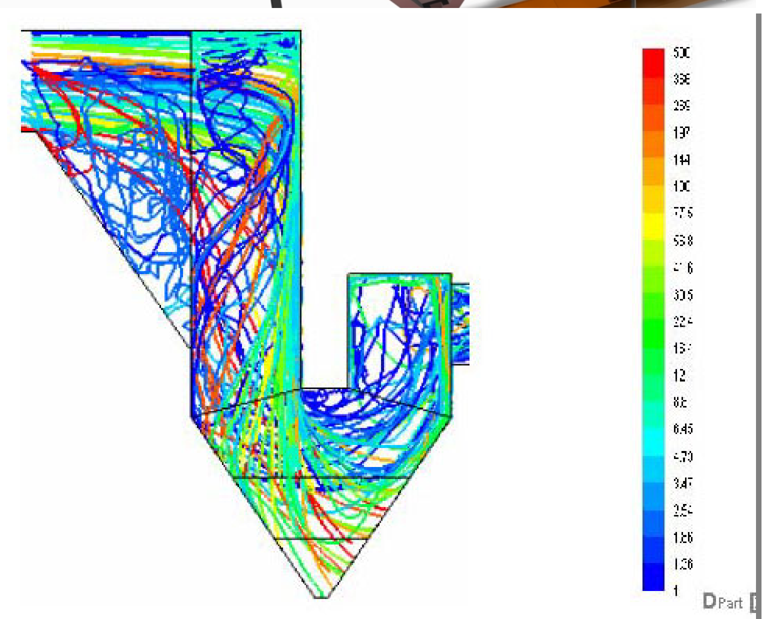
Furnace Ca sing & Combustion Air Ducts

Secondary Combustion Chamber

This chamber provides final combustion of the gases from the Furnace. The chamber also provides for mixing of the furnace gas with the Dryer System flue-gas. After mixing and blending, the gases are discharged to the Dryer ducting. The Chamber is refractory lined and includes a drop out chamber and flue-gas turn around design for maximum removal of fly ash in front of the Dryer. The chamber is designed with the top as a secondary combustion chamber to burn-out the carry over and the bottom as an ash drop-out in order to get clean burned-out gas that can be directly fed into the dryer.



Right: Secondary Combustion Chamber/Ash Dropout Chamber



CFD - Fluid modeling of Ash drop section.

Refractory

Internal refractory block insulation rated to 1900°F. Furnace material is plastic rated to 2700°F. Using low cement materials and installation to be done using shot-crete method. To be blown-in-place on site.

Note: Refractory design by TSI; supply/installation/cure-out offered under Refractory Works option below within this document.

Refractory shown with moving grates

Wet Ash Conveyor

The Wet Ash Conveyor of drag chain design, complete with gearbox and drive, collects ash from underneath the Heat Energy System's reciprocating grate as well as from the Secondary Combustion Chamber's ash drop out chute. The Wet Ash Conveyor is submerged in water and it provides an effective air lock to the Heat Energy System, thus preventing ambient air from infiltrating and making the Heat Energy System less energy efficient.

Typical Wet Ash Conveyor

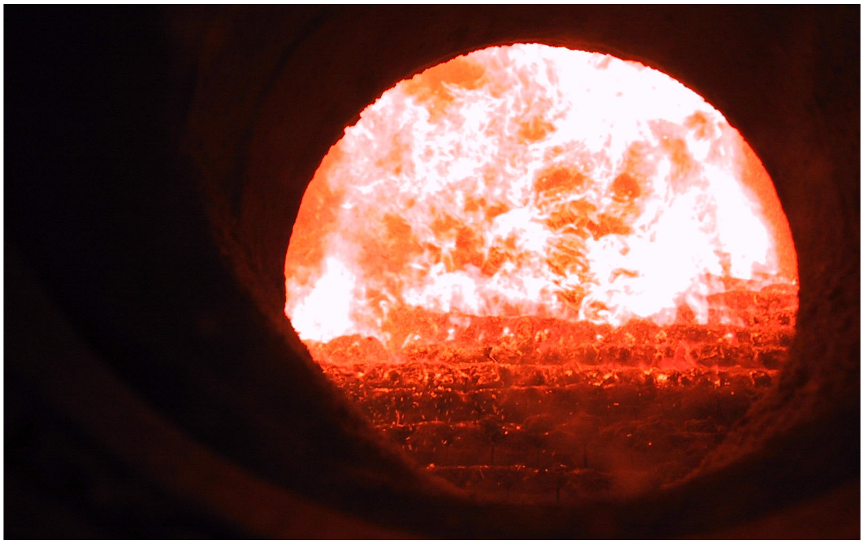
Abort Stack

Mounted on top of the Furnace and includes a counter-weighted stack cap that is actuated via a pneumatic cylinder. The purpose of the Abort Stack is to open at high temperature and/or high pressure in the system as well as during plant power outages. It is fabricated from Carbon-Steel and refractory-lined for the first five (5) feet above the Furnace roof. The remainder of the stack is fabricated from Stainless-Steel. Stack cap is also refractory lined. During normal operating conditions the Abort Stack is kept closed via the pneumatic actuated damper; during a power outage when pneumatic air isn't available the stack-cap automatically opens due to the counter-weight.

Abort Stack

Video Camera and Monitor

An air-cooled video camera is provided at the rear end of the Furnace with a monitor to allow for visual inspection of the furnace combustion process from the operator Control Room.



Typical Grate fire

Control Devices

The following devices are supplied to control the Heat Energy System via PLC:

- Temperature Control Sensors
- Temperature Transmitters
- Zero Speed Switches
- Pressure Transmitters
- Proximity Switches (Capacitive and Inductive)
- Deluge Nozzles

Structural Steel

Purpose

To provide structural support for the Heat Energy System and to provide personnel access via stairs, ladders, and platforms.

Description

TSI supplies the support structures, stairs, ladders, and platforms from grade level as is typically required by the Heat Energy System. This includes access to areas requiring regular maintenance or monitoring by operating personnel. Stair access is provided to areas requiring maintenance on a daily or weekly basis; longer maintenance intervals will have ladder access. Client will have opportunity during system design to comment on access and add more if needed with an appropriate price adjustment.

Design Details

Assembly: Bolted and welded assembly.
Finish: Painted.

Typical Structural Steel (shown during construction)

ITEM 03 DRYER SYSTEM

Shown below and on following pages are some of the major individual components that make up the Dryer System.

Hot Gas Isolation Gate

Purpose

When activated, to hold back gasses generated by the Heat Energy System from entering the Dryer System, and together with the Blending Duct Isolation Gate, provide safe passage for plant maintenance personnel into the Dryer System.

Operation

The Hot Gas Isolation Gate is bolted between the Heat Energy System and the Blending Bustle. This gate together with the Blending Duct Isolation Gate enables plant personnel to seal off the Dryer System from the Heat Energy System. The Hot Gas Isolation Gate comprises a refractory lined housing assembly and a gate assembly that slides in the housing powered by two hydraulic cylinders. The gate center panel is a corrugated profile to allow for thermal expansion. The clearance between the frame of the gate and its housing is pressurized by a Seal Fan, to prevent leakage of hot gas into the Dryer System when the gate is in place, and thus enable for safe entry of plant personnel into the Dryer System.

Design Details

Materials of construction: Housing assembly is fabricated from Carbon-Steel plate for housing, with structural shapes for reinforcing; gate assembly is constructed from ¼" thick RA-253 reinforced floating structure.

Actuator: Twin hydraulic cylinders powered by a dedicated hydraulic power-pack and mounted external to the housing.

Seals: Seal fan.

Insulation: Two-layer refractory; low density layer with hard refractory face containing about 46% to 50% aluminum oxide.

Note: Refractory design by TSI; supply/installation/cure-out offered under Refractory Works option below within this document.

Blending

Purpose

To control the flow of Dryer System flue-gas back to the Dryer Drum via the Blending Bustle.

Operation

Blending consists of a duct that runs from the discharge of the ID Fan to the Blending Bustle; the Blending Bustle is located between the Hot Gas Isolation Gate and the Inlet Fitting. Within the duct is a Blend Damper that modulates the amount of flue-gas blended back to the Dryer Drum. This control loop modulates to hold the Dryer Drum outlet temperature set point, which determines the moisture content of the biomass exiting the Dryer Drum. The Blend Damper is operated automatically via the PLC Controls. Within the duct is also a Blending Duct Isolation Gate that together with the aforementioned Hot Gas Isolation Gate, when closed, provides safe passage for plant maintenance personnel into the Dryer System.

The Heat Energy System generates hot gas at about 1650°F. This temperature needs to be 'cooled' prior to contacting wet-woody-biomass within the Dryer Drum. One way to cool this temperature is to utilize ambient fresh air, which isn't energy efficient, and can impact significantly the production capacity of the Dryer System during cold weather. The preferred method of cooling the Heat Energy System's hot gas is with the warm humid Dryer System flue-gas.

The Dilution benefits are:

1) Year-round stable operations
2) Better product conditioning as 'warm humid' gas better dries woody biomass
3) Up to 50% lower gas flow and emissions to atmosphere or to the Emission Control Equipment
4) Up to 25% lower fuel consumption by the Heat Energy System

Blending Bustle

Purpose

To accept Blending gas and blend it back into the incoming hot gas stream generated by the Heat Energy System.

Operation

The Drying System is designed to recycle a portion of the spent gas back through the Dryer System. This has several advantages…

- The recycle gas is blended with the Heat Energy Systems hot gas to achieve optimal gas flow thru the Dryer System
- It reduces the overall oxygen level within the Dryer System thus making the system safer
- It increases the humidity of the gas stream thus increasing capacity of the gas to carry heat and facilitates the ability of the gas to transfer heat into the center of the wood chips without flash drying the surface
- It reduces volume of gas exhausted to atmosphere or emission control equipment
- It improves energy efficiency by about 25%

The design of the Blending Bustle is critical to good operation of the Dryer System. The re-entry point for the recycle gas is positioned as far away from the Dryer Drum Inlet as possible, giving the gasses time to mix before contacting wet-woody-biomass within the Dryer Drum. The design includes 'jetted-tubes' to create turbulence and promote gas mixing. By achieving well-blended gas ahead of the Dryer Drum inlet many problems associated with "hot streaks" in the gas can be avoided, thus minimizing emissions, fires, and improving quality of dried biomass.

Design Details

Materials of construction for chamber: ¼" thick Carbon-Steel.
Materials of construction for jetted-tubes: ¼" thick 310-Stainless-Steel.
Insulation: Two-layer refractory; low density layer with hard refractory face containing about 40% aluminum oxide.
Note: Refractory design by TSI; supply/installation/cure-out offered under Refractory Works option below within this document.
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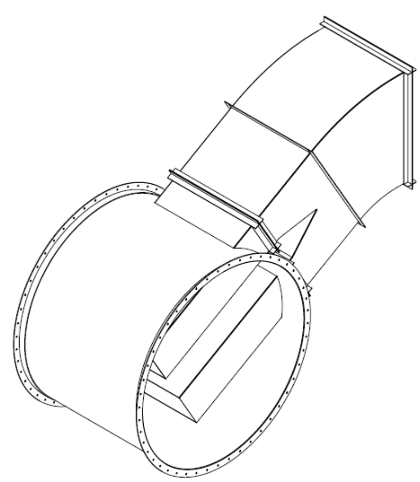


3D view of the recycle duct connecting to the Dilution Bustle; shown within the Dilution Bustle are the 'jetted-tubes' that crate turbulence and promote gas mixing prior to Dryer Drum

Inlet Fitting

Purpose

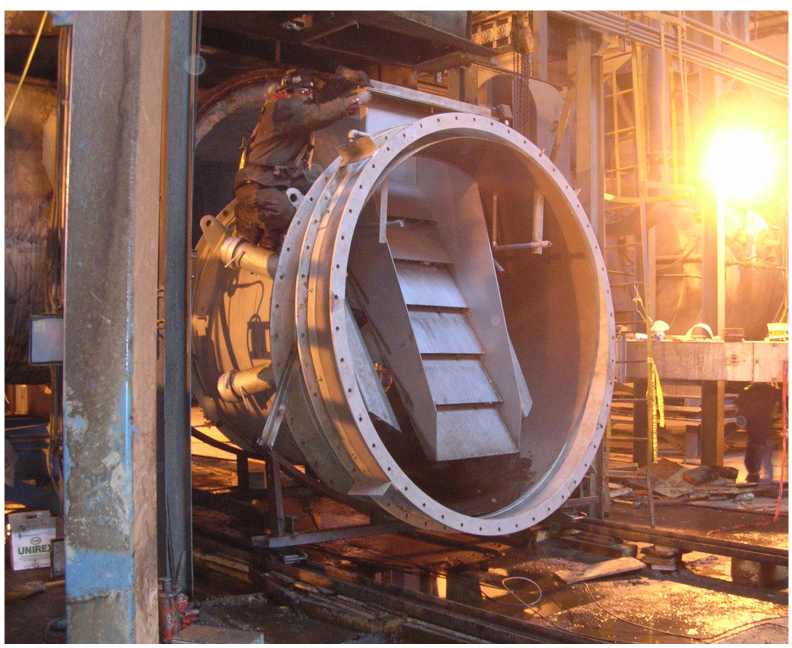
To act as a conduit for the transition of the homogeneous drying gas from the Blending Bustle into the Dryer Drum, and for the introduction of the wet-woody-biomass into the Dryer Drum.

Operation

The Inlet Fitting is a steel duct section with a flange mount for the Infeed Airlock, a louvered chute for the incoming material, tapped ports for injection nozzles, an access door, and a flange mount for the Dryer Drum Inlet Seal. The drying gas passes through the Inlet Fitting into the Dryer Drum. The louvered material chute angles down from the discharge of the Infeed Airlock through the gas stream delivering material into the throat of the Dryer Drum. The drying gas passes through the louvered chute also creating mixing turbulence. There are misting nozzles located within the Inlet Fitting; these provide the Dryer Operator with flexibility to simulate drying load.

Design Details

Materials of construction: ¼" thick Carbon-Steel.
Fittings: For pressure taps, cool-down or artificial load mist nozzles, and deluge nozzles as required by the fire suppression and system control schemes.
Insulation: Two-layer refractory; low density layer with hard refractory face containing about 40% aluminum oxide.
Note: Refractory design by TSI; supply/installation/cure-out offered under Refractory Works option below within this document.



Front view of the Inlet Fitting showing the louvered chute and cool-down nozzles

Purge Fan

Purpose

To purge combustible gas from the Dryer System in order to prevent explosions and fires.

Operation

During a power outage the fuel in the Heat Energy System will continue to smolder, as well as any 'pitch' buildup or biomass that may have accumulated within the Dryer System. This smoldering has the potential to fil up the Dryer System with combustible gas, which upon startup of the system, can cause an explosion due to fresh oxygen that is injected along with sparks coming from the Heat Energy System. To prevent this from occurring, the Purge Fan is connected to the Buyer's Back-up Power Generator and it turns on automatically when the main Dryer System ID Fan is offline. The Purge Fan injects fresh air into the system and purges any combustible gasses from the Dryer System via the Dryer System Abort Stack.

Purge Fan shown at grade level and with connecting duct to the Dryer System's Hot Gas Ductwork

Dilution Duct Isolation Gate

Purpose

To prevent hot gas entering the Dryer System back-wards via the dilution duct.

Operation

The Dilution Duct Isolation Gate is located in the dilution duct just prior to the Dilution Bustle. The Dilution Duct Isolation Gate is in the open position during normal operation. Under upset operating conditions and when the ID Fan stops, the Dilution Duct Isolation Gate will close and prevent hot gas from entering the back end of the Dryer System (the ID Fan, the Abort Stack, Cyclones, etc.). The Dilution Duct Isolation Gate comes equipped with a seal fan. The seal fan will pressurize the gate so hot gas cannot go around the metallic plate that make-up the Dilution Duct Isolation Gate. The seal fan will also purge free the dilution duct of potential for combustible gas buildup.

Design Details

Materials of construction: Housing assembly is fabricated from Carbon-Steel plate for housing, with structural shapes for reinforcing; gate assembly is constructed from ¼" thick Carbon-Steel reinforced floating structure.
Actuator: Twin hydraulic cylinders powered by a dedicated hydraulic power-pack and mounted external to the housing.
Seals: Seal fan.

Dilution Duct Isolation Gate just prior to the Dilution Bustle

Metering Bin

PURPOSE

To receive wet-woody-biomass from the Buyer, store that material, and meter wet material to the Conveyor.

OPERATION

The Metering Bin is located at grade level. The Buyer is responsible for feeding wet-woody-biomass into the Metering Bin; the Buyer is responsible for structurally supporting the Buyer's infeed conveyor due to Metering Bins structural inability to support the said infeed conveyor. The Metering Bin contains augers at bin bottom that are driven by variable frequency drives. These augers feed/meter biomass one the Conveyor. Above the augers is an agitator that distributes biomass evenly across the augers to ensure proper and constant feed.

DESIGN DETAILS

Materials of Construction: 3/16" thick Carbon-Steel for round silo; 304-Stainless-Steel for bottom ten (10) feet of the round silo contacting wet-woody-biomass; 304-Stainless-Steel base plate.

Augers: 3/8" thick 304-Stainless-Steel for housing and flights; 304-Stainless-Steel for pipe.

Rotor Discharge: 304-Stainless

Conveyor

Purpose

To receive wet-woody-biomass from the Metering Bin and convey that wet-woody-biomass into the Infeed Airlock.

Operation

The Conveyor receives wet-woody-biomass from the Metering Bin and conveys that biomass to the Infeed Airlock. The Conveyor is VFD driven and speeds up and slows down based on Metering Bin feed rate.

DESIGN DETAILS

Type: Drag-Chain design.
Drive: Direct coupled electric motor with gear reducer.
Materials of construction: Stainless-Steel for sides and top plate; bottom plate AR400; flights AR400.
Capacity: 300,000 lbs/hr @ 50% moisture content.
Fittings: To receive a speed switch.

Typical Drag-Chain Conveyor

Infeed Airlock

Purpose

To receive wet-woody-biomass from the Conveyor and discharge it onto the louvered chute of the Inlet Fitting.

Operation

The Infeed Airlock comprises a formed machined steel body with a rotating vane. The vane has eight pockets with knife tips. The design loading is based on achieving the optimum balance between minimizing the introduction of ambient air into the system and creating a maximum, non-plugging load in each pocket.

DESIGN DETAILS

Type: Eight-pocket, rotating vane; low-leakage, knife type.
Drive: Direct coupled electric motor with gear reducer.
Materials of construction: Carbon-Steel body with Brass tips.
Fittings: To receive a speed switch that monitors the rotation of the airlock.

Feeder-type Airlock shown installed and operating with direct coupled drive

Dryer Drum

Purpose

To receive wet-woody-biomass and drying gas, expose wet-woody-biomass to the drying gas in an efficient manner, and discharge flue-gas and dried material into the material duct.

Operation

The Dryer Drum consists of three major subassemblies: the drum, the trunnions, and the drive.

The drum is a cylindrical structure formed of rolled mild steel plate, reinforced with structural section channel, tee, and angle ribs, and external bands. The drum rides on two full diameter forged tracks. Drum's interior is a network of lifting flights and baffles, designed to shower material across the drum's cross-section as it rotates and to regulate the forward movement of material through the drum. Around the circumference of the drum are mounted segmented chain teeth sets, on which a roller chain rides. Drum rotation is affected by an electric motor and a gear reducer.

Drum's tires are supported on four trunnion wheels, arranged in opposed pairs at the two track locations. Each trunnion is cast and machined from nodular iron, with shafts riding in split pillow-block spherical roller bearings. Rear trunnion wheels are flanged to fix the location of the drum.

Seals are located at both ends of the drum and are designed to limit ambient air infiltration. Seals are mounted to adapter-taper fittings to insure alignment. Drive chain, trunnions wheels, and tracks are lubricated. The drum is clad with a corrugated skin, which creates an air gap that acts as an effective insulator.

Shown Ø13'x60' long Dryer Drum
(inboard location of tracks for reduced stress on the shell, the reinforcing channels throughout, and oversized trunnion wheels & tracks for long service life)

Design Details

DRUM

Materials of construction: 3/8" thick A572-Grade 50 Carbon-Steel plate for drum wall, with formed and welded channel structural members to reinforce the high strength weldment, using ¾" angle iron flanges to connect the sections. Forged tires are machined for bolted connection to the drum sections.

Drum rotational drive: NEMA B electric motor and parallel-shaft gear reducer.

Drum backup drive: A backup drive is provided to rotate the Drum during power outage situations.

Typical Dryer Drum section – pictured during installation
(note the 'open' flighting within the Drum; the flighting promotes chip individualization so each particle moves thru the Drum at its own pace; the open design also provides for easier maintenance as maintenance personnel can walk thru the length of the Drum)

TRUNNIONS
Type: Flat/flanged couple; idling.
Materials of construction: ASTM grade 60 cast nodular iron for wheels, mounted on mild steel base weldment structures.
Bearings: Pillow blocks with split housings; spherical, self-aligning roller elements.

SEALS
Type: Fiberglass belt with spring steel plates for support.

INSULATION
Type: Galvanized corrugated sheet metal with air gap between sheet metal and drum shell; insulation is designed by TSI, supplied/installed by the Buyer.

LUBRICATION
Type: Oiler.

SAFETY GUARDS
Type: Track guards that cover drum’s tracks and trunnion wheels.

Ductwork

Purpose

To convey dried biomass and spent gas from the Dyer Drum discharge to the High Efficiency Cyclone(s), and to convey spent gas from the High Efficiency Cyclone(s) discharge to the ID Fan, and from the ID Fan either to the Dilution Bustle and Exhaust Stack (or Wet Electrostatic Precipitator).

Operation

The Ductwork is made from rolled Carbon-Steel. There are two (2) types of ducts: the material duct that conveys both spent gas and dried biomass and gas duct that conveys spent gas only. The material duct runs from the Dryer Drum discharge to the High Efficiency Cyclone(s) inlet. The gas duct runs from the High Efficiency Cyclone(s) discharge to the ID Fan, and from the ID Fan to the Dilution Bustle and to the Exhaust Stack or the Wet Electrostatic Precipitator.

DESIGN DETAILS

Type: Rolled Carbon-Steel with flanged connections.
Materials of Construction: ¼" thick for material duct and 3/16" for gas duct.
Elbows within Material Duct: ½" thick T1.
Expansion Joints: Corrugated Stainless-Steel.

Typical corrugated Stainless-Steel Expansion Joints

Double-Duct

Purpose

To keep inner walls of the Ductwork's gas ducts hotter than the condensable temperature of the complex hydrocarbons that evaporate from biomass during the drying process, thus prevent 'pitch' buildup.

Operation

The Double-Duct keeps the 'inner' walls of the gas duct hotter than the condensable temperature of complex hydrocarbons that evaporate from biomass during the drying process. This prevents hydrocarbons from condensing onto the 'inner' walls of the gas duct, which is commonly in the industry referred to as 'pitch' buildup. Pitch buildup is prone to fires, explosions, and while it accumulates it gradually reduces production capability of the Dryer Island due to restricting gas flow. It is costly and time consuming to manually clean 'pitch' buildup. Double-Duct does not completely eliminate 'pitch' buildup and manual cleaning is still necessary but at reduced intervals. Double-Duct is heated via Air-to-Air Heat Exchanger and is backed up by an Electrical Heater.

Zones:

1) Gas duct from Cyclone(s) discharge to ID Fan inlet
2) Abort Stack from bottom level to Abort Damper

Design Details

Materials of Construction: 3/16" Carbon-Steel.

Typical double-duct; please note the inner duct and outer duct

High Efficiency Cyclone(s)

Purpose

To separate dried biomass from the flue-gas and deliver dried biomass into Cyclone Airlock(s).

Operation

The High Efficiency Cyclone(s) accepts flue-gas and dried biomass from the incoming material duct. The inlet geometry features a tangential transition to the tub section with inlet angle between material duct and transition of fifteen (15) degrees. The Cyclone bottom cone is a relatively shallow angle for better efficiency at removing smaller particulate from the flue-gas. At the exit of the cone there is an oversized vortex breaker with anti-spin baffles to effectively stop the cyclonic action of the dried biomass and to evenly distribute dried biomass into Cyclone Airlock pockets, thus minimizing the risk of plugging and wear on the tips of the Cyclone Airlock. Flue-gas is drawn from the top of the Cyclone and into the gas duct. Explosion relief panels are located on top of the Cyclone.

Design Details

Access: A door on the gas inlet and gas outlet of the Cyclone.

Explosion Panels: NFPA certified explosion panels located at top of each Cyclone.

Cyclones are positioned directly on top of the Buyer's Fire Dump; underneath each Cyclone is a Cyclone Airlock; under Cyclone Airlocks are Collection Screws that process biomass under normal operating conditions to Buyer's process conveyor; under upset operating conditions Collection Screws reverse direction to dump biomass to Buyer's Fire Dump.

Oversized vortex breakers underneath the Cyclones

Cyclone Airlock

Purpose

To receive dried biomass from the High Efficiency Cyclone and discharge dried biomass to the Collection Screw.

Operation

The Cyclone Airlock comprises a formed machined steel body with a rotating vane. The vane has eight pockets with knife tips. The design loading is based on achieving the optimum balance between minimizing the introduction of ambient air into the system and creating a maximum, non-plugging load in each pocket.

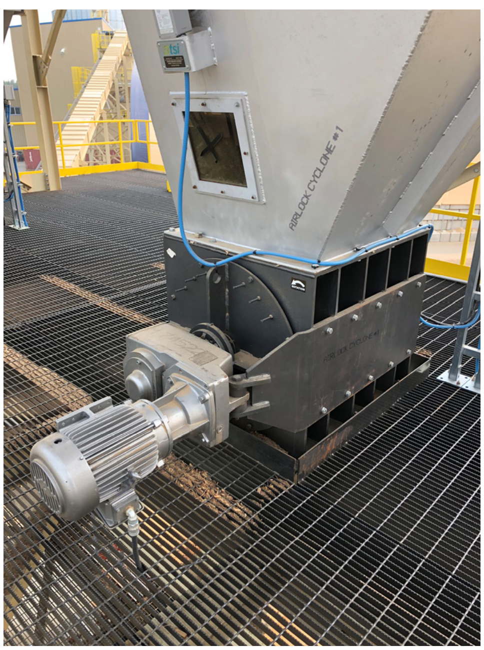
Note: each Cyclone has a dedicated Cyclone Airlock

Advantages

- Lower emissions (any ambient air leakage upwards through the Cyclone Airlock will lift particulate removed by the Cyclone and exhaust to the WESP)
- Lower WESP loading (lower dust loading onto the WESP will result in less maintenance)
- Lower Dryer System operating oxygen levels (any ambient air leaked into the Dryer System will result in higher operating oxygen levels, which is detrimental for fires and sparks)
- Lower maintenance (knife tips are typically adjusted once/year, whereas rubber tips need to be replaced at least twice/year)

Design Details

Type: Eight-pocket, rotating vane; low-leakage, knife type.
Drive: Direct coupled electric motor with gear reducer.
Materials of construction: Carbon-Steel body with Brass tips.
Fittings: To receive a speed switch that monitors the rotation.



Cyclone Airlock underneath the vortex breaker operating with a direct coupled drive

Collection Screw

Purpose

To collect dried biomass from the Cyclone Airlock(s), and process dried biomass to the Buyer's take-away conveyor during normal operating conditions or to the Buyer's Fire Dump during upset operating conditions.

Operation

The Collection Screw is located underneath the Cyclone Airlock(s) and receives dried biomass from the Cyclone Airlock(s). The Collection Screw conveys biomass to the Buyer's take-away conveyor during normal operating conditions. During upset operating conditions the Collection Screw will reverse direction and dump biomass directly into the Buyer's Fire Dump. The tower holding the Cyclone(s), Cyclone Airlock(s), and the Collection Screw, is located directly on top of the Buyer's Fire Dump.

Design Details

Drive: Direct coupled electric motor with gear reducer.
Materials of construction: ½" thick Carbon-Steel body with ½" thick Carbon-Steel for screw.

Shown in the picture is the entire assembly of the Cyclones, Cyclone Airlocks, and Collection Screw all located direction above the Buyer's Fire Dump.

ID Fan

Purpose

To provide the motive force and requisite pressures through the Dryer System.

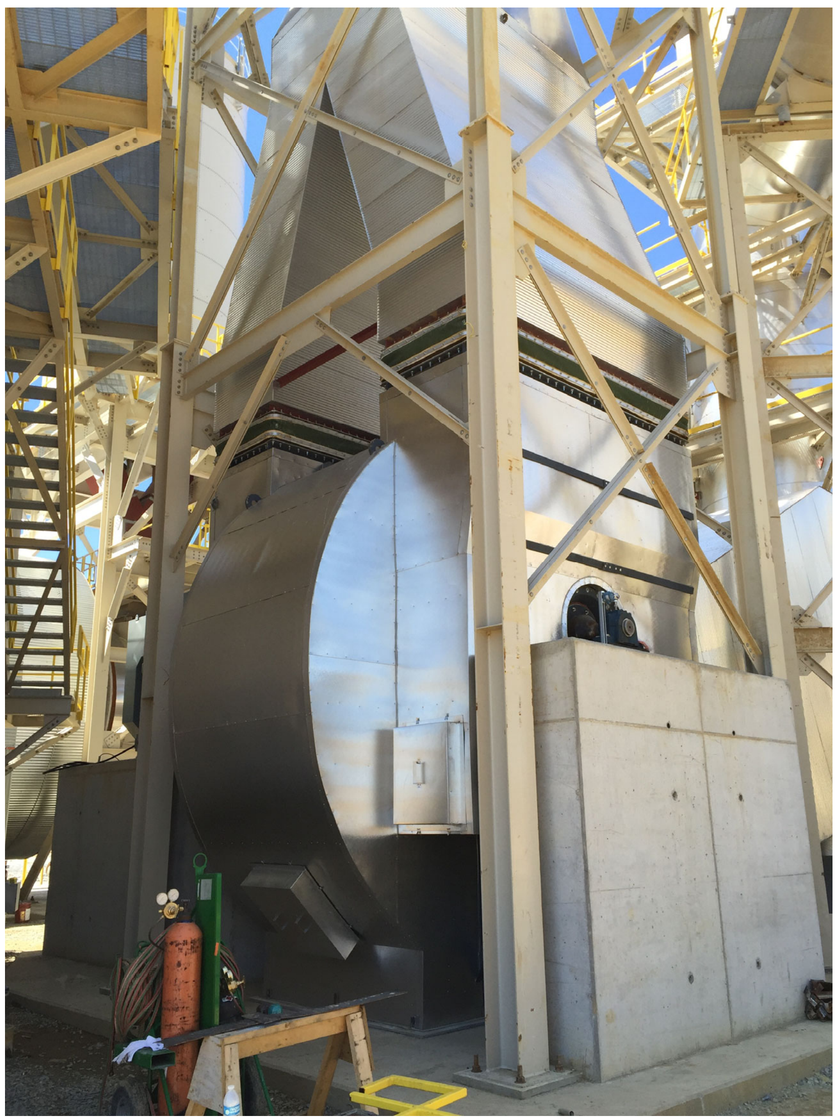
Operation

The ID Fan is positioned at grade level after the High Efficiency Cyclone and connects to Gas Ductwork on both the inlet and the outlet sides. It draws gas through the entire Dryer System prior to the inlet and then forces some gas back into the Dryer System via the Recycle Bustle and the reminder of the gas to the WESP. There are expansion joints located at both the inlet and the outlet of the ID Fan that accommodate for the thermal expansion of the Gas Ductwork, but also isolate the Ductwork from any potential vibrations originating with the ID Fan. The ID Fan flow is modulated via a Variable Frequency Drive and it is governed by the pressure differential reading across the High Efficiency Cyclones.

Design Details

Type: Single wheel, double inlet, single outlet, centrifugal, class IV.
Blade Shape: Radial Tip.
Access: Man-door for maintenance.

Typical ID Fan



Dilution & Stack Damper

Purpose

To control the flow of flue-gas to the Dilution Bustle or to the Pollution Control Equipment.

Design Details

Type: Opposed blade louver.
Actuator: BECK actuators.

Emergency Abort Stack

Purpose

To vent Dryer System flue-gas to atmosphere during upset operating conditions.

Operation

At times the Dryer System flue-gas will need to be aborted to atmosphere during upset operating conditions. The Emergency Abort Stack provides the ability to vent gases to atmosphere during upset operating conditions. The control damper is air actuated and is fail safe; if there is a power outage or air failure the Emergency Abort Stack will automatically open.

The Emergency Abort Stack is a 'free-standing-stack'.

Structural Steel

Purpose

To provide structural support for the Dryer System and to provide personnel access via stairs, ladders, and platforms.

Description

TSI supplies the support structures, stairs, ladders, and platforms from grade level as is typically required by the Dryer System. This includes access to areas requiring regular maintenance or monitoring by operating personnel. Stair access is provided to areas requiring maintenance on a daily or weekly basis; longer maintenance intervals will have ladder access. Client will have opportunity during system design to comment on access and add more if needed with an appropriate price adjustment.

Design Details

Assembly: Bolted and welded assembly.
Finish: Painted.

Typical Structural Steel (shown during construction)

Control Devices

Description

The following devices are included in order to control the Dryer System via PLC:

- Temperature Control Sensors
- Temperature Transmitters
- Pressure Transmitters
- Speed Switches
- Proximity Switches (Capacitive and Inductive)
- Plug Detectors
- Deluge Nozzles

Typical quick-disconnect removable nozzle

Spark Detection and Suppression

Purpose

To monitor the Dryer System for sparks and fires, and extinguish those sparks and fires.

Operation

The Spark Detection and Suppression monitors various locations within the TSI Dryer System. Deluge nozzles are linked to the spark detection devices and respond appropriately based on input. The deluge works in conjunction with the Collection Screw to abort material to the Buyer's Fire Dump. The Spark Detection and Suppression is integrated into the overall Dryer System controls with audible fire alarm, control panel display, and fire sequence relay.

Design Details

Type: Computerized spark detection and extinguishing system.
Suppression Equipment: Water suppression system complete with nozzles, valves, spark sensors, and control logic for automatic and manual operation; deluge valves are supplied that include Y-strainers to clean water from impurities, flow switches to indicate flow, ASCO solenoid valves to actuate flow, with manual by-pass.
Notes:
1) Fire detection & suppression by the Buyer.
2) TSI will supply Deluge Nozzles for the Dryer System with exception to the fast-acting suppression nozzles located between the Drum & Cyclone(s); Buyer responsible for supplying Deluge Valves (as described above complete with ASCO solenoid, manual by-pass, Y-strainers, and flow switches; heat tracing if required is by the Buyer) as specified by TSI along with pipework from Deluge Valves to the TSI supplied Deluge Nozzles (TSI will only supply Deluge Nozzles along with engineering drawings).

Typical Spare Detection Equipment at connecting chute

ITEM 04 WET ELECTROSTATIC PRECIPITATOR (WESP)

Shown below and on following pages are some of the major individual components that make up the WESP.

Required Water Quality for the WESP

The WESP utilizes water and a 50% solution of Sodium Hydroxide (NaOH) to flush out and clean the collection tubes. NaOH is injected directly into the flushing system to assist in the cleaning process. The NaOH injection will drive the pH of the flush water into the basic range (generally in the order of pH 10 – 12). The high pH is an essential element in maintaining clean surfaces within the WESP. By driving pH into basic range, $CaCO_3$ will precipitate out of the water causing buildup in the pump, piping, and nozzles. In order to mitigate the amount of hard water buildup in the system it is **required** that the incoming water hardness be at or below the level of "soft water". Below is a range that describes total water hardness.

- 0-60 ppm $CaCO_3$ – soft
- 60-120 ppm $CaCO_3$ – moderately hard
- 120-180 ppm $CaCO_3$ - hard
- >180 ppm $CaCO_3$ - very hard

Total water hardness of water delivered to the WESP should always remain below 60 to ensure trouble free operation.

The Water Treatment System is by the Buyer (below is WESP water requirement):

- pH: 6 – 8
- Conductivity (uS/cm): <1000
- COD (mg/l): <500
- Suspended Solids (mg/l): <100
- Water Hardness (°dh): <10 (preferably <5)
- Calcium (mg/l): <80 (preferably <40)
- Formaldehyde (mg/l): 0 (limit 10)
- Sulfates SO4: <100
- Chlorides (mg/l): <50

Required NaOH Quality for WESP

NaOH is manufactured with two distinct methods (Diaphragm and Membrane). Diaphragm grade caustic, while less expensive, has up to 100 times more-free NaCl in the solution. The introduction of NaCl can cause stress corrosion cracking as well as general corrosion on the internal surfaces of the wet ESP.

Membrane grade caustic has less NaCl. It is essential that the NaOH purchased for the WESP is membrane grade in order to prevent damage to the WESP. Additionally, because the recycle water is often sprayed back into the Heat Energy System, or the Dryer System, similar corrosion impacts might be realized there as well.

Quench-Duct

Purpose

The Quench-Duct sprays recycled water into the incoming Dryer System flue-gas stream, thereby saturating and cooling that gas stream to the wet-bulb temperature, and at same time removes larger particulate prior to the WESP.

Operation

The Quench-Duct is equipped with recycled water header, sprays, and nozzles to saturate the gas stream and scrub out larger front-half particulate (or filterable particulate) from the gas stream. Saturating the gas stream also allows the WESP to condense and remove some back-half particulate (or condensable particulate); back-half particulate that condenses at temperatures lower than the operating gas stream's wet-bulb temperature will not be captured by the WESP. Scrubbing the larger front-half particulate prior to the WESP allows the precipitator to operate cleaner and have higher efficiency for smaller front-half particulate.

Design Details

Design Pressure: ±25" w.c.
Materials of Construction: T-304L Stainless-Steel skin/piping/nozzles with Carbon-Steel externals.

Typical Inlet Quench Duct

Wet Electrostatic Precipitator

Purpose

The Wet Electrostatic Precipitator collects and removes fine particulate from the Dryer System flue-gas stream.

Design Details

Design Pressure: ±25” w.c.

Inlet Section:

- 3/16” thick T-304L Stainless-Steel internals with Carbon-Steel externals
- Flooded floor design which eliminates buildup on the bottom surface
- Turning vanes for even distribution of gas stream across tube sections

Collection Section:

- T-304L Stainless-Steel internals with Carbon-Steel externals
- 14-gauge x Ø10” collection tubes with ¼” thick tube sheet
- Carbon-Steel structural supports
- Carbon-Steel vane axial fans (one per tube bundle) to blow ambient air across the tube section, this promotes condensation on the internal surfaces of the collection tubes thus keeping the tube walls wet

Power Grid Housing:

- 3/16” thick T-304L Stainless-Steel internals with Carbon-Steel externals (stiffeners, brackets, etc.)
- T-304L Stainless-Steel flush header
- T-304L Stainless-Steel collection electrodes (rigid mast with concentric disk electrodes complete with triangular plate alignment mechanism for final alignment)
- T-304L Stainless-Steel power grid that is suspended from outboard porcelain insulators within Purged Insulator Compartments
- T-304L Stainless-Steel Purged Insulator Compartments with integrated purge air system (see further details in proposal), suspension bracket for high voltage insulator, and access hatch for easy access to each insulator.

Wet Electrostatic Precipitator

Power Grid and Discharge Electrodes

Flush Header within the Power Grid

High Voltage Power Supply

Purpose

The High Voltage Power Supply delivers DC rectified high voltage to the electrostatic fields of the WESP.

Description

The High Voltage Power Supply and its control panel are included. The Transformer Rectifier (T/R) will be located at the power grid level of the WESP and the control panel will be located in the owner supplied MCC room.

Design Details

Type: 3 phase, air cooled.
T/R: IP 65 (NEMA 4).
Control Panel: IP 54 (NEMA 12) to be located in the Dryer Island E-House.
Output Rating: 70 kV; as required milliamps.
Input Power: 460 V / 3-phase / 60 Hz.
High Voltage Transmission: Pipe in grounded duct.
Features: Control Panel with digital controller, KV and MA signal transmitters; remote start/stop function; grounding switch; key interlock system.

High Voltage Power Supply

Discharge Duct

Purpose

The Discharge Duct conveys particulate cleaned gas stream from top of the WESP to grade level to connect to the downstream RTO.

Description

The discharge duct will connect the top of the WESP to the RTO's Mist Eliminator Chamber located at grade level.

Design Details

Design Pressure: 25" w.c.
Discharge Duct: 3/16" thick T-304L Stainless-Steel internals with Carbon-Steel externals.

Discharge Duct shown

Quench Water Recycle

Purpose

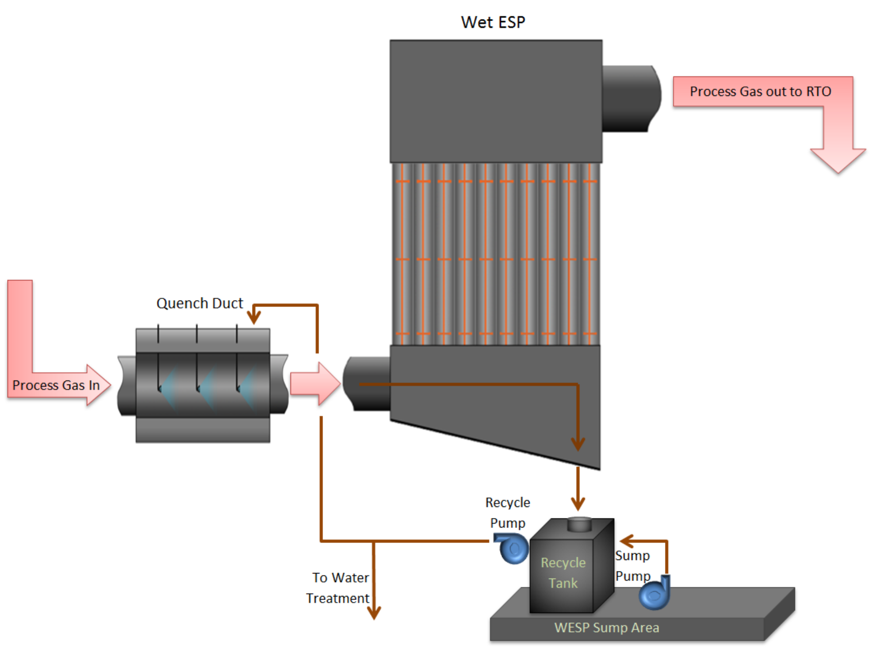
Quench Water Recycle delivers recycled water to the Quench-Duct and collects all water from the Wet Electrostatic Precipitator, including recycle water draining from the Quench Chamber and spent water and particulate from flushing of the WESP collection tubes.

Description

The Quench Water Recycle includes a recycle tank, a recycle pump, valves, strainers and all specialty fittings. The Quench Water Recycle periodically flushes independent electrical fields to wash away collected debris. Recycle water is sprayed (via the recycle pump) into the Quench Duct and spent recycle water will gravity drain back into the recycle tank located beneath the WESP. The Quench Water Recycle is controlled automatically by the Dryer Island PLC control system. Make up water requirements due to evaporation, or blow down, will be satisfied with flush water. PLC programming will control flush sequence based on recycle tank water level.

Design Details

Recycle Tank: Rectangular T-304L Stainless Steel tank with water dual jet agitation sprays.
Recycle Pump: ANSI centrifugal; T-316L Stainless Steel wet end.
Sump Pump: self-priming containment evacuation in the event of a spill.
Features: Includes all required nozzles, automatic and manual valves, and an oversized duplex strainer to prevent nozzles from plugging; piping and general fittings are to be supplied by the installation contractor.
Containment Area: Recycle tank is placed within a concrete curbed area to contain any spills from the tank, pumps, or strainers. The containment area is self-draining to a collection sump where the water can be pumped back into the recycle tank.



Flush

Purpose

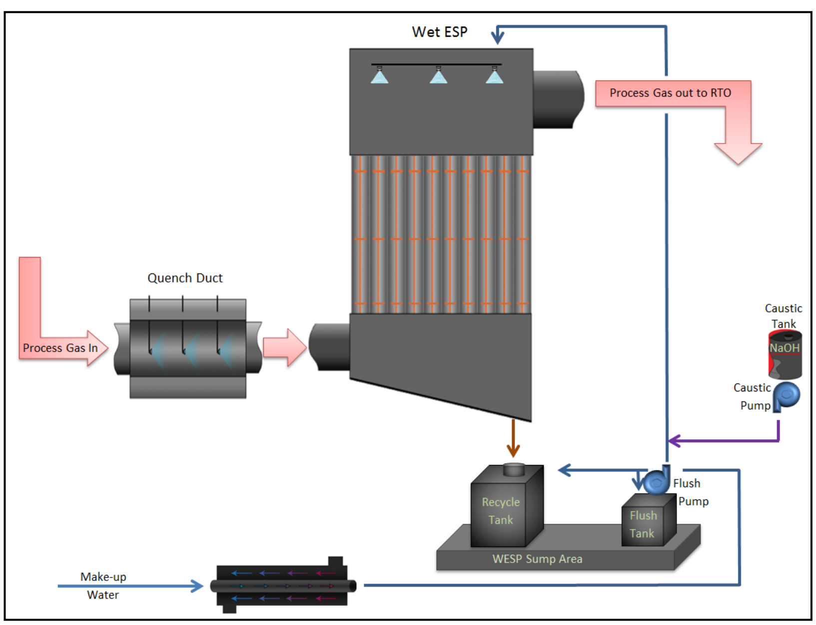
Flush delivers hot clean water to the collection tube of the WESP to rinse away collected particulate.

Description

Flush includes a flush tank (immersed within the recycle tank for heating purpose), a flush pump, valves, strainers, and all specialty fittings. Flush periodically flushes independent electrical fields to wash away collected debris. Flush is controlled by the PLC and is based on timers. A "pause" timer controls the time between flushes. A "duration" timer controls the duration of the Flush. If the recycle tank cannot accept Flush water the pause timer will be extended to allow evaporation to reduce the level of water within the tank. If the recycle tank is running low on water the pause timer will be advanced and trigger a Flush.

Design Details

Flush Tank: 2000 gallons immersed within the recycle-tank.
Flush Pump: Centrifugal style pump sized to deliver appropriate flow and head pressure to flush header and nozzles.
Nozzles: T-304L stainless steel maximum passage nozzles; arrangement insures proprietary overlapping pattern above each collection tube to guarantee adequate coverage to all tube surfaces.
Features: All required nozzles and internal headers are provided; one feed per WESP unit consisting of heated flush tank immersed in the recycle water for heat transfer purposes and a pump will be supplied; hot water with caustic added is more effective in removing sticky organic deposits from the collection tubes than cold water; piping and fittings are to be supplied by the installation contractor.



Typical Flush

Chemical Injection

Purpose

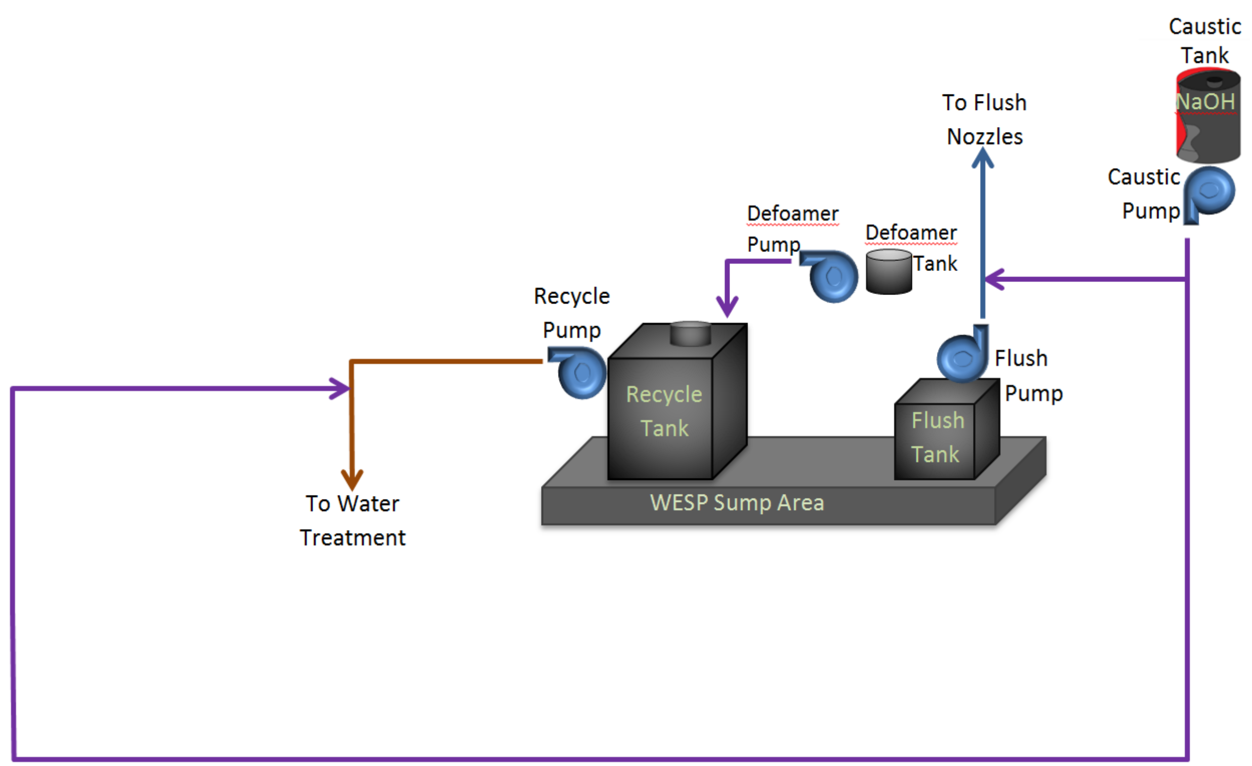
Chemical Injection delivers necessary chemicals (NaOH or Caustic and a defoaming agent) to the Recycle System and Flush System.

Description

The Chemical Injection is incorporated into the flush and recycle. Chemical Injection is designed to periodically inject sodium hydroxide (NaOH) directly into the flush water to aid in cleaning of the Wet ESP collection tubes. The flush and caustic systems will be controlled by the Dryer Island PLC. The Chemical Injection is also designed to inject a de-foaming agent into the water recirculation system to control foam when it occurs. The de-foaming system will be controlled at the PLC and also have the capability for manual control. The caustic and de-foaming system will be enclosed in a containment area. TSI will supply a Caustic Tank Pump that will receive and pump caustic from incoming trucks into the tank.

Design Details

NaOH Pump: Gear pump with 2 to 3 gallons per minute capacity (7.5 to 11.25 liters/minute).
De-foaming Pump: Gear pump with 2 to 3 gallons per minute capacity (7.5 to 11.25 liters/minute).
NaOH Tank: 6,500-gallon cross linked polyethylene with surface heaters.
De-foaming Agent: To be determined after startup; totes provided by chemical vendor.



Purge Air

Purpose

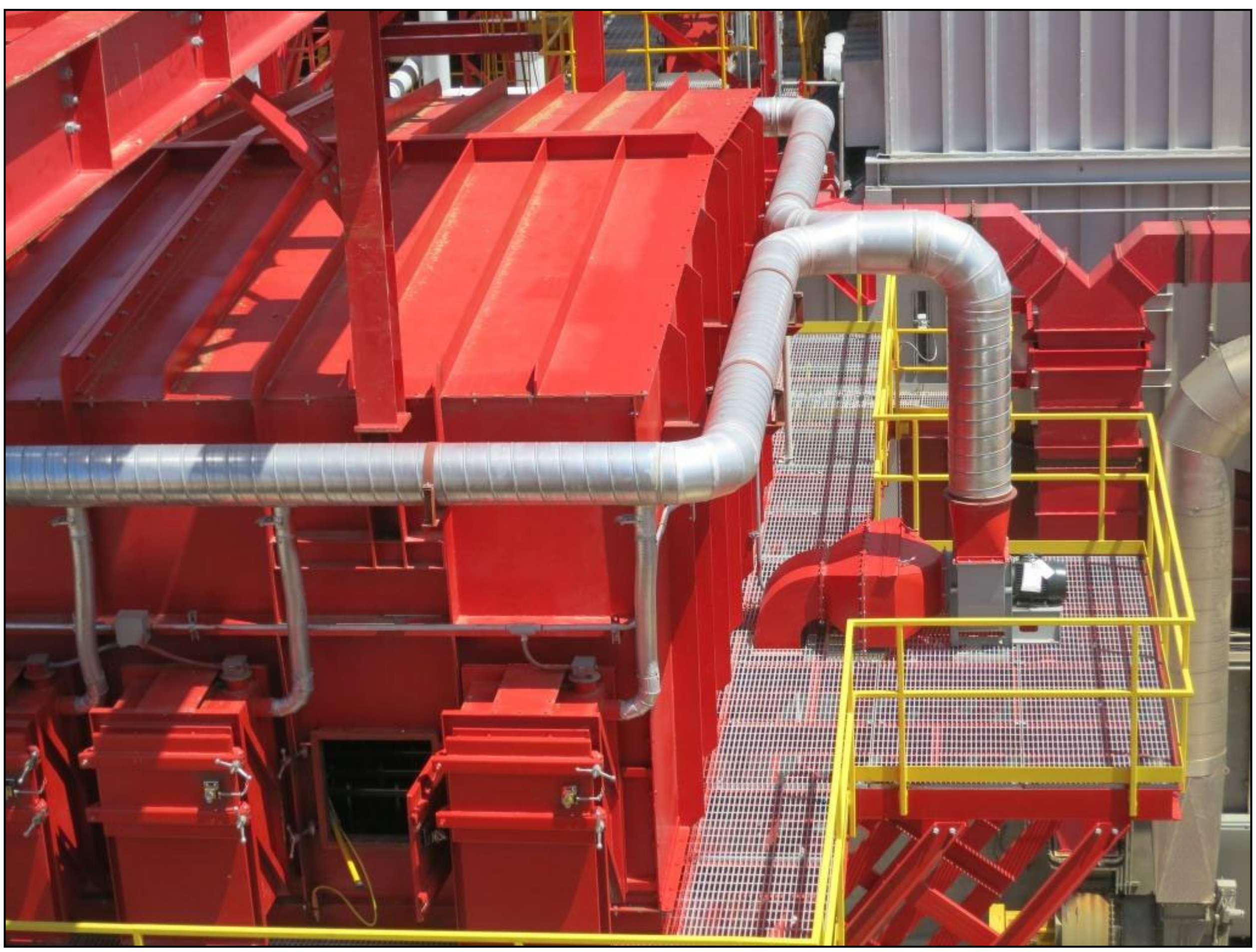
Purge Air delivers warm air to the insulator boxes to prevent contamination, which can cause arcing in the insulator boxes that will degrade WESP's performance, from the process gas stream.

Description

Purge Air includes a fan, heaters, and a duct network to deliver air to the insulator boxes. The fan will draw air from the outside surface of the tube section. Initially, electric resistance heaters located at each insulator box will be energized to supply the heat necessary to raise the temperature of the purge air. Once the WESP is warmed the heat will be gained from the tube section and the heaters will be de-energized.

Design Details

Fan: Centrifugal fan capable of supplying 1000 CFM per electrostatic power field
Heaters: Four (4) per power field; electric resistance 1.5 kW each



Purge Air Fan shown with connecting insulated ductwork

Decanter Centrifuge

Purpose

Decanter Centrifuge removes solids suspended in the process water, thus reducing concentration of solids in the water, therefore minimizing amount of water blow-down required by the WESP.

Description

The Decanter Centrifuge removes solids collected by the WESP. The Decanter Centrifuge is configured to treat a slipstream of up to 50 gallons per minute (187.5 liters/minute) of recycle water from the WESP. The cake produced by the Decanter Centrifuge is approximately 50% solids by weight; this discharge is typically land-filled. The centrate (cleaned water) gravity drains back to the recycle tank. A small blow-down stream of approximately two (2) gallons per minute (7.5 liters/minute) is necessary to control concentration of dissolved solids within WESP's water. The exact amount will be determined after start up based on dissolved solids level.

Design Details

Materials of Construction: 304L-Stainless-Steel for wetted parts.
Capacity: 50 gallons per minute (187.5 liters/minute).

Structural Steel

Purpose

To provide structural support for the WESP and to provide personnel access via stairs, ladders, and platforms.

Description

TSI supplies the support structures, stairs, ladders, and platforms from grade level as is typically required by the WESP. This includes access to areas requiring regular maintenance or monitoring by operating personnel. Stair access is provided to areas requiring maintenance on a daily or weekly basis; longer maintenance intervals will have ladder access. Client will have opportunity during system design to comment on access and add more if needed with an appropriate price adjustment.

Design Details

Assembly: Bolted and welded assembly.
Finish: Painted.

Piping Materials

Fresh Water Lines: threaded black iron
Chemical Lines (NaOH & Defoamer): Threaded black iron
Flush System Lines: Flanged black iron
Process Water Lines: Combination of flanged and threaded T-304 Stainless-Steel

Control Devices

Description

The following devices are included in order to control the WESP via PLC:

- Temperature Control Sensors
- Temperature Transmitters
- Zero Speed Switches
- Pressure Transmitters
- Proximity Switches (Capacitive and Inductive)
- Level Indicators
- PH Level Indicators

ITEM 05 REGENERATIVE THERMAL OXIDIZER (RTO)

Shown below and on following pages are some of the major individual components that make up the RTO.

Mist Eliminator Chamber

Purpose

To remove as much suspended water droplets from the gas stream as possible in order to minimize bed fouling and reduce heat requirement on the RTO burners.

Operation

The Mist Eliminator Chamber slows the incoming gas stream to required velocity to enable the mist eliminator modules to remove water droplets from the incoming gas stream. The modules are of chevron style. The mist eliminator modules are flushed routinely utilizing the WESP flush system and water drains back to the WESP sump.

Design Details

Materials of Construction: 3/16” thick 304-Stainless-Steel.
Operational Parameters: ±25” w.c. @ 150°F.
Access: One (1) access door on each side for internal inspection of both leading and trailing side of the modules.
Flush: Integrated into WESP Flush and includes leading edge and top-down flushing.

Mist Eliminator Chamber
(incoming gas stream from the left; discharge into the RTO to the right)

FD Fan

Purpose

To provide the motive force and requisite pressures through the WESP and the RTO.

Operation

The FD Fan is controlled by a variable frequency drive (VFD). The FD Fan modulates automatically via the PLC to maintain a static pressure set-point at the inlet to the WESP. The FD Fan induces gas flow thru the WESP and pushes gas flow thru the RTO.

Design Details

Materials of Construction: Stainless-Steel with external Carbon-Steel reinforcing structural members.

Design Conditions:

- Flow = Actual flow +10%
- Pressure = Actual Pressure +21%.

Bearings: Complete with vibration transmitters and temperature elements.

Expansion Joints: Stainless-Steel.

Inlet Manifold

Purpose

The Inlet Manifold distributes process gas to the Diverter Valves.

Design Details

Materials of Construction: 3/16" thick 304-Stainless-Steel.
Operational Parameters: ±25" w.c. @ 150°F.
Access: One (1) hinged and plug insulated access door for internal inspection.

Inlet and outlet manifold shown on either side of centered valve

Poppet Diverter Valves

Purpose

To control the flow direction of the flue-gas through the RTO media chambers.

Operation

The Poppet Diverter Valves are controlled by timers within the Programmable Logic Controller (PLC). At intervals of approximately three (3) minutes, pairs of Poppet Diverter Valves will simultaneously shift, reversing the flow direction of the process gas through the RTO. This allows the heat recovery beds to alternate between a heat source and a heat sink, thus allowing the RTO to recover approximately 95% of the thermal energy.

Design Details

Materials of Construction: 10-gauge 304-Stainless-Steel.
Operational Parameters: ±25" w.c. @ 150°F inlet and 250°F outlet.
Valve Trim Construction: Main-disk fabricated from 7-gauge thick Duplex-Stainless-Steel; support-disks fabricated from 10-gauge 304-Stainless-Steel; seat materials are 304-Stainless-Steel; seal arrangement is metal to metal sealing surfaces.
Access: One (1) hinged and plug insulated access door for internal inspection of valve and bottom side of the hopper.
Valve Actuation System: Parker 2A heavy duty pneumatic cylinder, adjustable end cushions at each end of travel; direct link with Parker linear alignment coupling, inductive proximity switches measuring actual valve shaft position, actuation time is 0.5 to 1.0 second full open to full close; each valve is pre-assembled and pre-wired to junction box.

Hopper Transitions

Purpose

The Hopper Transitions distribute flow evenly to the bottom surface of the heat recovery media.

Operation

The Hopper Transitions allow gasses exiting the Poppet Diverter Valve to slow down and spread out evenly across the bottom face of the media bed.

Design Details

Materials of Construction: 3/16” thick 304-Stainless-Steel.
Operational Parameters: ±25” w.c. @ 150°F inlet and 250°F outlet (excursions up to 600°F during bakeout).

Typical Hopper Transition

Heat Recovery Chamber

Purpose

To serve as a vessel for the heat recovery media.

Operation

The Heat Recovery Chamber houses the heat recovery media that enables the RTO to recover approximately 95% of the thermal energy. The Heat Recovery Chamber also houses the media support structure for the heat recovery media, sometimes referred to as the “cold face”.

Design Details

Materials of Construction: 3/16” thick 304L-Stainless-Steel reinforced outside with Carbon-Steel stiffeners.

Operational Parameters: ±25” w.c. @ 150°F inlet and 1500°F outlet; maximum operational temperature 1800°F.

Media Support Structure: Laser cut or high-def plasma slotted 316-Stainless-Steel plate (laser cutting or high-def plasma mitigates stress concentration due to cold working); maximum free passage of 70% open area; centered in Heat Recovery Chamber with no direct contact to outside walls; completely floating design to prevent stress concentrations while allowing for thermal expansion.

Access: Inspection access to the support structures is through the diverter valve; inspection access to top of heat recovery section is through combustion chamber access.

Note: Most vendors fabricate Heat Recovery Chamber from Carbon-Steel with mastic lining; when hot spots develop the mastic lining will burn off and leave the internal surfaces unprotected from oxidation long after hot spots are corrected; TSI fabricates Heat Recover Chambers from Stainless-Steel *to eliminate this potential issue.*

Media support beams
‘Norton Beam Style’

Combustion Chamber

Purpose

Emissions created by the Heat Energy System and the Dryer System, which were not removed by the WESP, are destroyed within the Combustion Chamber.

Operation

The Combustion Chamber houses a natural gas burner that regulates the internal temperatures of approximately 1500°F and greater. The Combustion Chamber is specifically designed to provide a minimum residence time of 0.5 seconds (along the flue-gas flow's "shortest path possible"). The combination of temperature and adequate residence time ensures that majority of the incoming hydrocarbons will be converted to CO_2 and H_2O. Volatile Organic Compounds (VOCs), Carbon Monoxide (CO), Hazardous Air Pollutants (HAPs), and Back-Half Particulate (BHP) are all destroyed within the Combustion Chamber.

Design Details

Materials of Construction: 3/16" thick 304-Stainless-Steel.
Operational Parameters: ±25" w.c.; normal operation 1500°F; maximum operational temperature 1800°F.
Access: One (1) access door on a davit in each combustion chamber.
Note: Most vendors fabricated Heat Recovery Chamber from Carbon-Steel with mastic lining; when hot spots develop the mastic lining will burn off and leave the internal surfaces unprotected from oxidation long after hot spots are corrected; TSI fabricates Heat Recover Chambers from Stainless-Steel *to eliminate this potential issue.*

Outlet Manifold

Purpose

The Outlet Manifold collects process gas from the RTO and delivers that process gas to the Exhaust Stack.

Design Details

Materials of Construction: 3/16” thick Carbon-Steel.
Operational Parameters: ±25” w.c. @ 450°F.
Access: One (1) hinged and plug insulated access door for internal inspection of outlet manifold.

Control Dampers

Purpose

The Control Dampers gas flow and fresh air flow thru the RTO.

Operation

There are three (3) control dampers within an RTO. They are the “blocking”, “fresh air”, and “bleed air” dampers. The blocking and fresh air dampers work together, isolating the RTO from the process gas, and allowing fresh air to enter the RTO. This is required during the burner ignition as well as the warm up cycle of the RTO, which must happen at a reduced airflow. When the blocking damper is closed the fresh air damper will be open and vice versa. The bleed air damper allows the discharge side of the RTO to vent during shutdown and outages; this serves as a vacuum break caused by the stack affect during those situations.

Design Details

Materials of Construction:

- Blocking: 304-Stainless-Steel butterfly valve with metal-to-metal seats and Carbon-Steel brackets and stiffeners; controlled by a pneumatic actuator.
- Fresh air: 304-Stainless-Steel butterfly valve with tadpole seats and Carbon-Steel brackets and stiffeners; controlled by a pneumatic actuator.
- Bleed air: Carbon-Steel with tadpole seats and Carbon-Steel brackets and stiffeners; controlled by a pneumatic actuator.

Exhaust Stack

Purpose

To exhaust treated process gas to atmosphere.

Design Details

Materials of Construction: Carbon-Steel.
Access: Sampling platform and ports at EPA required position, ladder from grade to platform, and will be free standing.

Internal Ceramic Refractory

Purpose

To protect the shell of the RTO from high internal temperatures

Operation

The Internal Ceramic Refractory is bolted to studs that are welded to the internal surface of the Heat Recovery and Combustion Chambers.

Design Details

Heat Recovery Sections: Minimum six (6) inch thick eight (8) pound density.
Combustion Chamber: Minimum eight (8) inch thick eight (8) pound density.
Type: Unifrax or equal; anchor-loc spun fiber ceramic modules.
Attachment Method: Welded/threaded stud; 304-Stainless-Steel.
Combustion Chamber Temperature: 1500°F.
Maximum Internal Temperature: 2200°F.
External Skin Temperature: ≤150°F at 70°F with 5 mph wind.

Heat Recovery Media

Purpose

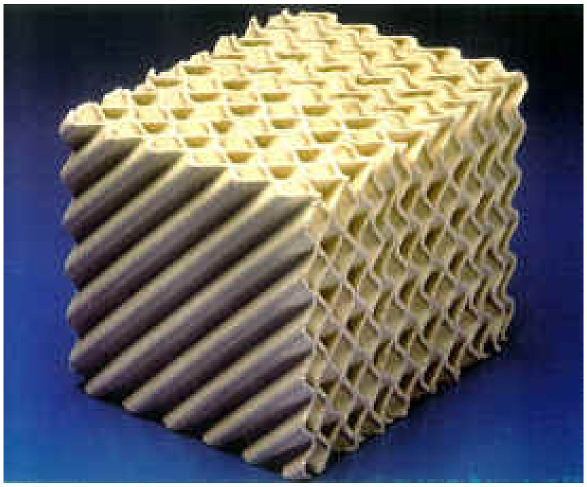
The Heat Recovery Media serves as the heat source and the heat sink to provide and store thermal energy provided by the burner system.

Operation

The Heat Recovery Media is cycled from the heat source to the heat sink by reversing the flow direction through the RTO. As "cool" process gas enters the "inlet" heat recovery bed the stored thermal energy is transferred and thus preheating the gas stream to within 100°F of the Combustion Chamber temperature. As hot process gas exits the Combustion Chamber the heat is transferred to the "outlet" heat recovery bed thus cooling gas stream to within 100°F of the actual gas stream inlet temperature into the RTO. Every three minutes the flow is reversed thus swapping inlet and outlet beds. The flow reversal is controlled by the Poppet Diverter Valves. There are many types of media available and below are some examples. Please see Equipment Specifications above for details on Heat Recover Media offered for this project.

Random Saddles

Corrugated



Monolith

Burner

Purpose

The Burner provides the necessary heat to maintain the Combustion Chamber temperature set-point.

Operation

Operating of the Burner is monitored by a microprocessor-based flame supervisory system manufactured by Honeywell. The flame supervisory system monitors all safety switches and ensures proper purge sequence during start-up. Once the Burner is lit and flame is proven, the supervisory system continues to monitor all safeties but the Burner control is handed to the PLC based control system. The Burner regulates to maintain Combustion Chamber's temperature set-point.

Design Details

Burners/Fuel Train/Flame supervisory:

- Burner - Maxon Kinemax burner
- Combustion Air Blower – Cincinnati or equal
- Fuel Train – Pre-piped and wired to junction box including (1 per RTO):
    - Maxon 5000 shutoff valves with position switches
    - Maxon Microratio (air/gas) proportioning valve with Beck actuator
    - United Electric low and high gas pressure switches
    - Pilot train
    - Scanner cooling air system pre piped
- Flame supervisory including:
    - Honeywell burner management
    - Honeywell UDC2000 high limit switches
    - Self-checking UV scanner
    - Dwyer pressure switches for proof of RTO and media bed minimum airflow

Structural Steel

Purpose

To provide structural support for the RTO and to provide personnel access via stairs, ladders and platforms.

Description

TSI supplies the support structures, stairs, ladders, and platforms from grade level as is typically required by the RTO. This includes access to areas requiring regular maintenance or monitoring by operating personnel. Typically, stair access is provided to areas requiring maintenance on a daily or weekly basis. Longer maintenance intervals will have ladder access.

Design Details

*Assembly***:** Bolted and welded assembly.
*Finish***:** Painted.

Control Devices

Description

The following devices are included in order to control the RTO via PLC:

- Temperature Control Sensors
- Temperature Transmitters
- Zero Speed Switches
- Pressure Transmitters
- Proximity Switches (Capacitive and Inductive)
- Flame Scanner(s)

ITEM 06 REGENERATIVE CATALYTIC OXIDIZER (RCO)

Shown below and on following pages are some of the major individual components that make up the RCO.

Quench-Duct

Purpose

The Quench-Duct sprays recycled water into the incoming Pelletizing Island flue-gas stream, thereby increasing the weight of the particles and allowing for their removal within the Disengagement Chamber.

Operation

The Quench-Duct is equipped with recycled water header, sprays, and nozzles to saturate the gas stream and scrub out larger front-half particulate from the gas stream. The Quench-Duct also increases weight of smaller particulate to enable for its removal within the Disengagement Chamber.

Design Details

Design Pressure: ±25” w.c.
Materials of Construction: T-304L Stainless-Steel skin/piping/nozzles with Carbon-Steel externals.

Disengagement Chamber

Purpose

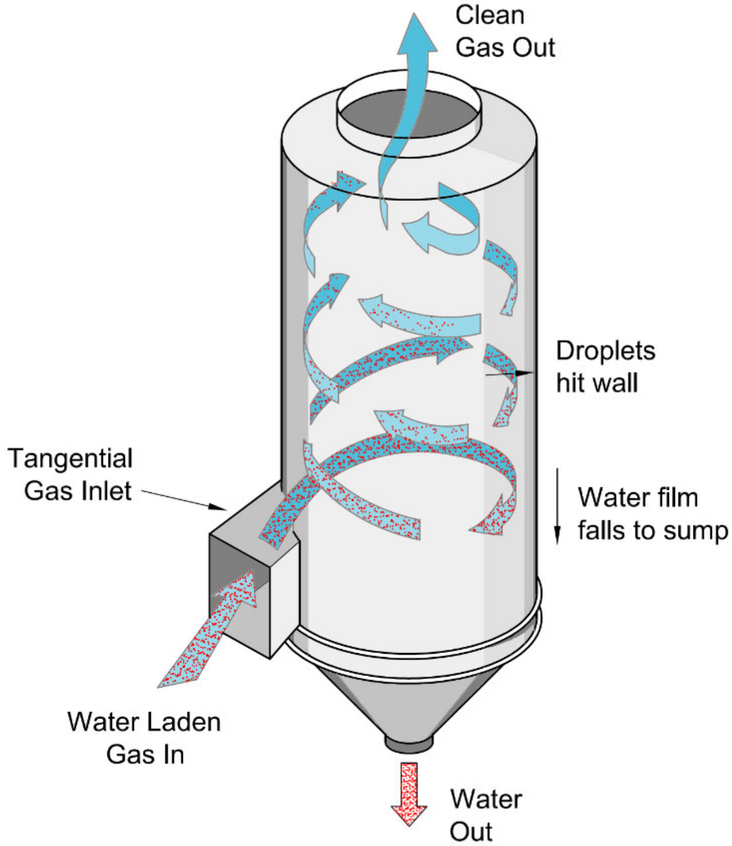
The Disengagement Chamber separates (by spinning out) water droplets and large dust particles from the gas stream prior to entry into the RCO.

Description

One Complete disengagement chamber will be provided. The units will be complete with a tangential inlet and integral cone bottom which will serve as a recycle tank for the recycle system.

Design Details

Materials of Construction: 304-Stainless-Steel.
Design Pressure: +/- 25” w.c.



Quench Water Recycle

Purpose

The Quench Water Recycle collects water from the Disengagement Chamber and delivers recycled water to the Quench-Duct.

Description

This Quench Water Recycle includes a recycle tank, a recycle pump, valves, strainers and all specialty fittings. Recycle water is sprayed via the recycle pump into the Quench-Duct and spent recycle water gravity drains back into the recycle tank. The Quench Water Recycle is controlled automatically by the PLC control system. Make up water requirements due to evaporation or blow down are satisfied with incoming fresh water.

Design Details

Recycle Tank: T-304L Stainless Steel, cone bottom.
Recycle Pump: ANSI centrifugal; T-316L Stainless Steel wet end.
Sump Pump: Self-priming containment evacuation in the event of a spill.
Features: Includes all required nozzles, automatic and manual valves, and an oversized duplex strainer to prevent nozzles from plugging; piping and general fittings are to be supplied by the installation contractor.
Containment Area: Recycle tank is placed within a concrete curbed area to contain any spills from the tank, pumps, or strainers. The containment area is self-draining to a collection sump where the water can be pumped back into the recycle tank.

Water Treatment

Purpose

Water Treatment manages levels of suspended and dissolved solids within the recycle tank.

Description

The Water Treatment consists of a decanter style Centrifuge for continuous removal of suspended particulate. Recycle water is routed to the Centrifuge where collected dust from the Disengagement Chamber is separated and emptied into a Buyer's tote. The Centrifuge minimizes amount of water blow-down required to maintain optimal levels of solids within the water, however some blow-down is still required. The blowdown water will be routed to the Furnace and Dryer System. By discharging a small amount of water, the dissolved solids are removed from Quench Water Recycle.

Design Details

Materials of Construction: 304L-Stainless-Steel for wetted parts.
Capacity: 50 gallons per minute (187.5 liters/minute).

FD Fan

Purpose

To provide the motive force and requisite pressures through the Quench-Duct, Disengagement Chamber, and the RCO.

Operation

The FD Fan is controlled by a variable frequency drive (VFD). The FD Fan modulates automatically via the PLC to maintain a static pressure set-point at the inlet to the Quench-Duct. The FD Fan induces gas flow thru the Quench-Duct and the Disengagement Chamber and pushes that gas flow thru the RCO.

Design Details

Materials of Construction: Stainless-Steel with external Carbon-Steel reinforcing structural members.

Design Conditions:

- Flow = Actual flow +10%
- Pressure = Actual Pressure +21%.

Bearings: Complete with vibration transmitters and temperature elements.

Expansion Joints: High temperature fabric.

Inlet Manifold

Purpose

The Inlet Manifold distributes process gas to the Diverter Valves.

Design Details

Materials of Construction: 3/16” thick 304-Stainless-Steel.
Operational Parameters: ±25” w.c. @ 150°F.
Access: One (1) hinged and plug insulated access door for internal inspection.

Inlet and outlet manifold shown on either side of centered valve

Poppet Diverter Valves

Purpose

To control the flow direction of the flue-gas through the RCO media chambers.

Operation

The Poppet Diverter Valves are controlled by timers within the Programmable Logic Controller (PLC). At intervals of approximately three (3) minutes, pairs of Poppet Diverter Valves will simultaneously shift, reversing the flow direction of the process gas through the RTO. This allows the heat recovery beds to alternate between a heat source and a heat sink, thus allowing the RCO to recover approximately 95% of the thermal energy.

Design Details

Materials of Construction: 10-gauge 304-Stainless-Steel.
Operational Parameters: ±25" w.c. @ 150°F inlet and 250°F outlet.
Valve Trim Construction: Main-disk fabricated from 7-gauge thick Duplex-Stainless-Steel; support-disks fabricated from 10-gauge 304-Stainless-Steel; seat materials are 304-Stainless-Steel; seal arrangement is metal to metal sealing surfaces.
Access: One (1) hinged and plug insulated access door for internal inspection of valve and bottom side of the hopper.
Valve Actuation System: Parker 2A heavy duty pneumatic cylinder, adjustable end cushions at each end of travel; direct link with Parker linear alignment coupling, inductive proximity switches measuring actual valve shaft position, actuation time is 0.5 to 1.0 second full open to full close; each valve is pre-assembled and pre-wired to junction box.

Hopper Transitions

Purpose

The Hopper Transitions distribute flow evenly to the bottom surface of the heat recovery media.

Operation

The Hopper Transitions allow gasses exiting the Poppet Diverter Valve to slow down and spread out evenly across the bottom face of the media bed.

Design Details

Materials of Construction: 3/16" thick 304-Stainless-Steel.
Operational Parameters: ±25" w.c. @ 150°F inlet and 250°F outlet (excursions up to 600°F during bakeout).

Typical Hopper Transition

Heat Recovery Chamber

Purpose

To serve as a vessel for the heat recovery media.

Operation

The Heat Recovery Chamber houses the heat recovery media that enables the RCO to recover approximately 95% of the thermal energy. The Heat Recovery Chamber also houses the media support structure for the heat recovery media, sometimes referred to as the "cold face".

Design Details

Materials of Construction: 3/16" thick 304L-Stainless-Steel reinforced outside with Carbon-Steel stiffeners.

Operational Parameters: ±25" w.c. @ 120°F inlet and 750°F outlet; maximum operational temperature 1800°F.

Media Support Structure: Laser cut or high-def plasma slotted 304-Stainless-Steel plate (laser cutting or high-def plasma mitigates stress concentration due to cold working); maximum free passage of 70% open area; centered in Heat Recovery Chamber with no direct contact to outside walls; completely floating design to prevent stress concentrations while allowing for thermal expansion.

Access: Inspection access to the support structures is through the diverter valve; inspection access to top of heat recovery section is through combustion chamber access.

Note: Most vendors fabricate Heat Recovery Chamber from Carbon-Steel with mastic lining; when hot spots develop the mastic lining will burn off and leave the internal surfaces unprotected from oxidation long after hot spots are corrected; TSI fabricates Heat Recover Chambers from Stainless-Steel *to eliminate this potential issue.*

Media support beams
'Norton Beam Style'

Burner Chamber

Purpose

The Burner Chamber maintains temperature of about 800°F within the catalyst media.

Operation

The Burner Chamber houses the natural gas burner that maintains internal temperatures off 850°F or greater. At this temperature the Burner Chamber typically is able to maintain a temperature of about 800°F within the catalyst media, within which incoming hydrocarbons will convert to CO_2 and H_2O.

Design Details

Materials of Construction: 3/16" thick 304-Stainless-Steel.
Operational Parameters: ±25" w.c.; normal operation 850°F; maximum operational temperature 1800°F.
Access: One (1) access door on a davit in each combustion chamber.
Note: Most vendors fabricated Heat Recovery Chamber from Carbon-Steel with mastic lining; when hot spots develop the mastic lining will burn off and leave the internal surfaces unprotected from oxidation long after hot spots are corrected; TSI fabricates Heat Recover Chambers from Stainless-Steel *to eliminate this potential issue.*

Outlet Manifold

Purpose

The Outlet Manifold collects process gas from the RCO and delivers that process gas to the Exhaust Stack.

Design Details

Materials of Construction: 3/16” thick Carbon-Steel.
Operational Parameters: ±25” w.c. @ 450°F.
Access: One (1) hinged and plug insulated access door for internal inspection of outlet manifold.

Control Dampers

Purpose

The Control Dampers gas flow and fresh air flow thru the RCO.

Operation

There are three (3) control dampers within an RTO. They are the "blocking", "fresh air", and "bleed air" dampers. The blocking and fresh air dampers work together, isolating the RTO from the process gas, and allowing fresh air to enter the RTO. This is required during the burner ignition as well as the warm up cycle of the RTO, which must happen at a reduced airflow. When the blocking damper is closed the fresh air damper will be open and vice versa. The bleed air damper allows the discharge side of the RTO to vent during shutdown and outages; this serves as a vacuum break caused by the stack affect during those situations.

Design Details

Materials of Construction:

- Blocking: 304-Stainless-Steel butterfly valve with metal-to-metal seats and Carbon-Steel brackets and stiffeners; controlled by a pneumatic actuator.
- Fresh air: 304-Stainless-Steel butterfly valve with tadpole seats and Carbon-Steel brackets and stiffeners; controlled by a pneumatic actuator.
- Bleed air: Carbon-Steel with tadpole seats and Carbon-Steel brackets and stiffeners; controlled by a pneumatic actuator.

Exhaust Stack

Purpose

To exhaust treated process gas to atmosphere.

Design Details

Materials of Construction: Carbon-Steel.
Access: Sampling platform and ports at EPA required position, ladder from grade to platform, and will be free standing.

Internal Ceramic Refractory

Purpose

To protect the shell of the RCO from high internal temperatures

Operation

The Internal Ceramic Refractory is bolted to studs that are welded to the internal surface of the Heat Recovery and Combustion Chambers.

Design Details

Heat Recovery Sections: Minimum six (6) inch thick eight (8) pound density.
Combustion Chamber: Minimum eight (8) inch thick eight (8) pound density.
Type: Unifrax or equal; anchor-loc spun fiber ceramic modules.
Attachment Method: Welded/threaded stud; 304-Stainless-Steel.
Combustion Chamber Temperature: 850°F.
Maximum Internal Temperature: 2200°F.
External Skin Temperature: ≤150°F at 70°F with 5 mph wind.

Heat Recovery Media & Catalyst

Purpose

The Heat Recovery Media serves as the heat source and the heat sink to provide and store thermal energy provided by the burner system.

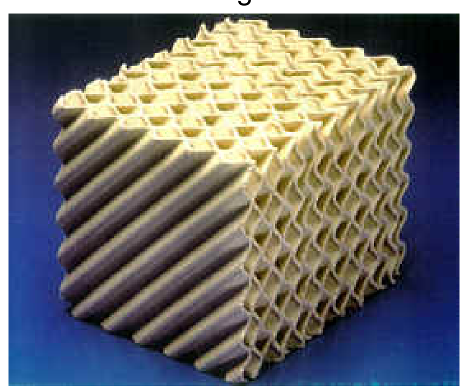
Operation

The Heat Recovery Media is cycled from the heat source to the heat sink by reversing the flow direction through the RCO. As “cool” process gas enters the “inlet” heat recovery bed the stored thermal energy is transferred and thus preheating the gas stream to within 50°F of the Combustion Chamber temperature. As hot process gas exits the Combustion Chamber the heat is transferred to the “outlet” heat recovery bed thus cooling gas stream to within 50°F of the actual gas stream inlet temperature into the RCO. Every three minutes the flow is reversed thus swapping inlet and outlet beds. The flow reversal is controlled by the Poppet Diverter Valves. There are many types of media available and below are some examples. Please see Equipment Specifications above for details on Heat Recover Media offered for this project.

A layer (generally 4” thick) of precious metal catalyst will be added to the top of the media bed. Catalyst will allow the conversion of organic vapors to H_2O and CO_2 to occur at lower temperatures (generally around 800°F). The catalyst will be Applied Catalyst. It comes in 6”x6”x4” tall blocks similar to the monolith media yet coated with the precious metal.

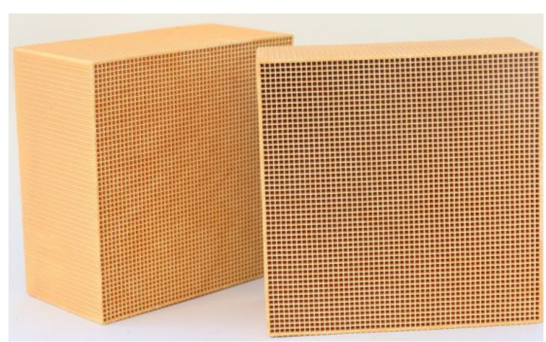
Random Saddles

Corrugated



Monolith

Catalyst



Burner

Purpose

The Burner provides the necessary heat to maintain the Combustion Chamber temperature set-point.

Operation

Operating of the Burner is monitored by a microprocessor-based flame supervisory system manufactured by Honeywell. The flame supervisory system monitors all safety switches and ensures proper purge sequence during start-up. Once the Burner is lit and flame is proven, the supervisory system continues to monitor all safeties but the Burner control is handed to the PLC based control system. The Burner regulates to maintain Combustion Chamber's temperature set-point.

Design Details

Burners/Fuel Train/Flame supervisory:

- Burner - Maxon Kinemax burner
- Combustion Air Blower – Cincinnati or equal
- Fuel Train – Pre-piped and wired to junction box including (1 per RCO):
  - Maxon 5000 shutoff valves with position switches
  - Maxon Microratio (air/gas) proportioning valve with Beck actuator
  - United Electric low and high gas pressure switches
  - Pilot train
  - Scanner cooling air system pre piped
- Flame supervisory including:
  - Honeywell burner management
  - Honeywell UDC2000 high limit switches
  - Self-checking UV scanner
  - Dwyer pressure switches for proof of RCO and media bed minimum airflow

Structural Steel

Purpose

To provide structural support for the Quench-Duct, the Disengagement Chamber, and the RCO, and to provide personnel access via stairs, ladders and platforms.

Description

TSI supplies the support structures, stairs, ladders, and platforms from grade level as is typically required by the RCO. This includes access to areas requiring regular maintenance or monitoring by operating personnel. Typically, stair access is provided to areas requiring maintenance on a daily or weekly basis. Longer maintenance intervals will have ladder access.

Design Details

Assembly: Bolted and welded assembly.
Finish: Painted.

Control Devices

Description

The following devices are included in order to control the Quench-Duct, the Disengagement Chamber, and the RCO via PLC:

- Level Transmitters
- Temperature Control Sensors
- Temperature Transmitters
- Zero Speed Switches
- Pressure Transmitters
- Proximity Switches (Capacitive and Inductive)
- Flame Scanner(s)

ITEM 07 SYSTEM CONTROLS

PURPOSE

To provide for automatic operation of the Dryer Island and Pelletizing Island RCO.

OPERATION

Automatic operation of the equipment is controlled by four (4) PLCs (L83E programmable Logic Controller) and seven (7) Remote IO Cabinets. The operation of the equipment is monitored by the Operator via multiple HMI stations (Human Machine Interface) c/w monitors located in the Buyer's plant control room.

SCOPE OF SUPPLY

The scope of services covers one (1) Dryer Island that consists of a Heat Energy System, the Dryer System, the WESP, and the RTO; scope of services also covers one (1) RCO. The proposed Control System is based on L83E processor, Flex I/O, and Wonderware Intouch 2014 R2 C/w run time license. The following is the breakdown of scope of services:

- Drawing Lists
- PLC IO & Tag Assignment Lists
- IP Address Assignment Lists
- PLC to PLC Handshake List
- Utility and UPS Power Requirements
- Panel Location Drawings
- Design of Main processor PLC Cabinets and Remote I/O Field Panels
  - Panel Layout
  - I/O Schematics
- Coordination and interface with Burner Management System
- Coordination and interface with upstream and downstream PLC systems
- Control Cable List
- Final Record Drawings
- Control System Functional Requirement Document
- PLC Programming and HMI Development
  - PLC Inputs and Output signals.
  - Control Loops,
  - Drive Control Logic,
  - Interface as required between systems
  - PLC logic and documentation
  - Development of HMI screens
  - In-House Logic Testing
- PLC Network Diagram
- Quality Control
  - Review P&ID/Motor/Device Lists
  - PLC/HMI Testing FAT
  - Panel shop inspections and testing

  - FAT & Post Fat Clean-up
- Commissioning Checkout
- Technical liaison with Pinnacle Pellets at TSI offices or offices in Vancouver, BC, Canada
- Attend weekly conference calls with all Stakeholders
- Four (4) main PLC panels: one (1) for the Heat Energy System, one (1) for the Dryer System, and one (1) for the WESP & RTO, and one (1) for the RCO
- Each main PLC panel located in Electrical Room, which has main CPU (1756-83E), communication modules and Flex IO modules.
- Seven (7) Remote Control Panels:
  - Two (2) for the Heat Energy System
  - Two (2) for the Dryer System
  - One (1) for the WESP
  - One (1) for the RTO
  - One (1) for the RCO
  - IO List, including interface with GreCon
  - Panel, Control Cable list
  - PLC Panel layout and BoM
  - IO Schematics and terminal layout.
- Control Narratives.
- PLC program (Studio 5000 Ver. 20).
- Master Alarm List.
- Two Wonderware Intouch HMI Runtime licences program (Wonderware InTouch 2014 R2).
- As-built.
- *Eighty (80) man-days for site service during commissioning & startup; two (2) programmers will be present on site; programming site service to be utilized at same time as Commissioning/Startup Site Service identified below with ITEM Site Service.*
- The current prevailing rate for programming staff is $2050/person/day and this includes all traveling and out of pocket expenses. A working day is calculated as up to ten (10) hours of onsite time. Travel days to and from site are each considered a working man-day.

DELIVERABLES

1. PLC Panel Fabrication drawings
2. Motor and Device List & Location
3. PIDs
4. Panel Location Drawings
5. PLC Panel IO Schematics
6. PLC IO List
7. IP Address list
8. PLC to PLC Handshake List
9. Control Cable List
10. Updated control narratives
11. PLC/HMI (Wonderware InTouch) Program & Configuration
12. FAT testing at Cogent Office.
13. Development of Commissioning Plan and Check sheets for PLC/HMI program and IO

14. Site Commissioning of PLC/HMI and IO
15. Final Record Drawings for PLC Panel Layout and IO Schematics

ASSUMPTIONS

- All Plant's PLC/HMI tag names based on TSI Numbering System
- PLC/HMI will be provided based on standard implemented at other Pellet Plants in North America
- Control Panel will be based on ControlLogix and Flex IO
- PLC panels will be provided similar to Standard PLC panels installed at other Pellet Plants in North America; each panel will have Flex IO (Rack, power supply, Ethernet adaptors).
- PLC Panel layout diagrams and IO Schematics will be similar to Standard PLC panels installed at other Pellet Plants in North America
- Motor Starters and Drives all come with EtherNet/IP interface.

BY OTHERS

- Fuel handling to the Heat Energy System's Metering Bin is by the Buyer
- Feedstock handling to the Dryer System's Metering Bin is by the Buyer
- Dry feedstock handling after the Dryer System's Collection Screw is by the Buyer
- The Buyer will provide main control room to accommodate TSI provided HMI stations

ITEM 08 SITE SERVICE

- The current prevailing rate for construction staff is $1450/person/day and this includes all traveling and out of pocket expenses. A working day is calculated as up to ten (10) hours of onsite time. Travel days to and from site are each considered a working man-day.
- The current prevailing rate for commissioning/startup/training staff is $1450/person/day and this includes all traveling and out of pocket expenses. A working day is calculated as up to ten (10) hours of onsite time. Travel days to and from site are each considered a working man-day.

  Below is recommended Site Service:
  - *Construction Site Service: three-hundred-ninety (390) total man-days*
    - *There are three-hundred-sixty (360) site-service man-days and thirty (30) travel days*
    - *Equipment installation starts from the time 1st equipment arrives to site until start of commissioning; TSI estimates this period will last six (6) months; TSI will require two (2) construction supervisors on site at the same time. During this time TSI crews will rotate. Travel days to and from site are each considered a working day*
    - *Down-days for weekends/holidays/weather/or any reasons not related to TSI are considered working days*
      Price: USD 565,500

  - *Commissioning/Startup Site Service: Eighty-eight (88) total man-days*
    - *There are eighty (80) site-service man-days and eight (8) travel days*
    - *Two (2) TSI staff will be on site*
    - *Down-days for weekends/holidays/weather/or any reasons not related to TSI are considered working days*
    - *Start of commissioning site service is initiated by the Buyer; the Buyer must provide TSI with minimum four (4) week notice prior to the commissioning start date*
      Price: USD 127,600

  - *24/7 Site Service post Commissioning: two-hundred (200) total man-days*
    - *There are one-hundred-eighty (180) site-service man-days and twenty (20) travel days*
    - *Two (2) TSI staff will be on site for 1st thirty (30) days per shift and one (1) TSI staff will be on site for 2nd thirty (30) days per shift*
      - *Total support is two (2) months*
    - *Down-days for weekends/holidays/weather/or any reasons not related to TSI are considered working days*
    - *Start of 24/7 Site Service will continue automatically following Commissioning Site Service*
      Price: USD 290,000

Notes:

1) *If additional working days are required by the Buyer, the Buyer can purchase those additional site service days at the rate shown above.*
2) *If the Buyer utilizes fewer site service days than the above, TSI will refund each fewer site service day to the Buyer at the rate shown above.*

ITEM 09 REFRACTORY WORKS

SCOPE

TSI offers to supply all manpower, lifting and hoisting equipment, and travel and living expenses, to install the refractory on the Heat Energy System and connecting hot gas ductwork between the Heat Energy System and Dryer Drum. TSI refractory installation crews will mobilize to site once Heat Energy System has been installed.

Items included in TSI installation package:

1) Heat Energy System refractory supply.
2) Heat Energy System refractory anchors supply.
3) Dryer System's hot gas ductwork refractory supply.
4) Dryer System's hot gas ductwork refractory anchor supply.
5) Heat Energy System anchor and refractory installation.
6) Dryer System hot gas ductwork anchor and refractory installation.
7) Heat Energy System refractory cure-out.
8) Dryer System refractory cure-out.
9) Refractory installation/cure-out 3rd party inspection.
10) Confined space area attendants and monitors.

Buyer's Responsibility:

1) Temporary electrical power supply and field wiring in the form of a 200 Amp 3-phase 480V power panel for welding machines and refractory cure-out equipment as well as a 110V power panel for electrical tools.
2) One (1) inch potable water line at 30 psi minimum stubbed at the installation area of refractory mixing.
3) Provide all weather and un-interrupted access to laydown areas for truck access, supplies, as well as storage of the same with suitable structure to support crane and forklift activity during inclement weather.
4) Installation of any equipment not listed above.
5) Winter package installation; the above installation is based on weather conditions at ≥6°C; if weather is <6°C then direct cost of additional items required (heaters/hoarding/fuel/etc.) will be borne by the Buyer with additional 10% added for processing; TSI will provide to Buyer the additional invoices due to winter installation.

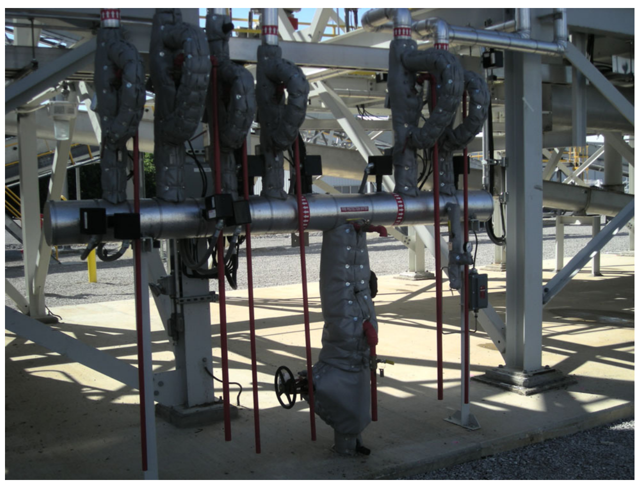
Note: TSI and its sub-contractors are non-union; if unionized work is required then an adjustment to the price will be applied and paid by the Buyer.

ITEM 10 EQUIPMENT INSTALLATION

Items included in TSI installation package:

1) Receive and unload all TSI equipment; storage/laydown area must be next to Dryer Island (within 50' of the Dryer Island boundaries); if storage/laydown area is not near Dryer Island than appropriate adjustment to price will be made once full impact of storage/laydown area location is determined.
2) All mechanical and structural equipment installation relating to the following equipment:
    a. Heat Energy System
    b. Dryer System
    c. WESP
    d. RTO
    e. Disengagement Chamber/RCO
3) Dryer System Exhaust insulation supply and installation; 4" mineral wool with 0.034" embossed aluminum for cladding; the following equipment will be insulated:
    a. Material Ductwork from Drum discharge to Cyclones' inlet
    b. Cyclones
    c. Gas Ductwork from Cyclones' discharge to ID Fan
    d. ID Fan
    e. Process portion of the Abort Stack
    f. Dilution Ducts
4) RTO insulation supply & installation; 4" mineral wool with 0.034" embossed aluminum for cladding.
5) RCO insulation supply & installation; 4" mineral wool with 0.034" embossed aluminum for cladding.
6) RTO gas piping supply & installation; TSI will specify during engineering the location where Buyer must locate Natural Gas with lockable isolation valve; TSI will specify quantity & pressure at this location; TSI will supply piping & installation from this location to RTO Burner(s).
7) RCO gas piping supply & installation; TSI will specify during engineering the location where Buyer must locate Natural Gas with lockable isolation valve; TSI will specify quantity & pressure at this location; TSI will supply piping & installation from this location to RCO Burner(s).
8) WESP process piping supply & installation; typical USA process piping specification for Pellet Plants; Buyer to provide water stub-up with lockable isolation valve next the WESP as shown by TSI during the engineering phase of the project.
9) RCO Quench-Duct & Disengagement Chamber process piping supply & installation; typical USA process piping specification for Pellet Plants; Buyer to provide water stub-up with lockable isolation valve next the Disengagement Chamber as shown by TSI during the engineering phase of the project.
10) Dryer Island WESP & RCO Disengagement Chamber blow-down water to be piped overhead to Furnace/Dryer System.

11) Pneumatic instrument air lines supply & installation; the Buyer is required to provide and install the pneumatic air generator as per the Dryer Island & RCO equipment requirements; the location of this unit shell be within the boundaries of the Dryer Island as specified by TSI during the engineering phase of the project; from this generator TSI will supply & install all required pneumatic air lines to the Dryer Island & RCO devices.
12) Dryer Drum cladding insulation.
13) All hydraulic piping supply and installation and hydraulic oil supply.
14) Storage containers for all weather sensitive equipment supplied by TSI.
15) TSI will provide its own offices on site.
16) Mechanical installation of all TSI supplied devices.
17) Supply & install of all valves/piping/switches from the Buyer supplied stub-up pipe to the deluge nozzles located throughout the Heat Energy System and the Dryer System; this excludes if required the fast-acting spark detect piping; piping will be heat traced and insulated; during the engineering portion of this project TSI will specify location to the Buyer near the Furnace and near the Dryer System for the stub-up pipes; stub-ups supplied by the Buyer with manual shutoffs.



Shown above is the stub-up pipe with manual shutoff valve supplied & installed by the Buyer; above the manual valve is supplied and installed by TSI

Buyer's Responsibility:

1) Provide uninterrupted access to area of equipment installation, laydown areas, and connecting roads between these two areas as well as into the plant; any interruption during construction due to no fault of TSI (e.g. the Buyer shuts down the site due to another vendor's safety infractions, or any other reasons that prevent TSI from working uninterrupted or at lesser efficiency) will be paid by the Buyer; the price for this interruption can only be determined during construction period and once full scope of interruption is realized.
2) All underground & inground works to be completed prior to TSI installation crew's

installation start.

3) Supply & installation of spark detection (unless Buyer purchases this option from TSI shown within pricing pages).
4) Fire water piping supply & installation
5) Potable water and 100V power for TSI site office trailers.
6) Temporary electrical power supply and field wiring for 480V welding machines and 110V electrical tools.
7) Provide all weather and un-interrupted access to laydown areas for truck access, supplies, as well as storage of the same with suitable structure to support crane and forklift activity during inclement weather.
8) Toilets, washing area/ and drinking water.
9) Any prevention of site access for construction that prevents TSI installation crews from installing equipment.
10) Equipment lubrication supply and flushing
11) Provide all weather working surfaces around equipment erection area to provide safe access and working surfaces for cranes, man-lifts, and forklifts during inclement weather.
12) Creation and repair of roads, site drainage, lay down area, parking, and water service by the Buyer (TSI to hook up water service to its trailer; water hook up to be within reasonable proximity to TSI trailer).
13) Installation of any equipment not listed above.
14) Any Safety Coordinators if required are by the Buyer.

Note: TSI and its sub-contractors are non-union; if unionized work is required then an adjustment to the price will be applied and paid by the Buyer.

ITEM 11 ELECTRICAL WORKS

SCOPE

TSI offers to design, supply all manpower, lifting and hoisting equipment, and travel and living expenses, to electrically install and commission the Dryer Island and the RCO, and supply and install the E-House for the Dryer Island and the RCO. During first twenty (20) weeks of engineering TSI will determine the location of the E-House; this building will be located adjacent to the TSI Dryer Island. Deviation by Client from TSI drawings may result in an upcharge; this price impact will be determined once engineering is complete.

Electrical Works supply will be as per the TSI's North American Pellet Plant typical standards; deviation from these standards may reflect in change of price.

<u>Items included in TSI installation package:</u>

1) Electrical Engineering:
    a. Prefabricated steel electrical building (E-House)
    b. Power distribution gear (Panelboards, Transformers, Switchgear, etc.)
    c. Motor Control (MCCs and MV VFDs)
    d. All equipment within the E-House is installed, wired, and tested prior to shipment to the Buyer's plant site
        i. Medium Voltage equipment will be inspected and commissioned onsite prior to plant startup
    e. E-House comes complete with stairs & platforms, lighting, 32 tons of HVAC cooling, working desk, and power receptacles
    f. E-House is a two-piece unit that will ship separately and require reconnection at the plant site
        i. Section 1 will house the Low Voltage Gear (41'6" long by 15' wide)
        ii. Section 2 will house the Medium Voltage Gear (27' long by 15' wide)
        iii. Total E-House dimensions are 68'6" long by 15' wide
    g. Eaton Power Distribution Equipment is supplied (Eaton distribution panels, transformers, LV Switchboard, and MV Switchgear
    h. Rockwell Motor Control
        i. IntelliCENTER MCCs
        ii. Dryer System ID Fan, the RTO FD Fan, and the RCO FD Fan VFDs are PF7000 MV
        iii. Recommended spare parts are included
        iv. Rockwell commissioning services are included (5 days on-site)
    i. Diesel Backup Power Generator with Automatic Transfer Switch (ATS)
    j. Four (4) Transformer Rectifiers
    k. Power/Motor cable list
    l. Dryer Island and RCO Single Line Diagram and protection coordination and arc flash
    m. Control cable list
    n. Final Low Voltage distribution MCC review

o. Motor O/L and drive configuration reviews
p. Uninterrupted Power System & Distribution Panels
q. Electrical Distribution Panels
r. Cable Tray Layout
s. Heat loss calculations review on E-house
t. LDS requirements
u. BOP electrical requirements
v. MCC, motor schematics reviews

2) Prefabricated steel electrical building (E-House)
    a. Power distribution gear (Panelboards, Transformers, Switchgear, etc.)
    b. Motor Control (MCCs and MV VFDs)
    c. All equipment within the E-House is installed, wired, and tested prior to shipment to the Buyer's plant site
        i. Medium Voltage equipment will be inspected and commissioned onsite prior to plant startup
    d. E-House comes complete with stairs & platforms, lighting, 32 tons of HVAC cooling, working desk, and power receptacles
    e. E-House is a two-piece unit that will ship separately and require reconnection at the plant site
        i. Section 1 will house the Low Voltage Gear (41'6" long by 15' wide)
        ii. Section 2 will house the Medium Voltage Gear (27' long by 15' wide)
        iii. Total E-House dimensions are 68'6" long by 15' wide
    f. Eaton Power Distribution Equipment is supplied (Eaton distribution panels, transformers, LV Switchboard, and MV Switchgear
    g. Rockwell Motor Control
        i. IntelliCENTER MCCs
        ii. Dryer System ID Fan & RTO ID Fan VFDs are PF7000 MV
        iii. Recommended spare parts are included
        iv. Rockwell commissioning services are included (5 days on-site)
3) Diesel Backup Power Generator with Automatic Transfer Switch (ATS)
4) Four (4) Transformer Rectifiers
5) Integration/wiring of TSI supplied PLC enclosures
6) Supply and installation of network equipment for operator control room (CISCO compatible)
7) Supply and install all of the Dryer Island motors
8) TSI supplied starters will be installed in a prefabricated building in a fabrication shop, pre-wired and tested prior to shipping
9) Electrically install all motors, control devices, and wire all motors and control devices to the E-House
10) Network connections between HMI stations in main control room and PLC systems located in electrical room
11) Supply the Backup Power Generator with Automatic Transfer Switch
12) Install and wire the Backup Power Generator

13) Supply and install all necessary cable trays & junction boxes
14) Dryer Island lighting, power outlets, and welding outlets
15) Dryer Island emergency power stoppers supply/installation
16) Above ground lightning protection & grounding

<u>Technical Specifications:</u>

- Medium voltage switchgear (4160V) including feeders from main power distribution transformers
    - Eaton AMPGARD LBS Loadbreak Switch **or**
    - Eaton AMPGARD Main Breaker
- Low voltage power distribution center (480V) including feeders from main power distribution transformers
    - Eaton Pow-R Switchboard
- Low voltage MCC's including feeders from MCC to Motor c/w Ethernet/IP Interface
    - Allen-Bradley Centerline 2100
    - Motor starters (FVNR, FVR) c/w E300 Electronic Overload Relay
    - VFD – Rockwell – PF755 c/w line and load reactors
- MV VFDs will be standalone units, including feeders from MCC to Motor c/w Ethernet/IP Interface c/w Ethernet/IP Interface
    - Allen-Bradley PF6000
- UPS power supplies and associated transformers and panelboards
- Emergency power including generators, automatic transfer switches, associated distribution transformers and panelboards
- Panelboards and associated transformers for utilities
- Network Cabinets and Fiber Patch panels
- Low voltage Local Disconnect Switches for motors as indicated in motor list document
- 8 welding outlets
- PLC cabinets, local control panels, remote control panels as listed in panel list documents
- Power, control, data, and instrumentation tray cables, trays, wires and required miscellaneous hardware, as required for the completion of the entire installation of the drying island including electrical devices including sensors, instruments, actuators, solenoids, control and remote I/O panels, Ethernet.
- Supply and install all nameplates and/or safety signs (Arch Flash) as many as required by code regulations
- (power and data) all customer supplied PC's, monitors
- E-Stop stations and panels.
- Lighting Transformers and Panels
- Outdoor Lighting fixtures to provide process lighting for Dryer Island area.
- Outdoor Convenience Outlets (8) field mounted 120V convenience outlets.
- Heating and Ventilating Equipment for the electrical room / E-House
- One-(1) camera in the energy system for the purpose of viewing furnace fire
- Equipment bonding and connection to drying island loop

Prefabricated MCC Building shown next to Dryer Island

<u>Buyer's Responsibility:</u>

1) Temporary electrical power supply and field wiring for 480V welding machines and 110V electrical tools
2) Any Civil Works and underground works (underground conduits, underground lightning grid, and any other equipment underground)
3) Supply the Power Transformers and Power Disconnects for the E-House
4) Provide all weather and un-interrupted access to laydown areas for truck access, supplies, as well as storage of the same with suitable structure to support crane and forklift activity during inclement weather
5) Installation of any equipment not listed above
6) Primary Site Distribution
7) Main Power Distribution Transformers
8) Fire Alarm Systems
9) CCTV System
10) Power Factor Correction
11) Plant Lighting
12) Telephone system
13) Network cameras
14) Building fire alarm
15) Security gates
16) Main control room console

Note: TSI and its sub-contractors are non-union; if unionized work is required then an adjustment to the price will be applied and paid by the Buyer.

TSI: General Terms and Conditions

The following items are part of TSI's proposal. In accepting TSI's proposal the Buyer also accepts these terms and conditions. Should the proposal be modified in any way to meet the Buyer's requirements these terms and conditions will still apply unless specifically modified and agreed to by TSI.

Please note the following items are specifically excluded from TSI's scope of supply unless otherwise clearly specified in the body of the proposal:

1) Building and floor slabs, building lights, electrical fittings, fire walls, wall and roof penetrations etc.
2) Site preparation, equipment foundations, anchor bolts, conduits, and all related civil work (including any civil calculations if required)
3) Plant air, water, gas, temporary gas lines, and power during installation and start-up.
4) Control room, including any desk, furniture or environmental equipment.
5) Any local use or permit taxes or fees; any state or provincial taxes; any other taxes.
6) Any items of machinery or system components which are not specified in the contract scope of supply. Integration of buyer supplied items is the responsibility of the buyer.

In addition to the above exclusions, the following items are conditions of this proposal:

7) Design details as specified in the proposal may vary from completed project to accommodate updates or improvements in machine operation or construction; in such cases overall operational specification will not be negatively altered.
8) TSI does not warrant interface data provided by the Buyer, the Buyer's engineers or by other suppliers to the Buyer.
9) The Buyer is responsible for the costs of any tests required by the regulatory bodies.
10) TSI is not responsible for the cost of any performance tests or the costs of any subsequent tests if adjustments or modifications made to the equipment as a result of prior test results, whether or not TSI equipment was at fault. Performance tests may be required to set-up/tune the system.
11) TSI provides a limited warranty against defects in workmanship and materials for twelve (12) months from date of first use, or within twenty-four months within first installation of that part. Any parts replaced by TSI due to warranty will have the warranty extended on the replaced parts by another twelve (12) months. The cost of parts and shipping to site will be paid by TSI. Fitting on site of the replacement parts will be at the Buyer's expense. Additional charges for expedited shipping, if requested, will be at the Buyer's expense. This warranty specifically excludes tooling, consumable supplies, and wear items. It also excludes damage due to improper installation, use, or upset conditions not directly attributable to TSI equipment. Changing the operating settings or modifying the equipment without written TSI approval will invalidate the warranty.
12) Failure of the Buyer to pay according to the terms of the contract will invalidate the above warranty.
13) Chargeable equipment deficiencies that arise during installation or warranty claims should be documented and forwarded to TSI prior to remedial action and TSI should be given reasonable opportunity to either approve the remedy or otherwise make good the deficiency; failure by the Buyer to adhere to above requirement may invalidate TSI responsibility towards chargeable equipment deficiency.
14) TSI reserves the right to photograph and video the installed and operating equipment for use in future TSI marketing and promotional efforts.
15) Any information provided by TSI in the course of a project, including machine designs, operating software, and other parameters, remains the property of TSI and may not be divulged to any third party not directly involved with the TSI portion of the project without the written consent of TSI. Failure to observe this condition may result in damage to TSI's immediate and future business interests for which recompense will be sought.
16) Where written authority is required from TSI that written authority must come from the President of TSI unless other representatives have been nominated by TSI as part of the project.
17) TSI is not responsible for consequential losses or damages incurred as a result of equipment failure of improper operation.
18) The conditions set forth in this document (TSI: General Terms and Conditions) take precedence over other parts of documentation submitted by TSI. If there is a conflict between the body of a proposal and this document, the terms as specified in this document will apply.

ATTACHMENT 4

Modeling Files