

SYNAGRO | MEMO

Date: February 15, 2018
Project: Slate Belt Heat Recovery Center
To: Project Team
From: FSBU Engineering
SUBJECT: Odor Control Design Approach and Criteria

1.0 PURPOSE

The intent of this memo is to confirm the engineering basis for the design of the odor control and treatment process to be designed and operated at the Slate Belt Heat Recovery Center (SBHRC) project. Through over 20 years of biosolids drying experience, the focus of Synagro's odor control is to understand the sources of odor, how to capture/control that odor and finally the proper treatment to levels that will have no nuisance impact offsite from the project. The memo will cover known odorous compounds associated with the major systems to be designed/installed/operated at the SBHRC and will confirm viable treatment technology in reducing odorous compounds, primarily hydrogen sulfide and ammonia to below nuisance levels prior to discharge to atmosphere.

2.0 BACKGROUND

The SBHRC will be designed to process up to 400 wet ton per day of biosolids via thermal drying technology, wherein the biosolids are conveyed from a receiving/storage tank into an enclosed belt dryer system that circulates warm air to evaporate moisture from the biosolids, resulting in a Class A biosolids product.

Synagro has confirmed that sources of odor at the SBHRC would be as follows:

- Biosolids receiving/storage;
- Belt dryer system;
- Product storage silo;
- Wastewater storage;

The biosolids receiving/storage process will be a potential odor source primarily of hydrogen sulfide and ammonia associated with biological activity during material storage. The storage tanks will be enclosed fully when not receiving material and are designed with live-bottom floors unloading is facilitated as first in/first out to minimize the potential for odor generation due to prolonged storage. The storage tanks are designed to contain 1.5 days of biosolids feedstock, which serves to minimize odor potential. Potential odors from the receiving / storage process will be active ventilated from the headspace of the tanks as source control, with routing of the collected air to the odor control system, which is designed to reduce hydrogen sulfide and ammonia effectively.

The belt dryer system will be a potential odor source primarily of ammonia associated with the off-gassing from the heat treatment during the drying process. The belt dryers are fully enclosed and operate in a negative air pressure manner, such that all off-gassing during the thermal treatment of the biosolids is contained within



the dryer system itself. The bulk of the airstream is recycled in the dryer system after moisture, containing ammonia, is condensed and transported to storage. There will be a small saturated airstream removed from each of the belt dryers, which will include the evaporated moisture and ammonia. This airstream is routed to a condenser that serves to knock out the majority of the moisture from the process, with the remaining air stream routed to the odor control system, which is designed to reduce ammonia effectively.

The product storage silo has the potential to be a minor source odor related to the product and primarily it will be remaining ammonia off-gassing. The product storage silo will have a dust collection system maintaining negative pressure condition on the headspace of the silo, which will be routed to the odor control system, which is design to reduce ammonia effectively.

The wastewater storage tank has the potential to be a minor source of odor related to the ammonia conditions via thermal dryer condensate and odor control system blowdown storage. Flow from the covered wastewater storage tank will be included in the odor control system as a negative pressure headspace source, to be routed to the odor control system, which is designed to reduce ammonia effectively.

Synagro understand the major process components, how to control and treat odorous sources associated with each, and has done so for the SBHRC project with learning from over 20 years of successful biosolids thermal drying facilities design and operations located in populated areas.

3.0 AIR TREATMENT

The following establishes the system design criteria, provides a description of the treatment process, and outlines system performance based on third party odor control systems proposed by suppliers familiar with, and established in, the biosolids industry.

3.1 Design Criteria

Design criteria establishing air flow rates and odor parameter loading to size the odor control design data is summarized in Table 1 below. The table includes information as identified on the Haarslev mass and energy balance dated January 22, 2018.

Table 1: Summary of Odor Sources

Stream Description	Flow rate [scfm]	Temperature [degree F]	%RH	NH3 Conc ¹ [ppm]	H2S Conc ¹ [ppm]
Dryer Train 1	2,015	104	100	150	5
Dryer Train 2	2,015	104	100	150	5
Cake Receiving	4,038	72	75	20	20
Dry Product Storage and Conveyance	751	104	10	150	5
Wastewater Storage Tank	93	72	75	20	18
Estimated Combined Process Air Strea	8,912	SCFM		89 ppm	12 ppm

Notes:

1. Presented as estimated peak concentrations, dry weight basis

The dust source design criteria establish the system conditions and loading. These data are based on information from Haarslev:

- Dryer train dust loading = up to 20 mg/m³
- Product storage dust loading = up to 20 mg/m³
- Product conveyance = up to 180 mg/m³

The intent of dryer building room air ventilation is to provide occupants with quality indoor air. Air exchange rates will adhere to codes and best industry practices. NH₃, H₂S, and dust concentrations are negligible in the



dryer building as all process and conveyance equipment is enclosed with dedicated system ventilation fans creating local negative pressure relative to the ambient building pressure.

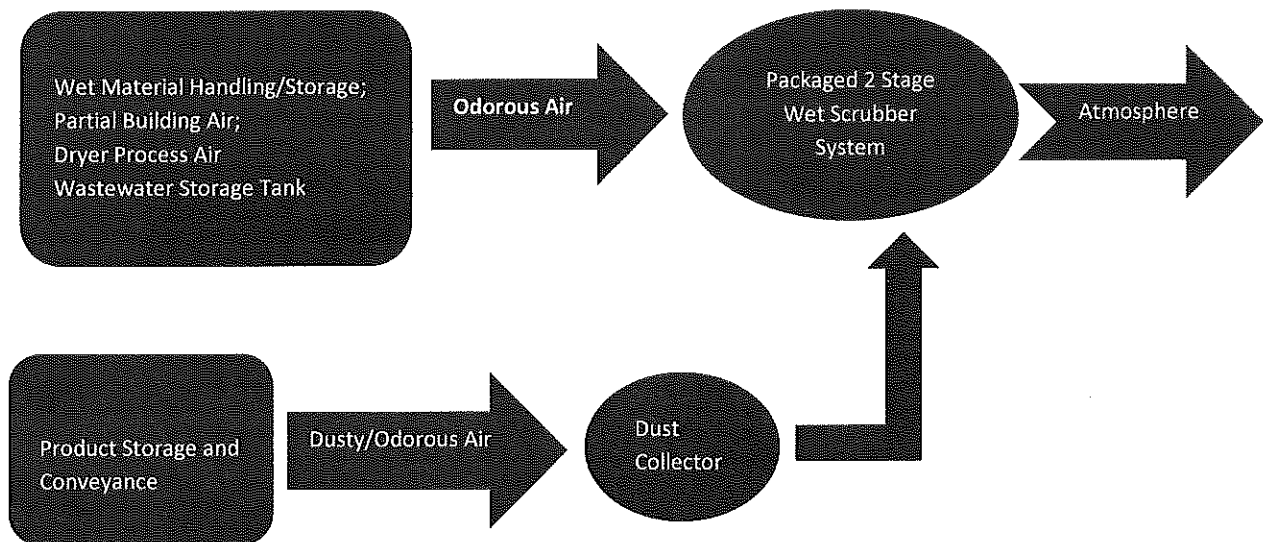
3.2 Process Description & Performance

The use of packed bed wet scrubbers to control odors associated with NH₃ and H₂S has a proven successful track record and design performance is well known. The two stage air treatment process is arranged in series. The air/mixture flows through a static bed of packed media in a non-linear path counter in direction to the continuously sprinkled spray water. Transformation of the odorous compounds NH₃ then H₂S to non-odorous compounds and water and dilution into aqueous phase occurs as the air/mixture contacts the water solution. The removal of wastewater and addition of fresh makeup water solution allows the reactions to occurring at the design rate.

The first stage wet scrubber is designed to remove NH₃. Aqueous acid, typically sulfuric acid, is continuously sprayed through the air stream to optimize air treatment. The system designed for the SBHRC has a target NH₃ removal of 99%. The second stage wet scrubber is designed to remove H₂S. Aqueous sodium hydroxide (caustic soda) is continuously sprayed through the air stream to optimize air treatment. The system designed for the SBHRC has a target H₂S removal of 99%. In each stage, the respective aqueous solution is collected in the column sump. A pH sensor continuously monitors the solution to control the chemical dose used to optimize removal efficiencies. The purchased equipment will be installed and operated in accordance with a performance test used to demonstrate the treatment goal.

The proposed SBHRC odor control system conceptual process flow is shown in Figure 1. The identified streams with low dust concentrations will be conveyed directly to the two stage wet odor control system supplied by a vendor with a proven track record in providing such systems. The dust originating by the handling of dry product is removed via mechanical separation, such as a baghouse, to protect the wet scrubber system from fouling resulting in additional wastewater generation in the blowdown and premature component replacement. The collected dust solids are collected and recycled in the process.

Figure 1: Odor Source Treatment Process Flow



3.3 Treatment Targets

The target discharge concentration the odor control system is design as follows:

- Hydrogen sulfide (H₂S) - OSHA states acute (short-term) exposure to 0.01 to 1.5 ppm is the odor threshold (when rotten egg smell is first noticeable to some). Odor becomes more offensive at 3-5 ppm.



- Ammonia (NH₃) - OSHA states the odor threshold for NH₃ is 5 ppm. American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) reports that people notice the presence of ammonia at 1 ppm in a closed room. (reference: Smyth, 1956 as cited in Memarzadeh F. 2005. Control of ammonia production in animal research facilities through ventilation system design. ASHRAE)

Table 2 presents the anticipated H₂S and NH₃ concentrations at the discharge of the second stage of the odor control system. The presented removal efficiencies are based on third party design and will have performance warranty conditions ensuring conformance.

Table 2: Summary of Odor Control Performance

	2 Stage - Wet Scrubber Design Efficiency	AVG Inlet Concentration	AVG Outlet Concentration -
H ₂ S Removal	99%	12 ppm	0.12 ppm
NH ₃ Removal	99%	89 ppm	0.89 ppm

4.0 Conclusions:

Compared to OSHA and ASHRAE published literature the design of the process air odor control system will remove hydrogen sulfide and ammonia from the stream below nuisance level at the outlet of the process and prior to discharge and dispersion to the atmosphere.

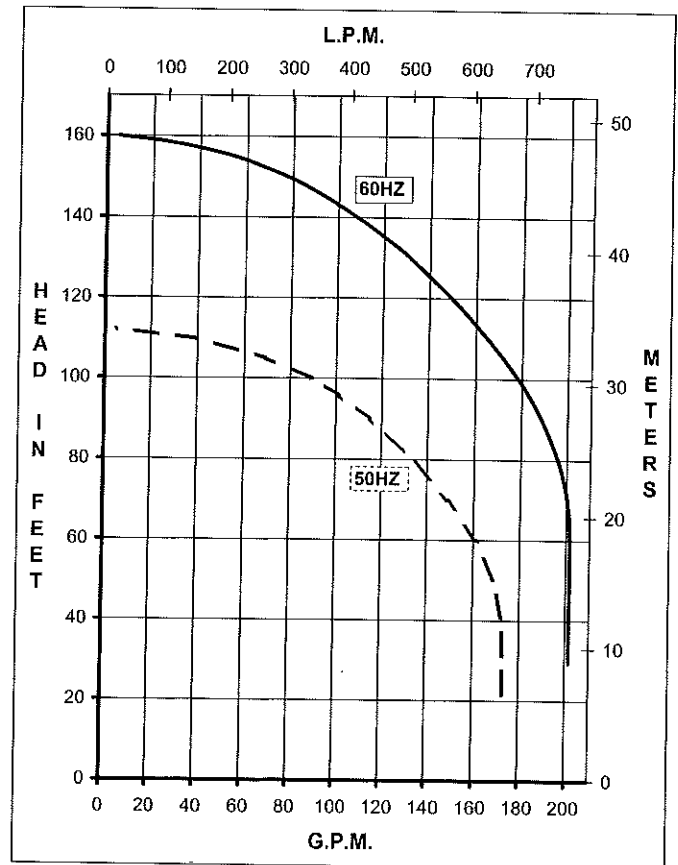
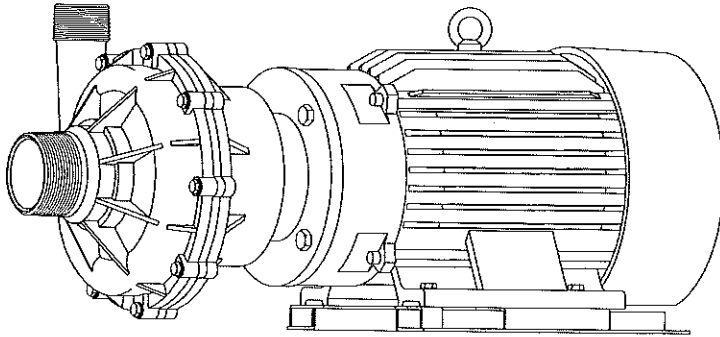




MARCH PUMPS

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TE-10K-MD



MODEL ABBREVIATIONS:

TE = Totally Enclosed Fan Cooled Motor

K = Kynar

MD = Magnetic Drive

CONSTRUCTION & SERVICING:

March "Orbital" Magnetic Drive Pumps eliminate the conventional shaft seals found in most pumps. Hence, there is no rotating shaft or seal to wear and allow the liquid being pumped to leak out. The only seal in the pump is a stationary Gasket between the front and the rear Housings. The pump can be serviced with the use of an adjustable wrench. The only moving part other than the motor is the Impeller Assembly which rotates on a stationary shaft and up against a thrust washer. These are the only parts that might wear, and may require replacement. See the repair Parts List for replacement parts.

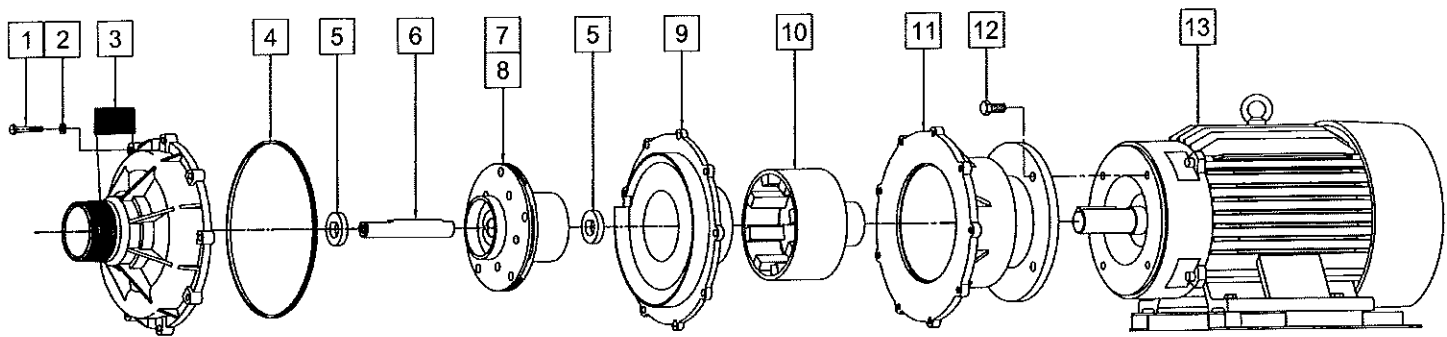
OPERATION:

Pumps are not self priming and will not produce a suction lift and must be installed with a positive flooded suction. We rely on the liquid being pumped to lubricate the Impeller Assembly bushing spinning on the stationary shaft. If the pump is run dry for longer than 60 seconds the Impeller bushing may "freeze" onto the shaft. The direction of motor rotation should be clockwise looking into the inlet of the pump. A trimmed impeller may be necessary when pumping a liquid with a specific gravity or viscosity greater than water as well in cases of high liquid temperature.

ELECTRICAL:

The standard pump motor is a TEFC, 3 phase, rated as continuous duty. A junction box is located on the side of the motor for making the electrical hook up. The wiring instructions are located on the motor label or on the junction box cover. The motor has U.L. yellow card recognition. Explosion proof and special voltage motors are available upon special order.

SPECIFICATIONS			TE-10K-MD
Max Flow	50Hz	lpm	654
	60Hz	gpm	200
Max Head	50Hz	m	34.1
	60Hz	ft (psi)	160 (69.3)
Inlet			3" MPT
Outlet			2" MPT
Max Internal Pressure	psi		75
	bar		5
Max Liquid Temperature	°F		190
	°C		87
Packed Weight	kg/lbs		118/260
Motor Type			TEFC 230/460
Phase			3
50Hz	Volts		380
	Watts		5700
	Amps		14.2
	Kw		5.59
	Rpm		2850
60Hz	Volts		230 460
	Watts		9350 9350
	Amps		22.8 11.4
	Hp		10 10
	Rpm		3450 3450
Electrical Connection			Conduit Box
Overall Pump Dimensions (Inches)	Height		13.32
	Width		13.94
	Length		30.74
Overall Pump Dimensions (cm)	Height		33.8
	Width		35.4
	Length		78.0



CAUTION IN ASSEMBLY/DISASSEMBLY:

The magnetic coupling in the pump is made of magnetized material and is strong enough to warrant caution. When disassembling the pump, remove the Impeller Assembly from the Rear Pump Housing. The attraction of the Impeller Magnet and the Drive Magnet may pull the Impeller from your grasp.

To assemble hold onto the outer diameter of the impeller vanes with both hands and slowly engage the Impeller into the magnetic field. As you feel the axial magnetic pull, hold the Impeller firmly and resist the pull of the magnets, but slowly allow the Impeller to be pulled into the magnetic field. The axial magnetic pull is greatest between 1/3 to 2/3 engagement. The axial pull will diminish as the two magnets become aligned. If you allow the Impeller Assembly to snap into the rear housing, you may damage the bushing, the rear thrust washer or the plastic. Care must be taken if you set the magnets down or near a steel surface due to the powerful magnetic pull. These individual magnets may affect the calibration or damage sensitive electronic instruments if set next to the instrument.

When attaching drive magnet to motor shaft, position the face of the drive magnet 3/16 inch above the face of the motor bracket.

REPAIR PARTS LIST

ITEM	DESCRIPTION	MATERIAL	QTY	PART #	TE-10K-MD
1	Screw 5/16-18 x 1-3/4" Lg.	Stainless Steel	9	0160-0029-1000	S
2	Washer	Stainless Steel	9	0160-0030-1000	S
3	Front Housing	Kynar	1	0161-0008-1000	S
4	Gasket	Viton	1	0161-0043-1000	S
5	Thrust Washer (Front & Rear)	Ceramic	2	0161-0001-1000	S
6	Shaft	Ceramic	1	0161-0002-1000	S
7	Impeller Assembly w/Carbon Bushing	Kynar/Carbon	1	0161-0005-0400	S
8	Impeller Assembly w/Mica Teflon Bushing	Kynar/Teflon	1	0161-0005-0600	O
9	Rear Housing	Kynar	1	0161-0009-1000	S
10	Drive Magnet Assembly		1	0161-0031-0100	S
11	Motor Connecting Bracket		1	0161-0007-0000	S
12	Screw 1/2-13 x 1" Lg.	Stainless Steel	4	0160-0031-1000	S
13	Motor, TEFC, 10HP, 3Phase		1	0161-0012-1000	S
W	Wet End Kit (Items: 1-7 & 9)	See Individual Items	1	0161-0035-0100	S

NOTE: Contact Factory for other materials and/or parts not listed.

Legend: S = Standard, O = Optional

MATERIALS IN CONTACT WITH SOLUTION:

Carbon filled Kynar® (PVDF), Ceramic, Viton, and Carbon.

NOTES:

All specifications & data are based on pumping water and are intended for use as a guideline only. Ratings & dimensions may vary depending on the current motor being used.

LIMITED WARRANTY:

March pumps are guaranteed only against defects in workmanship or materials for a period of one year from date of manufacture pumping water. On all other solutions, contact the factory for application assistance. March Pump Application Worksheet 0750-0130-1000 is available for additional warranty information.

S I G M A  **T H E R M A L**

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February 5, 2018

Dave Pitts
Process Engineering Associates
700 South Illinois Ave.
Oak Ridge, TN 37830
dpitts@processengr.com

Dear Mr. Pitt

I want to start by thanking you for your interest in working with Sigma Thermal. Following this letter is a complete proposal for an engineered process heating system for your project. The proposal reference number is STQ170194 Rev1. Our ultimate goal is to engineer and supply a product that exceeds your expectations and to provide unparalleled support for that product throughout its service life.

Please review this quotation at your earliest convenience. I am available to you anytime by phone or e-mail to answer any questions or to discuss this proposal in further detail. I look forward to hearing from you in the near future.

Best Regards,



Nick Krauss
Sigma Thermal
Phone: (678) 324-5767
Cell: (770) 317-0373
nkrauss@sigmathermal.com
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SYSTEM DESIGN DATA

Thermal Fluid System Datasheet

Customer Name		Process Engineering Associates		Project Name		Synagro	
Date completed		February 5, 2018		Project Location		Pennsylvania	
Revision number		A		Sales Engineer		Nick Krauss	
Heater Design & Performance							
Heat Input	37.00	MMBTU/hr	Heater Model Number		HC2-35.0-H-SF		
Heater Type	HC2			Heater Configuration		Horizontal	
System Flow Rate	900	gal / min.	Fluid Pressure Drop		21	lb / in ² (d)	
Heater Flow Rate	900	gal / min.	Flue Gas Pressure Drop		4.9	in W.C.	
System Bypass	0	gal / min.	Average Heat Flux		11,334	Btu / hr / ft ²	
Heater Bypass	0	gal / min.	Radiant Zone Heat Flux		28,271	Btu / hr / ft ²	
Thermal Fluid	Therminol 55			Maximum Film Temperature		548	°F
Process Supply Temperature	480	°F	Inner Coil Velocity		9	ft / sec	
Heater Outlet Temperature	480	°F	Outer Coil Velocity		6	ft / sec	
Process Return Temperature	299	°F	Thermal Efficiency		85.4%	% LHV Basis	
Heater Coil Design Temperature	750	°F	Heater Coil Design Pressure		250	lb / in ² (g)	
Burner & Combustion Data							
Fuel Type	Gas			Selected Burner Make		Hauck	
Combustion Air Preheat	No			Burner Model Selected		B118	
Efficiency with Preheat	N/A	% LHV Basis	Steady State Firing Rate (HHV Basis)		47,938,023	Btu / hr	
Oxygen Trim	No			Burner Design Margin		5%	
Combustion Control Type	Parallel Point Positioning			Design Firing Rate (HHV Basis)		50,334,924	Btu / hr
Low NOx Required	No			Combustion Air Design Temperature		60	°F
BMS Type	Standard			Available Fuel Pressure From Customer		10	lb / in ² (g)
Combustion Control Type	Standard			Excess Air		15	%
Control Panel Location	Heater Mounted			Design Fuel Flow Rate		49,537	(std)ft ³ / hr
NOx Required (if any)	N/A	ppm	Burner Duty Cycle		Continuous		
CO Required (if any)	N/A	ppm	Fuel Train Location		Heater Mounted		
Gas Consumption @ Steady State	47,178	(std)ft ³ / hr	Fuel Train / BMS Code Compliance		NFPA 87-15		
Air Consumption @ Steady State	9,054	(act)ft ³ / min	Estimated Primary SSOV Size		3	in.	
Gas Consumption @ High Fire	49,537	(std)ft ³ / hr	Fuel Train Type		Sigma Thermal Standard		
Air Consumption @ High Fire	9,506	(act)ft ³ / min	Fuel Train Construction		NPT		
Exhaust Gas Flow Rate	18,545	(act)ft ³ / min	Flue Gas Velocity		57	ft / sec	
Exhaust Stack Mounting Configuration	Free Standing			Exhaust Gas Temperature		540	°F
Exhaust Stack Diameter	32	in	Exhaust Stack Height From Grade		20	ft	
Pump, Piping, & Expansion Tank Data							
Estimated User & Piping Pressure Drop	30	lb / in ² (g)	Pump Model		ZTNX 80200		
Pump Configuration	2 x 100%			Estimated Motor Size		50	hp
Calculated Total Pump Flow Required	900	gal / min.	Line Size		8	in	
Calculated Total System Pressure Drop	60.9	lb / in ² (d)	Valve Specification		Sigma Thermal Standard		
Selected Pump Make	Sihi			Valve Type		Flanged Gate	
Thermal Fluid Piping Design Temperature	580	°F	Thermal Fluid Piping Design Pressure		150	lb / in ² (g)	
Total Estimated System Volume	3,263	gal	Tank Type		Sigma Thermal Standard		
Calculated Expansion Volume	800	gal	Nitrogen Blanket Pressure (if applicable)		5	lb / in ² (g)	
Expansion Tank Size	1300	gal	Drain Tank Size		By Others	gal	
General Project Data							
Minimum / Maximum Ambient Temperature	-20 / 105	°F	Control Panel Area Classification		General Area		
Elevation (above mean sea level)	800	ft	Skid Area Classification		General Area		
Installation Location	Outdoor			Wiring Standards		Sigma Thermal Standard	
Motor Requirements	Premium Efficiency TEFC			Electrical Code of Construction		NEC	
Instrumentation	Sigma Thermal Standard			Control Panel Certification		UL	
Motor Starters	By Others			Primary Voltage		460V / 3 / 60Hz	
Minimum Electrical Enclosures Rating	NEMA 4			Control Voltage		120V / 1 / 60Hz	
Will a blanket be used?	Optional Scope			Will a tank tower be supplied?		Optional Scope	
Will the heater be skid mounted?	No			Are there secondary circulation skids required?		No	
Will a side stream filter be used?	No			User Control Valves		No	
Automated System Bypass Valve	No			Heater Code of Construction		ASME Section VIII	
Expansion Tank Code of Construction	ASME Section VIII			Applicable Piping Code / Standard		ASME B31.1	
Paint Colors	Sigma Thermal Standard			Overall Paint Specification		Sigma Thermal Standard	

SYSTEM DESCRIPTION

This project involves the design, fabrication, and start-up of a thermal fluid heating system for your project. The thermal fluid system will provide heating for an undisclosed number of secondary users.

A gas fired thermal fluid heater will be supplied. This heater will heat a circulated thermal fluid. The fluid will be pumped at a constant flow rate through the heater, and distributed directly to the secondary users. The users will utilize flow control valves to modulate the flow rate and control the process outlet temperature.

DESIGN NOTES & EXCEPTIONS

1. This system will be assembled only to the level where standard shipping methods can be utilized.
2. Sigma Thermal is quoting its standard equipment and scope of supply. Introduction of third party specifications will affect price and delivery.
3. Fuel train will use 2 regulators and 2 control valves (1 for NG and 1 for waste gas)

CONSOLIDATED SCOPE OF SUPPLY SUMMARY***Sigma Thermal's Scope of Supply***

Thermal fluid system equipment engineering, design, & project management
Thermal fluid heater
Burner and fuel train
Heater control panel and burner management system
Exhaust Stack
PLC based combustion control system
2x100% Primary Loop Pumps with Valves and Skid – quoted separately
1300 Gallon Expansion Tank with Inert Gas Blanket – quoted separately
Start-up support – quoted separately

Customer's Scope of Supply

Unloading and placement of all Sigma Thermal supplied equipment
Installation of all Sigma Thermal supplied equipment
Design and installation of all system piping
All piping, ducting, and exhaust stack insulation
Design and installation foundations
Mounting and interconnecting wiring of all loose valves and instruments
Thermal fluid solution
Power supply to motors and control panel
Motor starters
Fuel supply to fuel train at required inlet pressure
PSV vent and/or discharge line connections
User isolation and control valves (if required)
Loop automatic bypass valves (if required)
PID control loops for all user control valves
Transportation of all heating system components
Verification of compliance with all required local codes

DETAILED SCOPE OF SUPPLY

Preliminary Engineering Design – Preliminary engineering design includes the initial engineering design work for the system. The intent of preliminary engineering design is to present a package of drawings to the customer for formal review and approval. Document deliverables will be as noted in ST-SEDP-0002 Standard Document Deliverables.

Detailed Engineering Design – Detailed engineering design includes the development of all final engineering details. The intent of detailed engineering is to develop and incorporate the review comments, and complete a documentation package fit for fabrication and/or construction. Document deliverables will be as noted in ST-SEDP-0002 Standard Document Deliverables.

Project Management – Project management will be provided throughout the course of the project to insure that all contract details are executed as agreed, and to generally communicate with and support all customer project personnel. Project management duties includes schedule development, schedule maintenance, equipment list development, vendor expediting, logistics coordination, coordination of documentation, invoicing and milestone tracking, and to serve as the primary contact for all formal project communication. Project Management deliverables include:

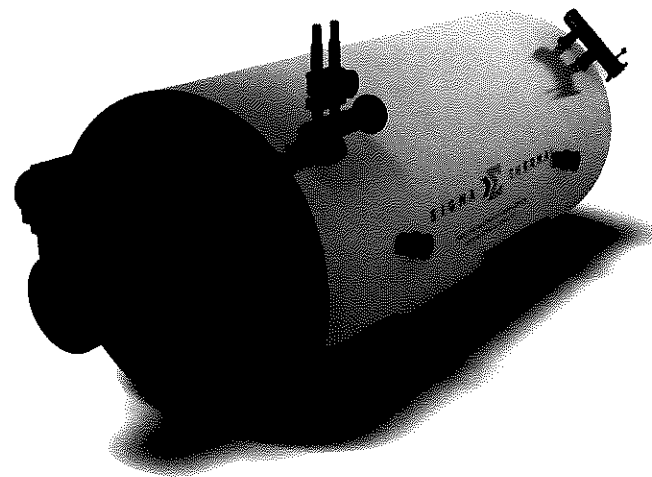
- Periodically updated project schedules
- Formal transmittals for all documentation submittals

Thermal fluid Heater – A high efficiency heater utilizing a double helical coil design. The heater performance will be as stated in the Design Data section of this quotation.

Coil: The heater coil will be designed and stamped per ASME as noted in the design datasheet. The design utilizes two concentric helical coils, each on 1-d centers. The coils are positioned such that the flue gasses make three complete passes, utilizing both the inside and the outside of the coil face. Coil velocities and available surface area are carefully calculated and chosen to minimize fluid film temperatures. Inner coil bending diameter and length are carefully chosen to prevent flame impingement and to optimize space heat release.

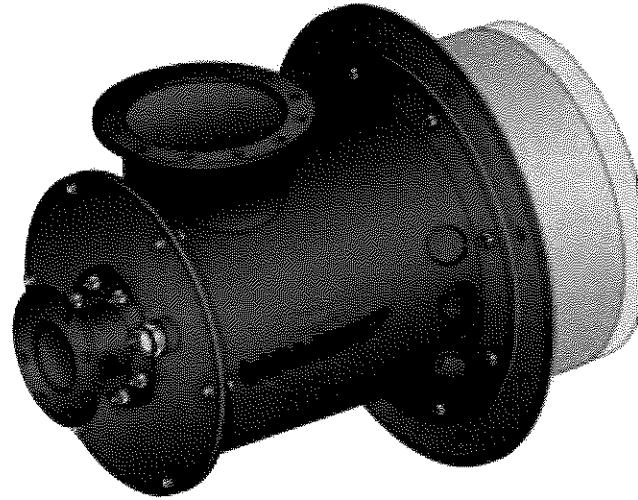
Shell: The shell is manufactured from A-36 carbon steel plate. The high efficiency double coil design eliminates the need for internal shell insulation, creating a significant advantage over single helical coil designs. The heater shell is externally insulated with ceramic fiber insulation and covered with aluminum cladding.

Heater Assembly & Factory Testing: The saddle mounted heater, burner, fuel train, heater mounted instruments, and control panel will be completely pre-piped, pre-wired, and factory tested (simulated operation) prior to shipment.



Burner – A gas fired burner will be provided. The burner package will contain a combustion air fan and fuel/air control system that allows for good control throughout the burner turndown. The burner will be mounted to the heater and pre-wired to the control panel (if locally mounted). A summary of the burner equipment provided is as follows

- Qty. 1 burner with integral combustion air damper
- Qty. 1 combustion air fan and TEFC motor
- Qty. 1 fuel control valve
- Qty. 1 air control damper
- Qty. 1 burner modulation actuator
- Qty. 1 low combustion air pressure switch
- Qty. 1 flame scanner
- Qty. 1 spark igniter
- Qty. 1 ignition transformer



PLC Based Combustion Control System – A control system will be designed to meet current NFPA requirements for safety instrumented systems as it relates to burner management and combustion control systems. The control panel will be designed for installation in environment as specified in the system design datasheet.

A micro-processor based burner management system will be supplied. This BMS system will provide proper burner sequencing, ignition and flame monitoring protection for the automatically ignited gas fired burner. A self-checking flame scanner will be provided as part of the new BMS system. The BMS system will be supplied with expanded text capabilities which will allow for detailed alarm messages to be displayed locally and remotely as necessary. A Modbus connection will be established between the BMS and PLC to allow for all burner management system data and alarms to be communicated to the new PLC. This information will also be available to the customer’s DCS via a connection to the local Ethernet switch mounted in the new control enclosure.

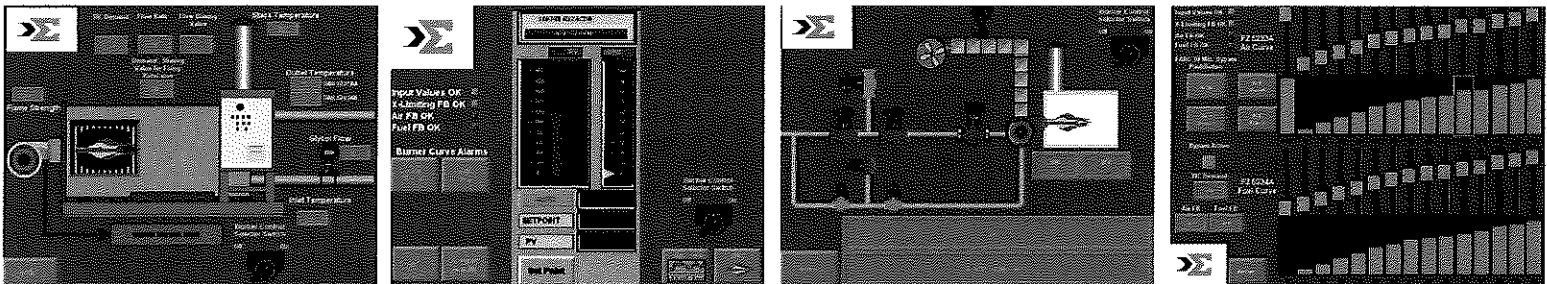
The combustion control logic will be accomplished by the use of a programmable logic controller (PLC) mounted to the new control panel back pan. The PLC will be configured to handle all of the system I/O as determined by the P&ID. All available process data will be gathered by the PLC and available for retransmission to the DCS via a network or hardwired connection. The PLC will be programmed in Allen Bradley RS5000 software using either ladder logic or function block formats. The program will be completely tested and provided at the completion of the project. The program logic will include, but not be limited to, the following.

- Process temperature control loop
- Burner Start/Stop and auto recycle logic
- Combustion air damper positioning for purge, light off, and normal modulation.

- Parallel positioning combustion control logic
- Process control status and alarm monitoring
- Remote temperature set point
- First in alarm annunciation

A 10” operator interface (HMI) will be supplied and installed on the new control panel door. The HMI will provide local operator interface with the system data and controls. The HMI will display process information, system alarm status, loop controller information, and various control functions that can be accessed by plant personnel. The HMI program will be developed using the Allen Bradley RS Studio development software. The HMI will communicate with the PLC via Ethernet IP protocol. The HMI will have display screens developed for the project which will include but not be limited to, the following.

- Process Heater Overview Screen
- System Data Screen
- Alarm History Screen
- Temperature Loop Screen
- Maintenance Screen
- Temperature & Process Data Trending
- Fuel Train Overview Screen



Control Panel Hardware & Fabrication – The system control panel will be assembled and tested at Sigma Thermal’s UL/cUL panel shop in Woodstock, GA. The control system will have a factory acceptance test performed and documented prior to shipment. The complete control panel will be inspected and a UL/cUL label will be applied. The following is a summary of the components supplied with the PLC upgrade option:

- Qty. (1) Hoffman Enclosure
- Qty. (1) AB CompactLogix Processor
- Qty. (1) AB CompactLogix Power Supply
- Qty. (1) AB CompactLogix 6 Channel TC Input
- Qty. (1) AB CompactLogix 16 Channel Digital Input
- Qty. (1) AB CompactLogix 8 Channel Digital Output
- Qty. (1) AB CompactLogix 8 Channel Analog Input
- Qty. (1) AB CompactLogix 8 Channel Analog Output
- Qty. (1) Prosoft Modbus Master/Slave Communication Module
- Qty. (1) AB PanelView Plus 10” High-Resolution Graphic HMI

- Qty. (2) PULS 24VDC Power Supplies
- Qty. (1) Tron 5 Port Ethernet Switch
- Qty. (Lot) Cutler-Hammer Relays (as required)
- Qty. (Lot) Cutler-Hammer Circuit Breakers (as required)
- Qty. (1) Hoffman Enclosure Light Kit
- Qty. (1) GFCI Computer Receptacle
- Qty. (Lot) Little Fuses and holders
- Shop Consumables As Necessary

Fuel Train – A pre-piped and pre-wired fuel train manifold will be provided. The fuel train is an integral part of the burner safety system which safely regulates the availability of natural gas to the burner. A summary of the fuel train equipment supplied is as follows:

Gas Train

- Qty. 2 - primary pressure regulator
- Qty. 2 - safety shut-off valves for primary line shut-off
- Qty. 1 - FO vent valve for primary line vent
- Qty. 4 - manual isolation ball valves for primary line isolation
- Qty. 1 - strainer for inlet fuel gas filtration
- Qty. 1 - high & low gas pressure switch
- Qty. 2 – pressure gauges with gauge valves for primary line indication
- Qty. 1 - pilot pressure regulator
- Qty. 2 - FC shut-off valve for pilot line shut-off
- Qty. 1 - FO vent valve for pilot line vent
- Qty. 2 - manual isolation ball valves for pilot line isolation
- Qty. 2 - pressure gauges with gauge valves for pilot line indication
- Pre-Piping & Pre-Wiring – The fuel train will be pre-piped from inlet isolation valve to outlet isolation valve. All of the fuel train components will be pre-wired to the heater mounted control panel or junction box.

Primary Loop Instruments & Controls – Safety and control instruments for the primary loop will be provided. A summary of the primary loop instruments and controls supplied is as follows:

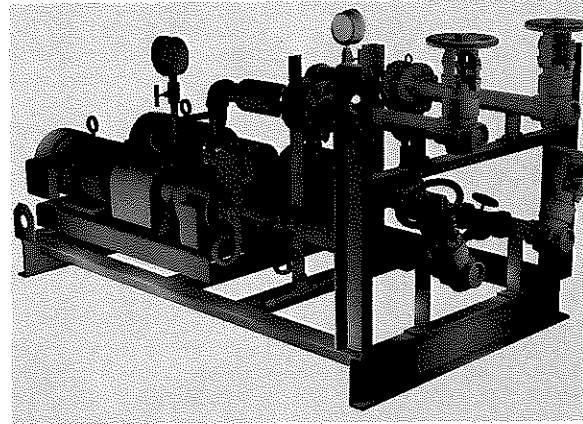
Heater Mounted

- Qty. 4 thermocouples with thermowells for fluid temperature measurement
- Qty. 1 thermocouple with thermowell for flue gas temperature measurement
- Qty. 1 flow orifice for differential pressure measurement
- Qty. 1 DP switch with low and low-low flow switches for low fluid flow interlock

Loose Primary Loop Instruments

- Qty. 1 liquid filled pressure gauge for heat outlet pressure indication
- Qty. 1 PSV for heater coil overpressure protection (per ASME Section VIII liquid relief)

2 x 100% Primary Loop Pump Skid & Valves – A pump skid with a 2 x 100% capacity primary system pump will be provided. The pump skid will be completely assembled on a structural steel skid frame. Isolation valves, strainers, check valves, expansion joints, and pressure gauges will all be provided as part of the assembled skid package. Butt weld connections will be used for all components (when possible) to minimize potential leak points. A summary of the equipment supplied with the primary loop pump skid is as follows:



- Qty. 2 x 100% centrifugal thermal fluid pump & motor
- Qty. 2 air cooled mechanical seal
- Qty. 2 – High temperature gate valve with butt weld connections for pump inlet isolation
- Qty. 2 – High temperature gate valve with butt weld connections for pump outlet isolation and throttling
- Qty. 2 – Y-pattern strainer with butt weld connections and drain valve
- Qty. 2 – Drain valve

Expansion Tank– A horizontal cylindrical expansion tank will be provided. The tank will be designed and stamped per ASME Section VIII. Butt weld nozzle connections will be used where possible to minimize potential leak points. A summary of the expansion tank equipment supplied is as follows:

- Qty. 1 horizontal expansion tank with saddles
- Qty. 1 float type low level switches for expansion tank low level detection
- Qty. 1 level gauge for expansion tank level indication. Gauge isolation valves will be provided.

Nitrogen Blanket - A pre-piped nitrogen blanket manifold will be provided to prevent oxygen from interacting with the fluid in the expansion tank. A summary of the nitrogen blanket equipment supplied is as follows:

- Qty. 1 Inlet nitrogen pressure regulator
- Qty. 1 Low nitrogen pressure switch
- Qty. 1 Vacuum breaker
- Qty. 1 Liquid filled pressure gauge with gauge valve for expansion tank pressure indication
- Qty. 1 PSV for tank overpressure protection
- Qty. 1 Back pressure regulator for relief of excess gasses during system expansion

Start-up Support – Start-up support will be provided at the customer’s facility during system commissioning. The purpose of start-up support is to properly commission and tune the heater, insure system safeties are properly defined and set, and to provide operator training as necessary. Start-up support is not included in the base proposal and is priced separately per the Sigma Thermal rate sheet.

SYSTEM PRICING SUMMARY

Thermal Fluid Heating System	\$ 635,721
2x100% Primary Loop Pump Skid with Valves	\$91,118
1300 Gallon Exp. Tank w/Inert Gas Blanket	\$24,972

Pricing Validity: Pricing is budgetary for 90 days, given in US dollars, and quoted FCA fabricator. Pricing does not include taxes, export packing, duties, or freight unless otherwise noted. Freight and packing can be included by Sigma Thermal on a pre-pay and add basis at cost plus a 10% handling fee. Should the outlined scope of supply change, pricing is subject to change as well.

Note on Engineering & Design Allowances: Pricing is based on submittals and documentation deliverables per notes and items given in Sigma Thermal Standard ST-SEDP-0002 as attachment to this proposal. Additional cost will apply if additional documents or submittals are required.

PAYMENT TERMS

- 20% with Purchase Order
- 20% with Submittal of Engineering Package
- 25% with Purchase of Heater Coil Materials
- 25% with Heater Coil Hydrotest
- 10% with Notification of Ready to Ship

All invoices are due NET 30 days. Payment terms for international projects must be negotiated with Sigma Thermal. Overdue accounts will be subject to a 2% finance charge per month. All pricing is subject to Sigma Thermal standard terms and conditions and approval of customer credit.

SYSTEM DELIVERY SUMMARY

Submittal of General Arrangments & P&IDs for Approval	6 – 8 weeks ARO
Equipment Delivery After Drawing Approval	18 – 20 weeks ARAD

Delivery times may vary depending on time of order
 ARO – After Receipt of Purchase Order
 ARAD – After Receipt of Approved Drawing

2018 Field Service & Engineering Rates

(All rates are US dollars)

Standard Service

Technician - Field Rates

*USA Only	Hourly Rate	Daily Rate (8 hrs/day)
Monday thru Friday (1 to 8 hrs/Std Rate)	\$160	\$1,280
Monday thru Friday (9 to 12 hrs/OT Rate)	\$240	N/A
Monday thru Friday (13+ hrs/DT Rate)	\$320	N/A
Saturday	\$240	\$1,920
Sunday & Holidays	\$320	\$2,560

Apprentice- Field Rates (Would work with a Technician)

*USA Only	Hourly Rate	Daily Rate (8 hrs/day)
Monday thru Friday (1 to 8 hrs/Std Rate)	\$40	\$320
Monday thru Friday (9 to 12 hrs/OT Rate)	\$60	N/A
Monday thru Friday (13+ hrs/DT Rate)	\$80	N/A
Saturday	\$60	\$480
Sunday & Holidays	\$80	\$640

*All Other Countries	Hourly Rate	Daily Rate (8 hrs/day)
Monday thru Friday (1 to 8 hrs/Std Rate)	\$185	\$1,480
Monday thru Friday (9 to 12 hrs/OT Rate)	\$275	N/A
Monday thru Friday (13+ hrs/DT Rate)	\$370	N/A
Saturday	\$275	\$2,200
Sunday & Holidays	\$370	\$2,960

Engineer - Field Rates

*USA Only	Hourly Rate	Daily Rate (8 hrs/day)
Monday thru Friday (1 to 8 hrs/Std Rate)	\$200	\$1,600
Monday thru Friday (9 to 12 hrs/OT Rate)	\$250	N/A
Monday thru Friday (13+ hrs/DT Rate)	\$300	N/A
Saturday	\$250	\$2,000
Sunday & Holidays	\$300	\$2,400

Engineer - Field Rates

*All other Countries	Hourly Rate	Daily Rate (8 hrs/day)
Monday thru Friday (1 to 8 hrs/Std Rate)	\$240	\$1920
Monday thru Friday (9 to 12 hrs/OT Rate)	\$300	N/A
Monday thru Friday (13+ hrs/DT Rate)	\$350	N/A
Saturday	\$300	\$2,400
Sunday & Holidays	\$350	\$2,800

Offshore, Arctic & Otherwise hazardous locations

Technician – Field Rates

	Hourly Rate	Daily Rate (8 hrs/day)
Monday thru Friday (1 to 8 hrs/Std Rate)	\$240	\$1,920
Monday thru Friday (9 to 12 hrs/OT Rate)	\$360	N/A
Monday thru Friday (13+ hrs/DT Rate)	\$480	N/A
Saturday	\$360	\$2,880
Sunday & Holidays	\$480	\$3,840

(Std Rate = Standard rate, OT Rate = Over Time rate, DT = Double Time rate)

Unavoidable travel delays (weather related, airline issues, etc.) will be invoiced at \$100 per hour.

Engineering

Engineer – Office Rate: \$175 per hour flat rate

MACT Testing

Customers will be invoiced for the following on all MACT jobs:

Pre-calibration/mobilization—2 hrs per heater at std rate

Post-calibration/demobilization—2 hrs per heater at std rate

Reporting—a minimum of 4 hrs per heater at std rate

Calibration gases--\$600 per heater

Travel time and on-site time will be invoiced per timesheets. Expenses will be invoiced per the “Expenses” section below.

Stand By Time

Stand by is considered to be any time that the technician is unable to perform his work due to site related issues. Stand by time will not exceed 8 hours in any day and will be billed at the prevailing daily rate whether the technician is at the site or not.

Expenses

All expenses including: Roundtrip Airfare (Business Class for International Trips), Rental Car, Lodging, Meals @ \$60.00 per diem Domestic and \$75.00 per Diem International, Vehicle Mileage @ \$0.60/mile for personal vehicles and \$0.75/mile for Company Service Truck, Parking, Tips, Tolls, etc will be invoiced at face value plus 10% administration fee.


Payment Terms

All invoices are due NET 30 days from receipt. Make all checks payable to Sigma Thermal Inc. Please contact us if you wish to make payment via EFT. Overdue accounts will be subject to a service charge of 2% per month.

A 50% pre-payment of the estimated total is required for service work being performed on equipment located outside the United States.

Foreign Government Taxes and Fees

All of the above rates are exclusive of any foreign government taxes or fees. When applicable, any foreign taxes or fees will be billed to the customer as an expense item.

 SIGMA THERMAL INC. PROCESS HEATING SYSTEMS DESIGN ENGINEERING & SERVICE		Standard Document Deliverables		Number: ST-SEDP-0003 Author: Jeff Ackel Approval: N/A Date: 1/23/15 Revision: 1 Date: 2/18/15	
Notes:					
1	This document deliverables matrix outlines the standard documents that will be submitted in conjunction with equipment deliverables.				
2	Approval drawings can be waived to expedite delivery if negotiated in advance				
3	Some drawings or documents included in this standard may not be applicable to every project or equipment type.				
4	Adequate engineering and design time has been included to execute the scope of supply detailed in the proposal. If, following the initial drawing submittal for any document set (process, electrical, mechanical, or otherwise) more than one iteration of customer comments are returned requiring further changes to submitted drawings, additional engineering time will be billable at the current in office engineering rate as noted in the Sigma Thermal Rate Sheet.				
5	For scheduling purposes, Sigma Thermal assumes a maximum of two weeks for customer review. (Documents must be returned Approved in order for work to proceed according to the original schedule. For documents returned with mark ups, schedule and commercial changes will apply.				Submittal Legend
6	P&IDs and datasheets will be generated using Sigma Thermal standard format and lead sheets. Custom P&IDs using a secondary format or symbology will be quoted on a case by case basis at the current in office engineering rate as noted in the Sigma Thermal Rate Sheet.				
7	Sigma Thermal standard tag numbers will be used where applicable.				
8	Quality Turnover Package provided separately from Operation and Maintenance Manual.				
	For Review & Approval	A			
	For Construction	B			
	For Information Only	C			
	As-Built	D			
Drawing or Document	Document Name	Document Description & Included Information	Customer	Submittal Code	
Process					
	Process & Instrumentation Diagrams	Provides Process Data, Piping Diagrams, and Instrumentation/Control Information		A, B, D	
	Process & Instrumentation Diagrams Lead Sheet	Process & Instrumentation Diagrams Symbology Legend		C	
Mechanical					
	General Arrangement Drawings or Dimension Sheets	General arrangement drawings identify the general dimensions of the equipment, interfaces, shipping splits, and weight.		A, B	
	Heater Datasheet	Heater design data including duty, orientation, design temperature, design pressure, and performance data		C	
Electrical					
	Wiring Schematics	Schematic used on all jobs which details power and control distribution within the control panel		C	
	Field Wiring Diagrams	Wiring details for Sigma Thermal Skid Wiring layout for panel room, exterior instrumentation (as required) and back panel layout. Also includes junction box details for the skid.		C	
	Panel Layouts	Panel layout details for the skid.		C	
	PLC Schematics if Applicable	Includes wiring details for I/O cards, processor communication and power wiring		C	
Quality Turnover Package					
	Inspection & Test Plan	Indicates hold, verification, and witness points for all required testing and documentation.		C	
	Material Test Report	Material Test Reports for all code materials.		C	
	Code Weld Map	Drawings of coil and pressure piping with welds marked and numbered.		C	
	Code Weld Traveler	Traveler containing welding procedures and inspections.		C	
	Weld Procedure Specifications	Describes weld procedures per code requirements.		C	
	Welder Performance Qualifications	Specifies requirements and certification details for welders.		C	
	Procedure Qualification Records	Details of welding tests.		C	
	Paint Traveler	Contains results of coating tests.		C	
	ASME Data Reports	Data report for heater coils and tanks.		C	
	Pressure Test Reports	Pressure test results for coils and pressure piping.		C	
	NDE Test Reports	Results of non-destructive examinations.		C	
	Data Plate Rubbing	Copy of the data plate.		C	
	FAT Checklist	Specifies details and results of the Factory Acceptance Test		C	
	NCR's (if applicable)	Non-compliance reports.		C	
Operation & Maintenance					
	Operation & Maintenance Manual	Standard Operations and Maintenance Manual for Heater. Including heater O&M information, Trouble Shooting Guide, As-Built Drawings, Calculations, Sub-Component Manuals, Quality Control Documentation, data sheets, and the Spare Parts List.		C	
	Troubleshooting Guide	Standard Trouble Shooting Guide for Heater		C	
	Spare Parts List	Strategic Spares for Heater - Includes Two Year Spares and Recommended Spares for Commissioning		C	
	Manufacturer Information	Manufacturer information on Subcomponents for Equipment		C	
	Equipment Datasheets	Equipment information for provided scope of supply		C	
Project Management					
	Project Schedule	Production Schedule Including Procurement, Design, and Fabrication		C	

Sigma Thermal
Manual Table of Contents

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SIGMA THERMAL STANDARD TERMS AND CONDITIONS OF SALE

GENERAL

This proposal is delivered to the entity identified as the customer on the face hereof ("Buyer") and may not be used by or disclosed to any other entity. This proposal does not create a contract between Sigma Thermal, Inc. ("Seller") and Buyer and is not an offer open to acceptance by Buyer. Any order(s) placed by Buyer based upon this proposal shall be subject to the acceptance of Seller at its principal office in Marietta, GA. Buyer agrees that all orders accepted by Seller shall be governed exclusively by the terms and conditions contained herein and no changes or additions to such terms and conditions shall be binding upon the parties unless clearly marked hereon and signed by both Seller and Buyer. Absent a written order, Buyer's acceptance of any products shipped or services provided pursuant to this proposal shall constitute an order by Buyer that has been accepted by Seller. Any and all terms or conditions set forth on any order form, change order, acknowledgment, specifications or other documents supplied by Buyer are hereby expressly rejected by Seller and shall not be binding upon either party. No waiver, change or modification of any terms or conditions on the face or reverse hereof shall be binding on Seller unless made in writing and signed by an officer of Seller.

PRICES, TERMS AND PAYMENTS

All prices are subject to change without notice at any time prior to acceptance of Buyer's order by Seller. Payment terms are 30 days net from the date of invoice, unless otherwise noted on the face hereof. If progress payments are specified on the face of this proposal, such progress payments shall be due on the dates specified. If, as a result of change orders requested by Buyer or a delay requested by Buyer, completion of manufacturing is delayed beyond 60 days after the delivery date specified on the face hereof, starting on that date a price escalation of 1% per month of the gross order amount will apply. Further, if, at Buyer's option, shipment of an order is delayed more than ten days after completion of manufacturing, Buyer will be invoiced at that date and will be responsible for any storage or other costs involved. Seller reserves the right to make partial shipments of the equipment described in this proposal (the "Equipment") and invoice for same. A finance charge of 2% per month (annual percentage of 24%), or the maximum rate allowed by applicable law, whichever is less, will be added to invoices not paid when due; for progress payments not paid when due, said interest shall relate back and commence from the date of invoice. Time is of the essence for all payments due hereunder, and if any payment due Seller is collected at law, or through an attorney at law or under advice therefrom, or through a collection agency, Buyer shall pay all costs of collection, including, without limitation, all court costs and reasonable attorneys' fees. Any payment received from or for the account of Buyer may be accepted and applied by Seller against any indebtedness or obligation owing by Buyer to Seller, without prejudice to and without discharging the remainder of any such indebtedness or obligation, regardless of any condition, provision, statement, legend or notation appearing on, referring to, or accompanying such check or remittance.

CHANGE ORDERS; CANCELLATION

All change orders must be communicated in writing. Change orders may affect the original ship date of the Equipment. Change orders are not valid unless and until accepted, in writing, by Seller. In the event of a cancellation by Buyer, Buyer shall pay all costs of Seller's performance to the date of cancellation and costs incurred as a result thereof, including, without limitation, costs relating directly or indirectly to preparation of documents and engineering work, purchases of material and special parts specifically for the Equipment, all material used for assembly, assembly labor, and any storage, shipping or freight charges incurred that are related to the Equipment, plus Seller's customary markup. In such event, Buyer shall also pay any cancellation fees actually incurred by Seller with respect to its suppliers and any cancellation fees specified on the face hereof.

SHIPMENTS; FORCE MAJEURE

Seller does not guarantee shipment by the proposal ship date, but will use its commercially reasonable efforts to cause shipment by such date, subject to the terms hereof. In case of delay by Buyer in furnishing any required information, change in any of the specifications at the insistence of Buyer or other delays caused by Buyer, shipment will be extended as reasonably necessary, taking into consideration the nature of such change or delay. If there are multiple shipments, (i) each shipment shall constitute a separate and independent transaction; (ii) Seller may invoice and collect payment for each such shipment without reference to any other; and (iii) Seller may defer further shipments until Buyer's default with respect to any prior shipment is cured. The proposed time of delivery is understood to be from date of receipt of all necessary information including Buyer's approval, if applicable. Any delay in delivery of any installment shall not relieve Buyer of its obligation to accept remaining deliveries.

Seller shall not be liable for damages or for cancellation of any order as a result of any delay due to any cause beyond Seller's reasonable control including, but not limited to, act of God, act of Buyer, embargo, or other governmental acts, regulations or requirements, fire, accident, labor disputes, war, civil insurrection or riot, delay in transportation, or the inability to obtain necessary labor, materials, or manufacturing facilities. In the event of any such delay, the date of delivery may be extended for a period equal to the time lost by reason of the delay.

TITLE & RISK OF LOSS; PURCHASE MONEY SECURITY INTEREST; DEFAULT

Title to and risk of loss or damage for all Equipment shall transfer to Buyer upon shipment by Seller, FOB Seller's dock. Buyer shall be deemed to have finally and conclusively accepted any delivery of Equipment unless it notifies Seller within forty-eight (48) hours of receipt thereof of the nonconformity of such Equipment with the specifications therefor. Buyer hereby grants to Seller a valid, first priority, purchase money security interest in and to all Equipment in order to secure Buyer's payment of the purchase price therefore. Buyer shall cooperate with Seller in filing appropriate UCC-1 or other financing statements in order to perfect such security interest. In the event Buyer fails to pay any amount due within thirty days of the date of receipt of Seller's invoice therefor or violates any other material term or condition hereof, Seller may, at its election and without demand or notice of any kind, enter into Buyer's premises and retake possession of any and all of the Equipment, and pursue any other remedy available at law or in equity. To the extent permitted by applicable law, all of Seller's rights and remedies are cumulative and not alternative, and may be enforced successively or concurrently.

Until Buyer has paid the full purchase price for the Equipment as specified herein, Buyer shall: (i) maintain the Equipment in good operating condition; (ii) not use or permit use of the Equipment in any manner likely to be injurious to the Equipment; (iii) not remove or permit removal of the Equipment from the location specified on this proposal; (iv) not make or permit any alteration to the Equipment without the prior written consent of Seller; and (v) procure and maintain fire, extended coverage, vandalism and mischief insurance for the full insurable value of the Equipment with Seller named as a loss payee.

SYSTEM LICENSE

To the extent that this proposal involves the sale of Equipment to be used in a system or process identified herein (a "System"), Seller hereby grants to Buyer a nonexclusive license to use the System, without the right to sublicense, under any applicable United States patents or other intellectual property right under which Seller has the right to provide the System. Seller agrees to defend and indemnify Buyer against any claim that the System infringes upon any valid United States patent, except to the extent that such claim arises from the Buyer's misuse of the System or combination of the System with other systems or equipment not provided by Seller. Upon receipt of notification of any claim of infringement, Buyer shall notify Seller within ten (10) days thereafter and shall permit Seller to defend such claim with counsel of Seller's choice. Seller shall have no liability or obligation with respect to any claim based upon any non-United States patent. Buyer agrees that it will not reverse engineer or otherwise use or convey the System or the design embodied thereby, except as expressly authorized by Seller.

RETURNS AND RESTOCKING CHARGES

Equipment may be returned only upon prior written authorization of Seller. Buyer shall pay all carrier charges for returns and shall be responsible for damages in transit, and a 25% minimum restocking charge. Equipment may be returned only if in new and unused condition and returned within six months from the original date of shipment. Any credit given by Seller will be based on the original invoice price or the current price, whichever is lower, less the applicable restocking charge.

SERVICE

Unless otherwise noted herein, the cost of the Equipment does not include service or installation. All services performed by Seller are subject to Buyer's payment of Seller's prevailing charges plus necessary travel and living expenses.

TAXES

Any taxes that may be imposed upon the goods or services described herein shall be the responsibility of Buyer and will be added to and become a part of the purchase price. The term "taxes" means all taxes, fees and assessments due, assessed or levied by any foreign, federal, state or local government or taxing authority, and any penalties, fines or interest thereon, which are imposed upon the sale, production or transportation of the Equipment, but shall not include any taxes based upon the net income of Seller. If Seller is required by applicable law to pay or collect any taxes on account of the sale, production or transportation of the Equipment, then such taxes shall be paid by Buyer unless Buyer is exempt from such taxes and timely furnishes Seller with a certificate of exemption.

CONFIDENTIAL INFORMATION

In supplying Equipment and/or a System pursuant to or in connection with this proposal, Seller may furnish confidential and/or proprietary information to Buyer, its affiliates, consultants, advisors and contractors (collectively, "Recipients"). By placing an order pursuant to this proposal, each Recipient agrees to hold and maintain such information in strict confidence and not to disclose such information to any third party without first obtaining the express written consent of Seller.

LIMITED WARRANTY; THIRD PARTY EQUIPMENT; REMEDIES

Limited Warranty. Seller warrants to Buyer only (not to any successors or assigns) that:

- (a) at the time any System is delivered to Buyer, such System will perform as stated in Seller's final specification sheets for such System only when (i) properly installed, connected, started, operated and maintained in accordance with Seller's instructions, manuals, and information guide(s), as revised from time to time, (ii) used for the applications specified and in the manner intended, and (iii) used in the environments specified.
- (b) For a period of eighteen (18) months from shipment or twelve (12) months from initial start up, whichever ends sooner, each item of Equipment manufactured by Seller (with the exception of burner blocks, glass, plastic, rubber, tube skin thermocouples, insulation or any refractory materials, which Seller does not warrant) shall be free from defects in material and workmanship under normal use, service and maintenance. As used in the preceding sentence, "normal use, service and maintenance" means: (i) not in excess of the maximum pressures, temperatures, volumes and rated capacities or other parameters specified in Seller's specifications; (ii) using only fuels, fluids, or other components specified in Seller's specifications; and (iii) operation and maintenance in compliance with the appropriate instructions and information guides.
- (c) Services performed by Seller shall be performed in accordance with prevailing industry standards.

This warranty does not apply to damage or failure caused by any or all of the following circumstances or conditions: (i) delivery or other circumstances beyond the control of Seller; (ii) corrosion, other environmental factors, or ordinary wear and tear; (iii) parts and/or accessories or components not manufactured by or for Seller; or (iv) use of the Equipment other than in strict compliance with the specifications therefore or Seller's other written instructions. SELLER EXPRESSLY DISCLAIMS ANY AND ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE OR PURPOSE. No person, including any dealer or representative of Seller, is authorized to make any representations concerning the Equipment or System on behalf of Seller or to assume for Seller any obligations beyond those contained in this warranty and all statements or warranties other than those set forth herein are hereby expressly denied and disclaimed. Seller reserves the right to make design changes, modifications or improvements upon its products or systems, without any obligation to install same on any previously sold or delivered products or systems.

Third Party Equipment. In addition to the foregoing warranties, with respect to any Equipment sold by Seller (whether as part of a System or separately) but not manufactured by Seller, such Equipment is not warranted by Seller, but Seller agrees to enforce the manufacturer's warranty, if any, for such Equipment on behalf of Buyer, upon request by Buyer. In the event of any warranty claim with respect to any such Equipment, Buyer shall promptly notify Seller thereof, in writing, and shall provide Seller with all information and assistance necessary to enable Seller to pursue the warranty claim against the manufacturer of such Equipment.

Remedies. In the event of that any Equipment does not conform to or comply with the limited warranty set forth herein, Buyer's sole and exclusive remedy shall be the repair or replacement, at Seller's option, of such Equipment by Seller, without charge for labor to Buyer, except for the costs of field erection and/or installation, if any, which shall be borne by Buyer. In the event any services provided by Seller do not comply with the limited warranty set forth herein, Buyer's sole and exclusive remedy shall be the completion of the services in compliance with the limited warranty set forth herein. These remedies are available to Buyer only if Buyer delivers written notice to Seller of any alleged defects (a) promptly after discovery thereof and (b) within the warranty period. The remedies described herein are subject to the limitations set forth in the following section and elsewhere herein.

Commissioning By Unauthorized Personnel. In the event that any Equipment is commissioned and/or is first operated without direct supervision by Sigma Thermal personnel or personnel pre-approved and authorized by Sigma Thermal, all warranty provisions will be void.

LIMITATION OF LIABILITY

In no event shall Seller's liability to Buyer with respect to any Equipment or service exceed the purchase price of such Equipment or service as set forth in this proposal, regardless of whether such liability is based upon the foregoing limited warranties or upon any tort, contract, indemnification or other theory and regardless of any determination of causation or negligence. In the event of multiple claims with respect to any item of Equipment or any service provided, such claims shall be aggregated in determining whether the limitation has been reached. Without limiting the foregoing, in no event will Seller be liable to Buyer or any person claiming by or through Buyer for any personal injury, loss of business profits, business interruption, plant shut-down, non-operation or increased expense of operation of other equipment or any other indirect, incidental or consequential damages or loss, or any punitive damages, arising out of or in connection with the sale, delivery, non-delivery, servicing, use, maintenance, installation, condition, ownership, possession, operation, selection or return of the Equipment, or for any claim made against Buyer by any other person, even if Seller has been advised of the possibility of such claim. In no event will Seller be liable for the cost of work performed or material or Equipment furnished by Buyer or third parties due to any breach of the limited warranty set forth herein unless such work, material or Equipment have been approved in writing by an authorized representative of Seller after having been provided a reasonable opportunity to perform such work and provide such material or Equipment.

INDEMNIFICATION

Other than claims for which Seller has agreed to indemnify Buyer pursuant to the System License provision hereof, Buyer agrees to indemnify and hold Seller harmless from and against any and all claims, demands, liabilities, losses, costs, and expenses (including, without limitation, reasonable attorneys' fees), irrespective of the theory upon which based (including, without limitation, negligence and strict liability), that Seller may suffer or incur as a result of any claims, demands or actions against Seller by third parties arising out of the sale, delivery, installation or servicing of Equipment sold or delivered to Buyer hereunder or in connection with the use, condition, possession, installation, ownership, selection, transportation, loading, unloading, maintenance or return of any Equipment sold or delivered to Buyer hereunder, including without limitation, claims for injury to property or person (including death).

GOVERNING LAW

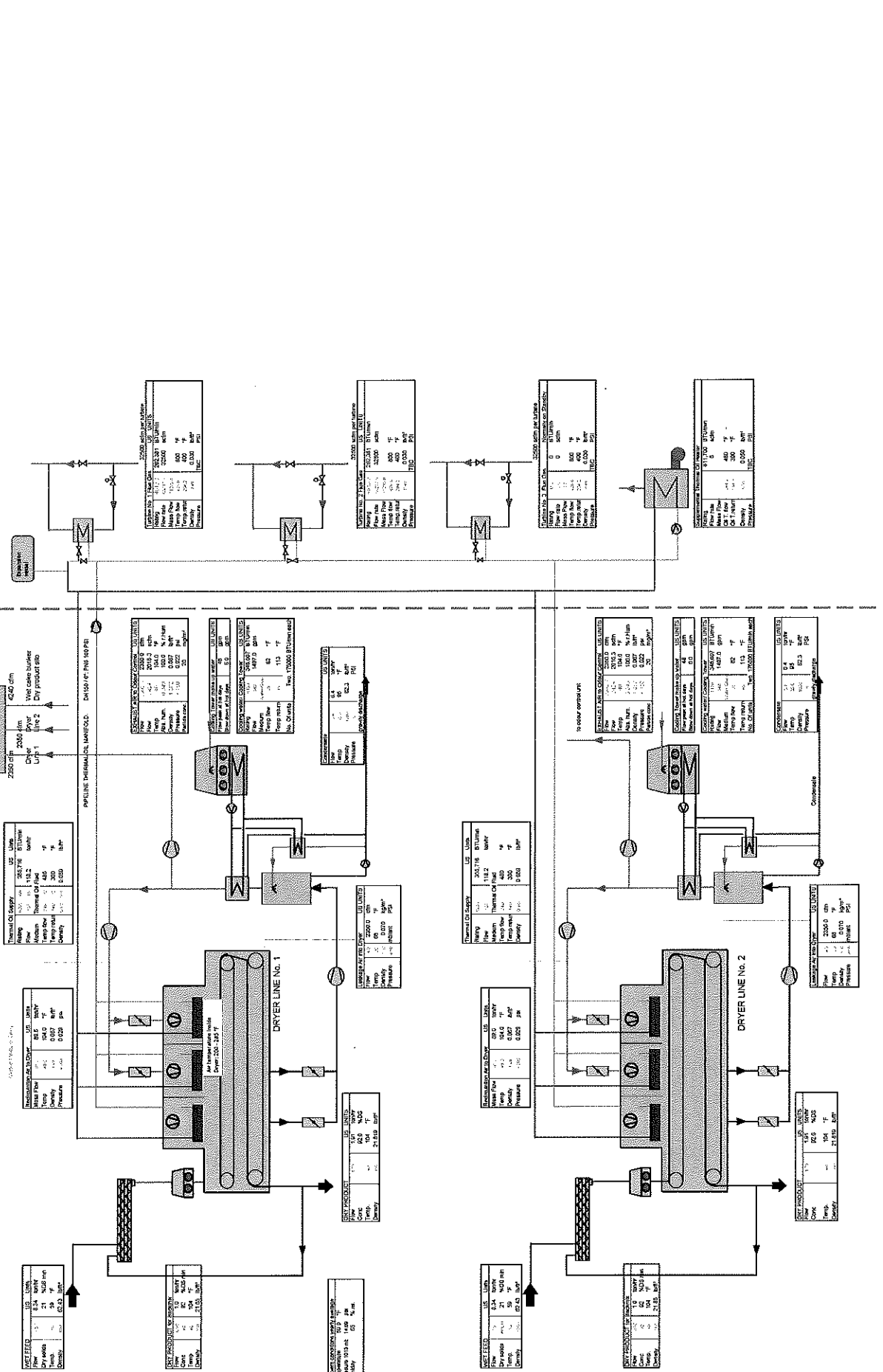
This agreement shall be governed by the laws of the state of Georgia, and venue for all disputes shall be in Cobb County, Georgia. Any dispute, controversy or disputed claim arising under, in connection with or relating to this agreement shall be finally settled and determined under and pursuant to the commercial arbitration rules of the American Arbitration Association ("AAA") by a panel of three arbitrators appointed in accordance with the commercial arbitration rules. Any award rendered by the arbitrators will be final, conclusive and binding upon the parties and any judgment thereon may be entered and enforced in any court of competent jurisdiction.

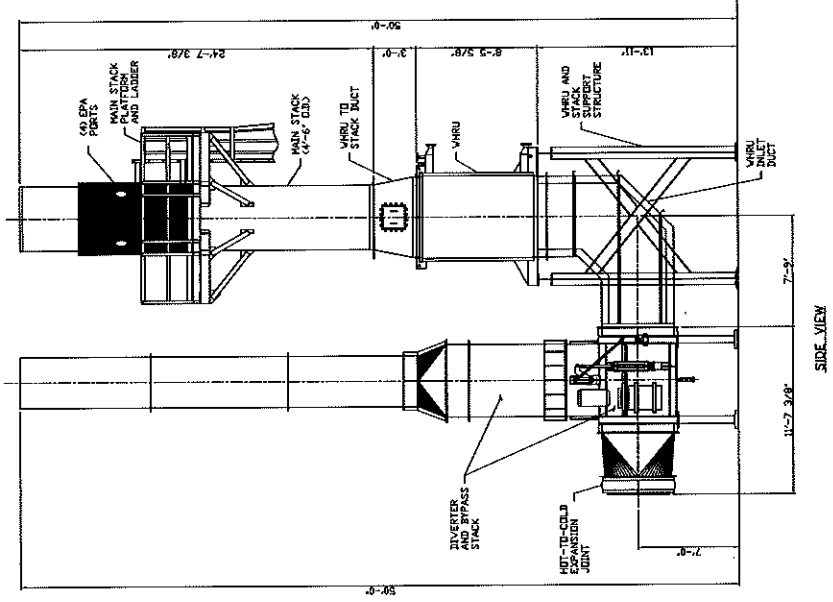
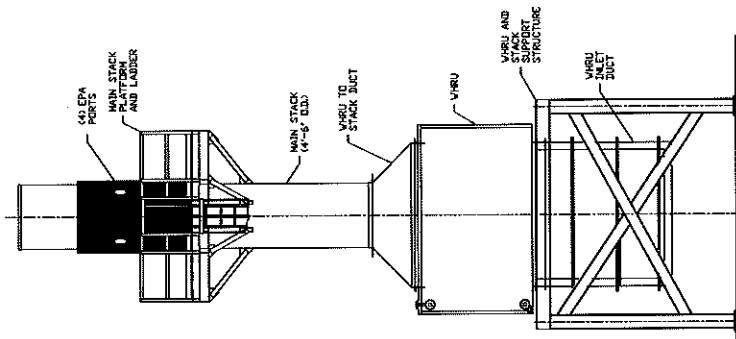
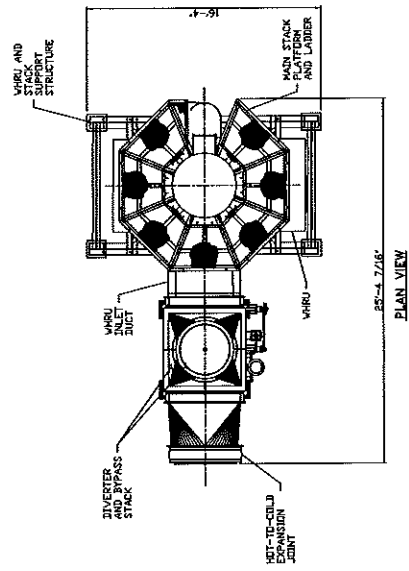
MISCELLANEOUS

- (a) This agreement may be amended only in a writing executed by the parties.
- (b) Seller's obligation to deliver Equipment to Buyer is subject to Seller obtaining all required permits, licenses and approvals, including export licenses when applicable, to deliver and install the Equipment.
- (c) All notices, consents or requests desired or required to be given hereunder shall be in writing and shall be delivered in person or sent by (i) registered or certified mail, return receipt requested, postage prepaid, or (ii) an overnight delivery service with the capability to verify delivery, to the address of the other party set forth hereon or to such other address as such party shall have designated by proper notice.
- (d) Any order placed by Buyer and accepted by Seller may not be assigned by Buyer to any other entity without the express prior written consent of Seller.
- (e) No legal action, regardless of form, arising out of or in connection with the sale of the Equipment hereunder (other than an action by Seller for any amount due from Buyer) may be brought more than six months after the cause of action has arisen.
- (f) In the event that any one or more of the provisions hereof is determined by a court of competent jurisdiction to be invalid, unenforceable or illegal, such invalidity, unenforceability or illegality shall not affect any other provision hereof and this proposal shall be construed as if the challenged provision had never been contained herein.
- (g) No waiver by either party of any default hereunder by the other party hereto shall operate as a waiver of any other default or of a similar default on a future occasion. No such waiver by either party shall be effective unless the same shall be in writing and signed by the waiving party.
- (h) Each party hereto is an independent contractor, and nothing contained herein may be construed as creating a joint venture, partnership, licensor-licensee, principal-agent or mutual agency relationship between or among the parties. Neither party, by virtue of this proposal, has any right or power to create any obligation, express or implied, on behalf of the other party. No employee of either party will be deemed to be an employee of the other party by virtue of this proposal or any sale made hereunder.

HAARSLEY BELT DRYER MASS ENERGY BALANCE

Process	SPINROZ / BRT S330
Serial No.	000000
Local Number of Dryer Chambers	7
Local Number of Dryer Lines	6
Local Number of Dryer Units	42
Local Number of Dryer Motors	21
Local Number of Dryer Drives	21
Local Number of Dryer Belts	21
Local Number of Dryer Rollers	21
Local Number of Dryer Supports	21
Local Number of Dryer Frames	21
Local Number of Dryer Motors	21
Local Number of Dryer Drives	21
Local Number of Dryer Belts	21
Local Number of Dryer Rollers	21
Local Number of Dryer Supports	21
Local Number of Dryer Frames	21





Boilers for people who know old cars®

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DESCRIPTION: PRELIMINARY SYSTEM ARRANGEMENT

PROJECT: SYNAGRO/MID-ATLANTIC PROJECT

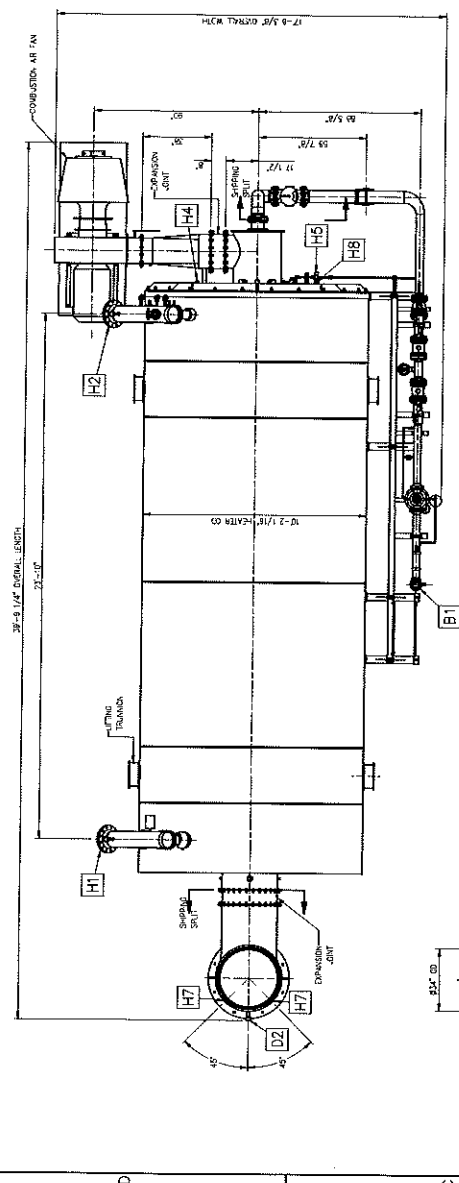
DATE: 1/17/10
 DRAWN BY: DBS
 CHECKED BY: DBS
 PROJECT NO.: OTB-H01-5528 A

NO.	DATE	REVISIONS	BY	CHKD.
1		REVISIONS		

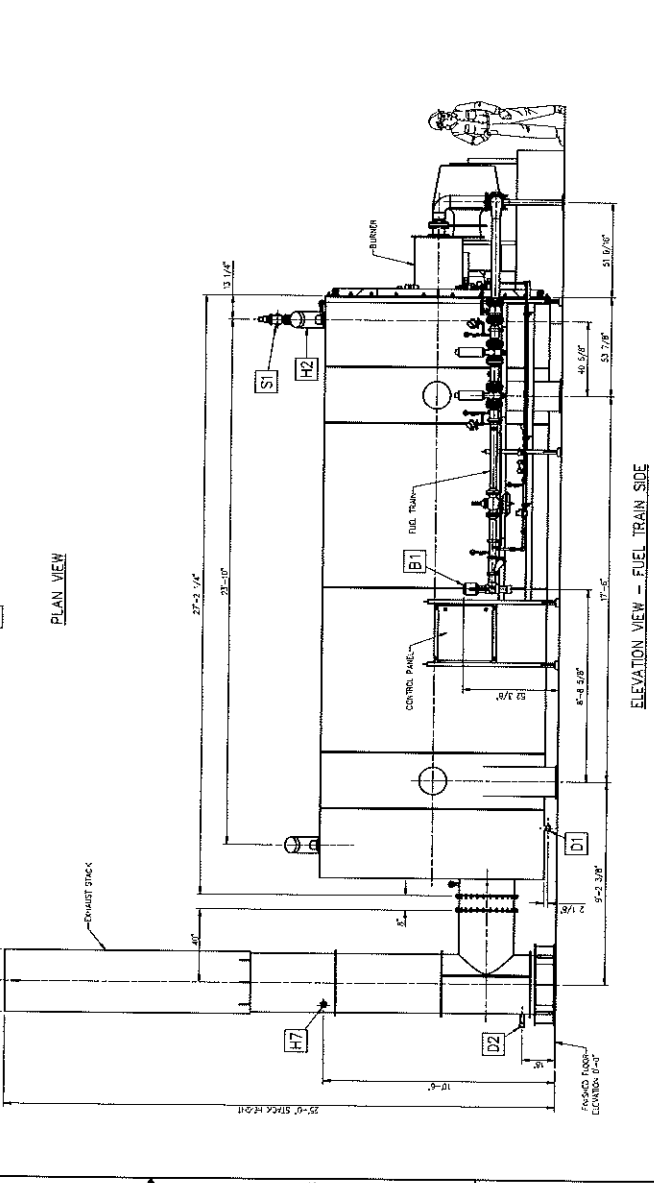
THINK SAFETY

NOZZLE	SIZE	TYPE	DESCRIPTION
H1	6"	3000# RF	PROCESS INLET
H2	6"	3000# RF	PROCESS OUTLET
H4	1"	3000# NPT	SHUFFLING PORT
H5	1"	3000# NPT	PRESSURE PORT
H7	2"	3000# NPT	STACK SAMPLE PORTS (2)
HB	1/4"	3000# NPT	PRESSURE PORT
B1	3"	NPT	FUEL TRAIN FUEL INLET
D1	2"	3000# NPT	HEATER DRAIN
D2	1 1/2"	3000# NPT	STACK DRAIN
S1	2"	150# RF	HEATER PSV

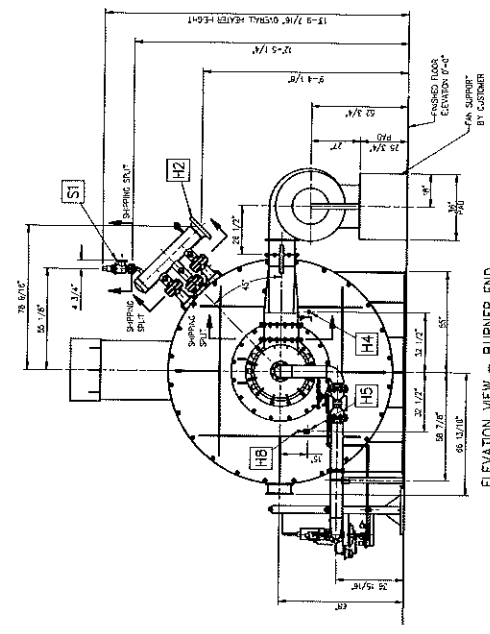
NOTES:
 1. SPONG ATTACHED TO THE HEATER SHOULD BE EXPOSED AND SUPPORTED IN A WAY TO AVOID
 2. THE COMPLETE HEATER SHOULD BE ASSEMBLED DUE TO SHOCK HEAT AND WITH RESPECTORS SENSITIVE INSULATION
 AND WELDING MAY BE REQUIRED.
 3. THE HEATER IS TO BE OPERATED AT 200 PSIG.
 4. CUSTOMER TO PROVIDE THE HEATER WITH THE FOLLOWING INFORMATION:
 5. THE HEATER IS TO BE OPERATED AT 200 PSIG.
 6. THE HEATER IS TO BE OPERATED AT 200 PSIG.
 7. THE HEATER IS TO BE OPERATED AT 200 PSIG.
 8. THE HEATER IS TO BE OPERATED AT 200 PSIG.
 9. THE HEATER IS TO BE OPERATED AT 200 PSIG.
 10. THE HEATER IS TO BE OPERATED AT 200 PSIG.



PLAN VIEW



ELEVATION VIEW - FUEL TRAIN SIDE



ELEVATION VIEW - BURNER END

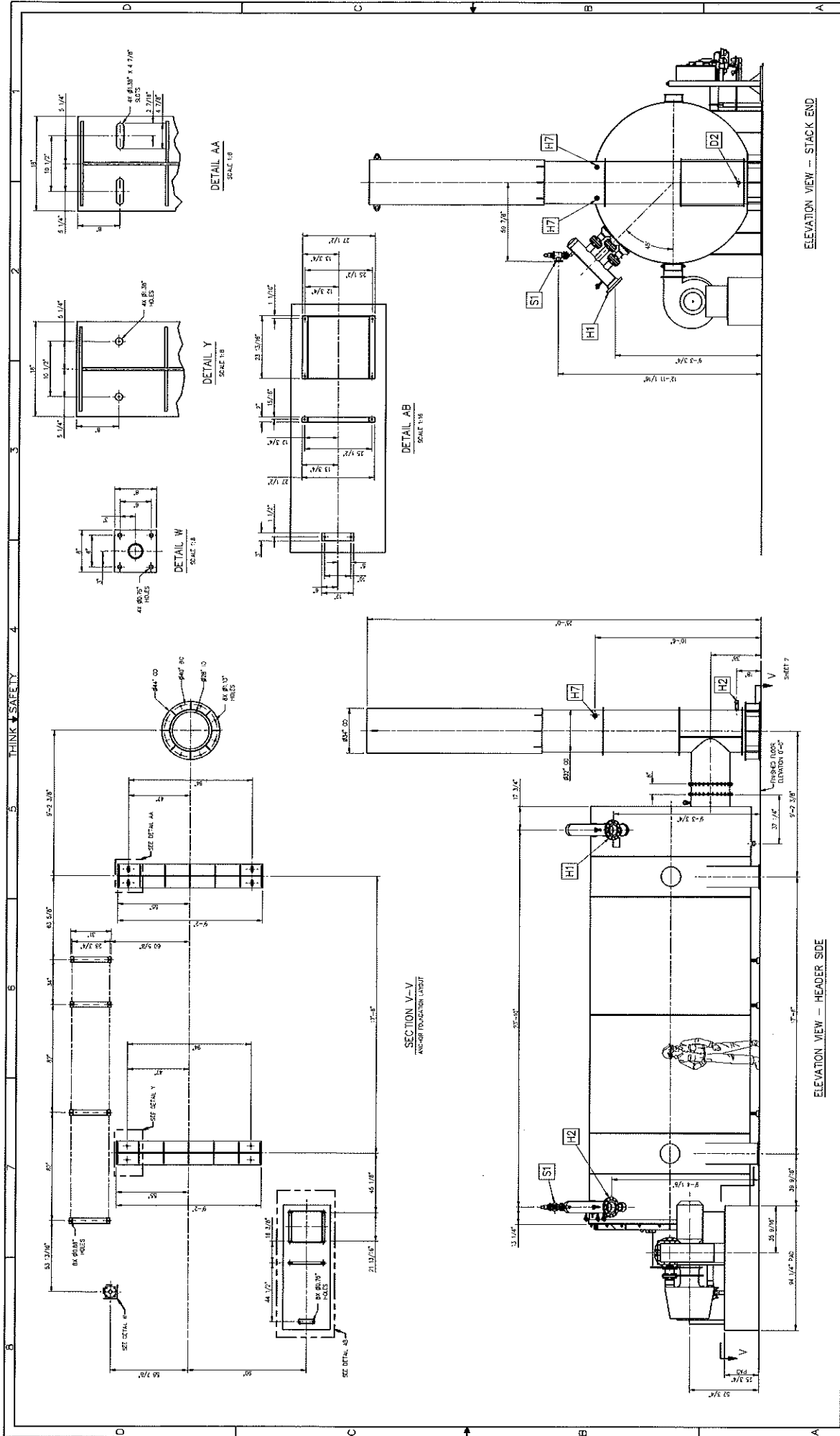
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SIGMA THERMAL CORPORATION
 10000 W. 15th Street
 Torrance, CA 90504-1500
 (310) 209-1500

HEATER GENERAL ARRANGEMENT
 THERMAL FLUID HEATER
 HC2-35.0-H-SF
 DATE: 04/25/2007
 DRAWN BY: 1018174
 CHECKED BY: 1018174
 PROJECT NO.: 27CA-020
 SHEET NO.: 2 OF 2

SIGMA THERMAL

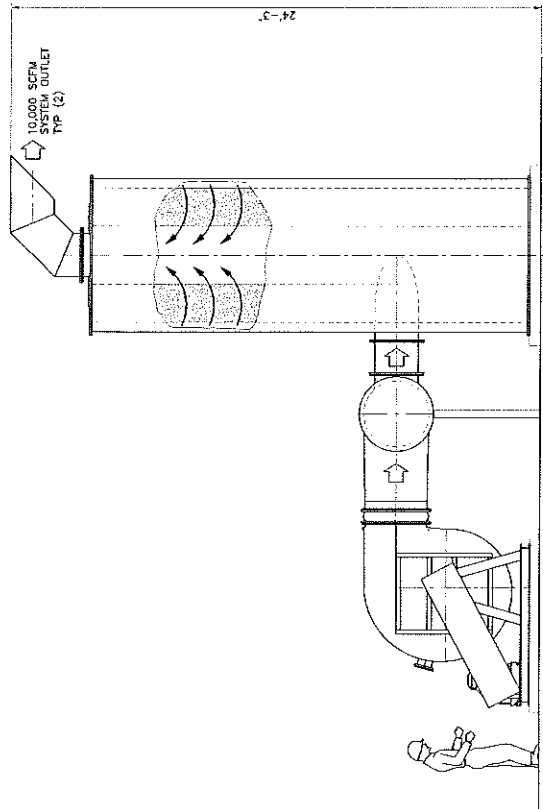
STAMP



THINK SAFETY

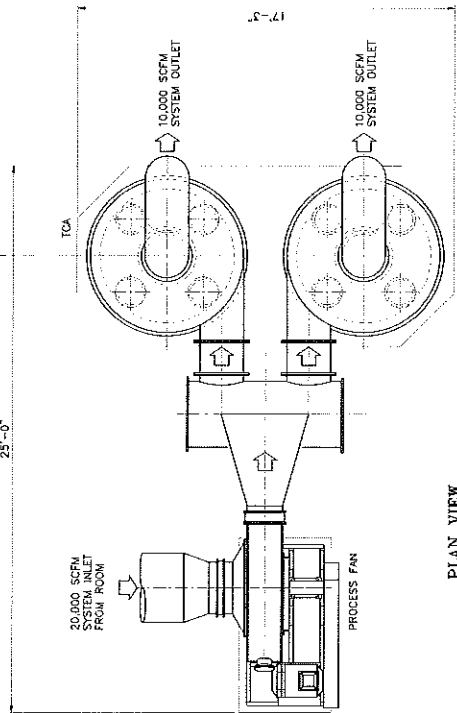
	STAMP	FORNAMES	DRAWING TITLE
	<p>SIGMA THERMAL</p>	<p>0.00 3 1/2 INCHES - 1 1/2 INCHES 0.000 1 1/2 INCHES - 4 1/2 INCHES 0.000 1 1/2 INCHES - 1 1/2 INCHES STAINLESS STEEL, WELDING - 1 1/2 INCHES WELDING - 1 1/2 INCHES WELDING - 1 1/2 INCHES</p>	<p>HEATER GENERAL ARRANGEMENT THERMAL FLUID HEATER HC2-35.0-H-5F</p>

SIGMA THERMAL CORPORATION
 1019714
 27CA-020



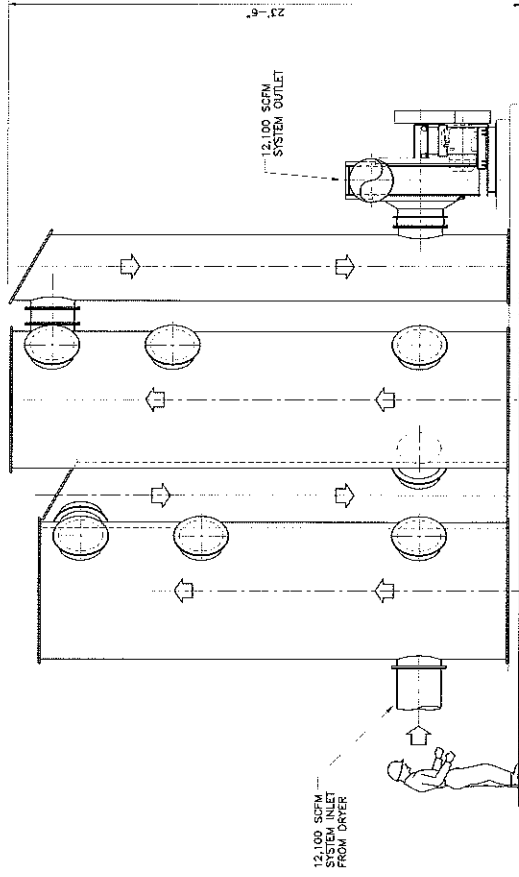
ELEVATION

25'-0"



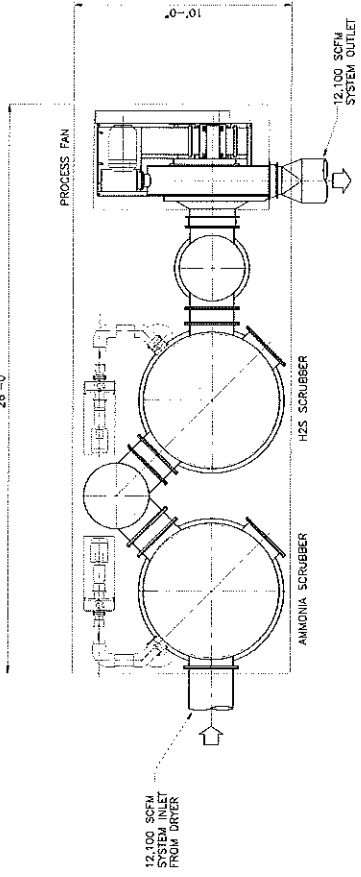
PLAN VIEW

DRYER ROOM ODOR ABATEMENT SYSTEM



ELEVATION

26'-0"



PLAN VIEW

DRYER VENT ODOR ABATEMENT SYSTEM

CMI ENVIRONMENTAL SERVICES INC.
 2420 Cabot Drive, Suite 200
 Portland, ME 04106
 P: 603.883.8800
 F: 603.883.8801
 www.cmienv.com

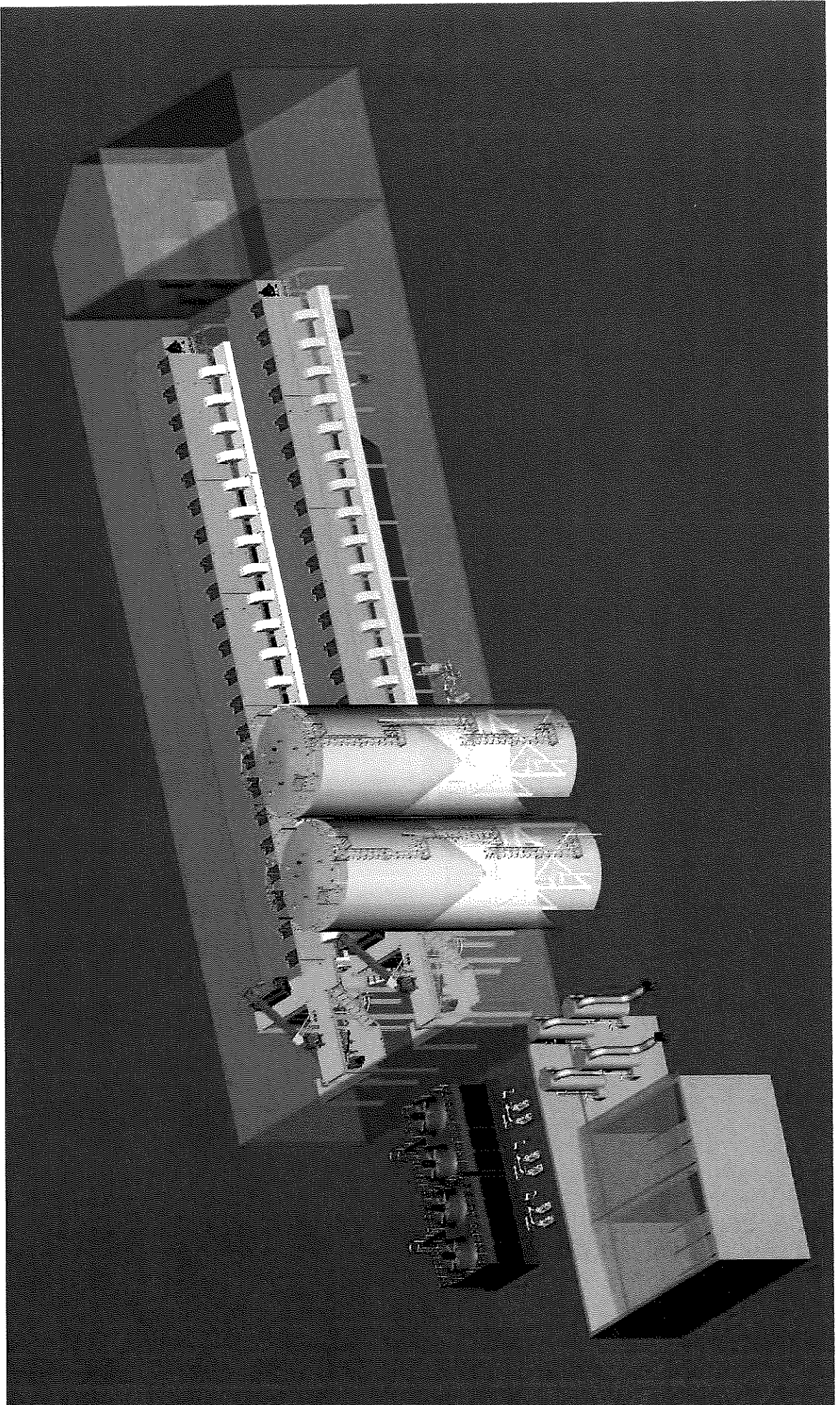
Odor Abatement System GENERAL ARRANGEMENTS

SYNARGO
 Brunswick, ME

DATE: 08/20/18
 DRAWN BY: JAC
 CHECKED BY: JAC
 PROJECT NO.: 18-0018
 SHEET NO.: 12/24/18

AM1179-GAL

NO.	DESCRIPTION	DATE	BY	CHKD
1	ISSUED FOR REVISION	08/20/18	JAC	JAC
2	ISSUED FOR REVISION	08/20/18	JAC	JAC
3	ISSUED FOR REVISION	08/20/18	JAC	JAC
4	ISSUED FOR REVISION	08/20/18	JAC	JAC
5	ISSUED FOR REVISION	08/20/18	JAC	JAC
6	ISSUED FOR REVISION	08/20/18	JAC	JAC
7	ISSUED FOR REVISION	08/20/18	JAC	JAC
8	ISSUED FOR REVISION	08/20/18	JAC	JAC
9	ISSUED FOR REVISION	08/20/18	JAC	JAC
10	ISSUED FOR REVISION	08/20/18	JAC	JAC



*Slate Belt Heat Recovery Center, LLC
Air Quality Plan Approval Application
March 2018*

ATTACHMENT D
PROOF OF MUNICIPAL/COUNTY NOTIFICATIONS

March 12, 2018

Northampton County Council
Northampton County Courthouse
669 Washington Street
Easton, PA 18042

**RE: Slate Belt Heat Recovery Center, LLC
Air Quality Plan Approval Application
Plainfield Township, Northampton County
EarthRes Project No. 151015.004**

Dear Council Members:

This letter is to advise you, pursuant to section 1905-A of The Administrative Code of 1929 (71 P.S. §510-5) regarding municipal notification requirements as cited in the Pennsylvania Air Pollution Control Regulations (25 Pa. Code §127.43a), that Slate Belt Heat Recovery Center, LLC (SBHRC) is submitting an air quality Application for Plan Approval to the Pennsylvania Department of Environmental Protection for the permitting and construction of the SBHRC, a biosolids processing facility, which will be sited on a parcel of land owned by Grand Central Sanitary Landfill (GCSL), and situated near Green Knights Economic Development Corporation (GKEDC) facility in Plainfield Township, Northampton County, Pennsylvania.

The proposed project involves the construction of a biosolids dryer facility. Dewatered municipal biosolids will be transported to the proposed facility where they will be thermally dried to produce Class A biosolids that will be marketed as a fertilizer, soil conditioner, and/or renewable fuel product. The thermal drying process will consist of two (2) fully enclosed indirectly heated belt dryers in parallel, each with a capacity of approximately 200 wet tons per day, for a total throughput of 400 wet tons (containing an average of approximately 21% solids) per day.

The existing turbine stacks located at the existing GKEDC plant will be modified to recover waste heat to a thermal oil loop for use in the belt dryers. During normal expected operations there may be a need for supplemental heat that will be provided by a stand-alone thermal oil heater. In the event that the GKEDC turbines are not at capacity or in maintenance, the supplemental thermal oil heater may utilize natural gas or excess / available landfill gas as a fuel.

A 30-day comment period regarding the application begins upon your receipt of this notice. Questions and/or comments regarding the application should be directed to the Pennsylvania Department of Environmental Protection, Northeast Regional Office, Bureau of Air Quality, 2 Public Square, Wilkes-Barre, Pennsylvania 18701-1915. The telephone number is (570) 826-2511.

Please contact me at (215) 766-1211 or John Goodwin of SBHRC at (443) 489-9069 if you have any questions regarding this letter.

Sincerely,
EarthRes Group, Inc.



Nicole C. Wilson, P.E.
Technical Manager – Air Quality Services

cc: Brian Cataldo, Slate Belt Heat Recovery Center, LLC
John Goodwin, Slate Belt Heat Recovery Center, LLC
Jim Hecht, Slate Belt Heat Recovery Center, LLC

VIA OVERNIGHT MAIL



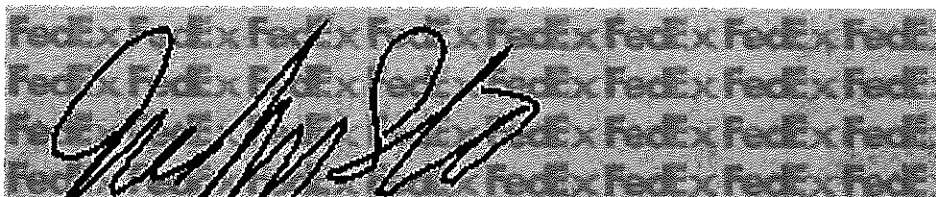
March 13, 2018

Dear Customer:

The following is the proof-of-delivery for tracking number **780003568462**.

Delivery Information:

Status:	Delivered	Delivered to:	Mailroom
Signed for by:	J.SCHAEFER	Delivery location:	669 WASHINGTON ST EASTON, PA 18042
Service type:	FedEx Priority Overnight	Delivery date:	Mar 13, 2018 08:44
Special Handling:	Deliver Weekday		



Shipping Information:

Tracking number:	780003568462	Ship date:	Mar 12, 2018
		Weight:	0.5 lbs/0.2 kg

Recipient:
NORTHAMPTON COUNTY COUNCIL
NORTHAMPTON COUNTY COURTHOUSE
669 WASHINGTON ST
EASTON, PA 18042 US

Shipper:
BARBARA JONES
EarthRes Group, Inc.
6912 Old Easton Road
PIPERSVILLE, PA 18947 US

Reference 151015.004
Department number Pipersville

Thank you for choosing FedEx.

March 12, 2018

Plainfield Township
Board of Supervisors
6292 Sullivan Trail
Nazareth, PA 18064

**RE: Slate Belt Heat Recovery Center, LLC
Air Quality Plan Approval Application
Plainfield Township, Northampton County
EarthRes Project No. 151015.004**

Dear Supervisors:

This letter is to advise you, pursuant to section 1905-A of The Administrative Code of 1929 (71 P.S. §510-5) regarding municipal notification requirements as cited in the Pennsylvania Air Pollution Control Regulations (25 Pa. Code §127.43a), that that Slate Belt Heat Recovery Center, LLC (SBHRC) is submitting an air quality Application for Plan Approval to the Pennsylvania Department of Environmental Protection for the permitting and construction of the SBHRC, a biosolids processing facility, which will be sited on a parcel of land owned by Grand Central Sanitary Landfill (GCSL), and situated near Green Knights Economic Development Corporation (GKEDC) facility in Plainfield Township, Northampton County, Pennsylvania.

The proposed project involves the construction of a biosolids dryer facility. Dewatered municipal biosolids will be transported to the proposed facility where they will be thermally dried to produce Class A biosolids that will be marketed as a fertilizer, soil conditioner, and/or renewable fuel product. The thermal drying process will consist of two (2) fully enclosed indirectly heated belt dryers in parallel, each with a capacity of approximately 200 wet tons per day, for a total throughput of 400 wet tons (containing an average of approximately 21% solids) per day.

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A 30-day comment period regarding the application begins upon your receipt of this notice. Questions and/or comments regarding the application should be directed to the Pennsylvania Department of Environmental Protection, Northeast Regional Office, Bureau of Air Quality, 2 Public Square, Wilkes-Barre, Pennsylvania 18701-1915. The telephone number is (570) 826-2511.

Please contact me at (215) 766-1211 or John Goodwin of SBHRC at (443) 489-9069 if you have any questions regarding this letter.

Sincerely,
EarthRes Group, Inc.



Nicole C. Wilson, P.E.
Technical Manager – Air Quality Services

cc: Brian Cataldo, Slate Belt Heat Recovery Center, LLC
John Goodwin, Slate Belt Heat Recovery Center, LLC
Jim Hecht, Slate Belt Heat Recovery Center, LLC

VIA OVERNIGHT MAIL



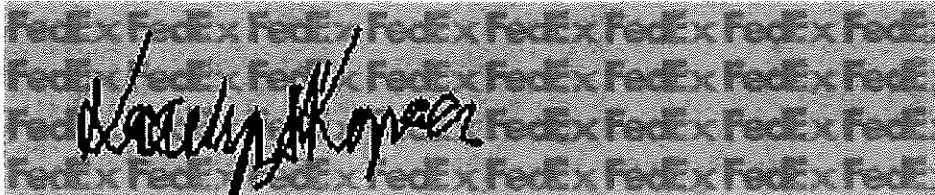
March 13, 2018

Dear Customer:

The following is the proof-of-delivery for tracking number **780003760261**.

Delivery Information:

Status:	Delivered	Delivered to:	Receptionist/Front Desk
Signed for by:	K.KOPACH	Delivery location:	6292 SULLIVAN TRL NAZARETH, PA 18064
Service type:	FedEx Priority Overnight	Delivery date:	Mar 13, 2018 08:52
Special Handling:	Deliver Weekday		



Shipping Information:

Tracking number:	780003760261	Ship date:	Mar 12, 2018
		Weight:	0.5 lbs/0.2 kg

Recipient:
MUNICIPAL SECRETARY
PLAINFIELD TOWNSHIP PLANNING COMM.
6292 SULLIVAN TRAIL
NAZARETH, PA 18064 US

Shipper:
BARBARA JONES
EarthRes Group, Inc.
6912 Old Easton Road
PIPERSVILLE, PA 18947 US

Reference
Department number

151015.004
Pipersville

Thank you for choosing FedEx.

Mr. Raymond Kempa
May 17, 2018
Page 2

AIR QUALITY

MAY 18 2018

FACILITY: _____
PERMIT #: _____
COUNTY: _____
FILE CODE: _____

Attachment A

March 20, 2018 Plainfield Township Zoning Letter excerpts



Plainfield Township Zoning & Code Office
6292 Sullivan Trail
Nazareth, Pa. 18064

AIR QUALITY

MAY 18 2018

FACILITY:
PERMIT #:
COUNTY:
FILE CODE:

Matthew Goodrich, Esquire
Applicant's Authorized Representative
Karasek Law Offices, LLC
641 Market Street
Bangor, PA 18013

VIA EMAIL AND UPS GROUND DELIVERY
(UPS Tracking # 1Z377E240319489395)

March 20, 2018

**RE: Slate Belt Heat Recovery Center – Grand Central Sanitary Landfill, Inc.
Zoning Officer Responses to Preliminary Land Development Application**

Dear Attorney Goodrich:

The following materials were received and reviewed for the above-referenced matter:

- Preliminary Land Development Application and Checklist, received February 23, 2018
- Project Narrative, dated February 23, 2018
- Preliminary Land Development Plan set, dated February 6, 2018
- Trucking Turning Exhibits, dated February 6, 2018
- Stormwater Management Report and calculations
- February 20, 2018 Owner Acknowledgement from GCSL
- Steep Slope Narrative dated May 2017, last revised September, 2017
- 1997 Recorded Easement Agreement
- 2007 DEP approval of the land use for "Developed Water Resource" for the reclaimed Doney II Quarry
- Haarslev Equipment Brochure

I. Additional Requirements for Material Separation Facility (Slate Belt Heat Recovery Center), §27-316 (2) (II)

The Project Narrative dated February 23, 2018 confirms the proposed use as a “Material Separation Facility,” which is a land use specifically defined within §27-202 of the Code of Ordinances of Plainfield Township. The Land Development Plans show a combination of two principal uses permitted by right and their accessory uses. The Zoning Officer is in agreement that the *combination* (emphasis added) of the two principal uses and their accessory uses are permitted by right in the Solid Waste Processing and Disposal District (SW) on the same lot, as per §27-319 (2). The two uses are as follows:

- Material Separation Facility (Proposed), §27-319 (2) (C);
- Refuse Derived Fuel Facility (Existing), §27-319 (2) (F).

It is the determination of the Zoning Officer that the proposed use of the Slate Belt Heat Recovery Center is a Material Separation Facility, which is a Permitted-by-Right Use within the Solid Waste Processing and Disposal District (SW) only. The Material Separation Facility has additional requirements for the Permitted-by-Right Use as set forth in §27-316 (2) (II) as follows:

- 1) The site shall contain at least three (3) acres for any facility with a capacity to treat or dispose of up to 300 tons of solid waste per day. The size of the site shall be increased by two additional acres of land for each additional capacity of 100 tons per day, or fraction thereof.*
- 2) Entrances and exits to the facility shall be separated and clearly designated; entrances and exits shall each be at least 30 feet in width and shall be located along either an arterial or collector road.*
- 3) All access roads shall be paved.*
- 4) Measures and procedures to prevent and minimize fire hazard shall be established and practiced at the site or facility. A report describing these procedures shall be provided to the Township.*
- 5) Each facility shall be operated and maintained in such a manner as to minimize health hazards, odors, dust, noise, environmental degradation, unsightliness, the attraction, harborage or breeding of insects, rodents or vectors and to eliminate conditions which create safety hazards or impose an undue burden upon the Township or its municipal services infrastructure.*
- 6) The operation of the facility shall comply with all applicable State and Federal regulations.*

Mr. Raymond Kempa
May 17, 2018
Page 2

.. AIR QUALITY

1
MAY 18 2018

FACILITY: _____
PERMIT #: _____
COUNTY: _____
FILE CODE: _____

Attachment B

April 9, 2018 Plainfield Township Land Use Letter

Plainfield Township Planning and Zoning

6292 Sullivan Trail
Nazareth, Penna. 18064

Phone 610-759-6944

Fax 610-759-1999

SENT VIA UPS GROUND DELIVERY
(UPS Tracking # 1Z377E240325791886)

Date: April 9, 2018

To: Clean Water Program
Permits Chief
Pennsylvania Department of Environmental Protection (PA DEP)
Northeast Regional Office
2 Public Square
Wilkes-Barre, PA 18701-1915

From: Plainfield Township (Northampton County, PA)

RE: Slate Belt Heat Recovery Center Land Use Letter
Plainfield Township, Northampton County

Pennsylvania Department of Environmental Protection (PA DEP) Permit Applications filed in reference to the Slate Belt Heat Recovery Center proposed Land Development/Major Subdivision application and received by Plainfield Township are as follows:

- 1. Individual NPDES Permit Application – Stormwater Runoff from Industrial Activities**
- 2. Municipal Waste General Permit Application**
- 3. Air Quality Application for Plan Approval**
- 4. Minor Permit Modification- Grand Central Sanitary Landfill, Inc. (Facility No. 100265)**

Project Location: 2100 Block of Pen Argyl Road
Plainfield Township, Northampton County, PA

Project Descriptions:

1). Individual NPDES Permit Application: Slate Belt Heat Recovery Center, LLC intends to submit an application to PA DEP for discharge of stormwater associated with industrial activity at a proposed biosolids processing facility located in Plainfield Township, Northampton County, PA.

2). Municipal Waste General Permit Application: Slate Belt Heat Recovery Center, LLC proposes to permit and construct a biosolids facility which contained within a parcel of land (Parcel ID No. E8 11 8 0626) owned by Grand Central Sanitary Landfill (GCSL) and situated

near Green Knight Economic Development Corporation (GKEDC) facilities in Plainfield Township, Northampton County, PA. The process involves drying dewatered biosolids materials to produce a Class A biosolids that can be used as a fertilizer blending agent, soil conditioner, and/or a renewable energy producing product.

3). ***Air Quality Application for Plan Approval:*** The proposed project involves the installation of heat recovery equipment, a supplemental thermal oil heater and thermal drying equipment to facilitate processing of imported dewatered biosolids into a Class A dried biosolids product. The Class A biosolids will be marketed as a fertilizer, soil conditioner, and/or renewable fuel product. The heat recovery equipment will be located and attached to the existing GKEDC facility, which is also located on GCSL land. The existing GKEDC turbine exhaust stacks will be modified to recover waste heat to a thermal oil loop for use in the belt dryers.

4). ***Minor Permit Modification- Grand Central Sanitary Landfill, Inc. (Facility No. 100265):*** The Slate Belt Heat Recovery Center facility will use waste heat from the existing GKEDC landfill gas-to-energy plant to dry dewatered biosolids and produce a Class A biosolid product. The facility will be developed on a parcel on the Grand Central Sanitary Landfill, Inc. site within the landfill permit boundary and adjacent to the existing GKEDC landfill gas-to-energy plant.

The municipality of ***Plainfield Township, Northampton County*** states that it:

has adopted a municipal or multi-municipal comprehensive plan.
 has not adopted a municipal or multi-municipal comprehensive plan.

The municipality of ***Plainfield Township, Northampton County*** states that it:

has adopted a county zoning ordinance, or a municipal or joint-municipal zoning ordinance.
 has not adopted a county zoning ordinance, or a municipal or joint-municipal zoning ordinance

If applicable:

The municipality of ***Plainfield Township, Northampton County*** states that its zoning ordinance is generally consistent with its municipal comprehensive plan and the county comprehensive plan.

The above referenced project:

meets the provisions of the local zoning ordinance.
 does not meet the provisions of the local zoning ordinance.

If zoning approval is required for the project to proceed, the above referenced project:

has received zoning approval.
 has not received zoning approval.

If the proposed project has not received zoning approval:

What is the status of the zoning request for the proposed project? (e.g., Special Exception Approval from the Zoning Hearing Board required, Conditional Use approval from the Governing Body required)

Plainfield Township has not issued any zoning or building permits at this time, and the applicant's request to use the property under the provisions of Chapter 22 of the Subdivision and Land Development of the Code of Ordinances of Plainfield Township is still under review.

Enclosed please reference the most recent review letter from the Zoning Officer and Township Manager dated March 20, 2018, which is incorporated herein within this Land Use Letter as though more fully set forth at length as Exhibit "A".

Is there a legal challenge by the applicant with regard to zoning for the proposed project?

There is currently not a legal challenge filed by the applicant with regard to zoning. However, there are currently four (4) variances required for the project as determined by the Zoning Officer and identified as follows:

- **Variance Required (#1):** A Variance is required from Section §27-316 (2) (II) (2) of the Code of Ordinances of Plainfield Township due to the fact that the proposed entrance and exit to the facility are not located along either an arterial or collector road.
- **Variance Required (#2):** A Variance is required from Section §27-505 of the Code of Ordinances of Plainfield Township to allow for an area of open space between the proposed structures/improvements and the pond that is less than 50 feet.
- **Variance Required (#3):** A Variance is required from Section §27-703 (3) (B) of the Code of Ordinances of Plainfield Township to allow for an aisle width of less than 25 feet.
- **Variance Required (#4):** A Variance is required from §27-703 (5) of the Plainfield Township Code of Ordinances in order to keep the proposed gravel parking lot surface as gravel in lieu of asphalt material.

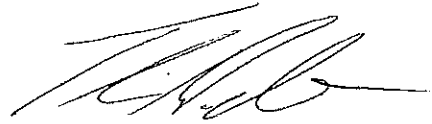
Name and Contact Information for Municipal Zoning Officer:

John Lezoche, Zoning Officer
Plainfield Township
6292 Sullivan Trail
Nazareth, PA 18064
Phone- (610) 759-6944 ext 103
Email Address- zoning@plainfieldtownship.org

Plainfield Township reserves the right to comment further on the above-referenced Pennsylvania Department of Environmental Protection (PA DEP) Permit Applications filed in reference to the proposed Slate Belt Heat Recovery Center Land Development use. Plainfield Township is only filing a Land Use Letter at this time under the purview of Act 14, and will reserve the right to file public comments in reference to these applications once said applications are published in the Pennsylvania Bulletin as set forth within PA DEP's Standard Operating Procedures. Plainfield Township is respectfully requesting to be notified in writing once the public notices are published.

If you have any questions or need anything further in this matter, please do not hesitate to contact me by email at manager@plainfieldtownship.org or by phone at (610) 759-6944 ext 102.

Sincerely,



Thomas R. Petrucci
Township Manager

TRP:trp

cc: John Lezoche, Plainfield Township Zoning Officer
Paige Gerstenberg, Administrative Assistant

Mr. Raymond Kempa
May 17, 2018
Page 2

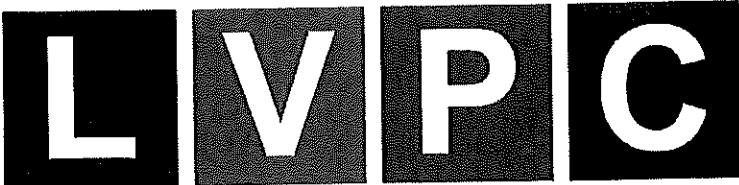
AIR QUALITY

MAY 18 2018

FACILITY: _____
PERMIT #: _____
COUNTY: _____
FILE CODE: _____

Attachment C

April 13, 2018 Lehigh Valley Planning Commission Letter



Lehigh Valley Planning Commission

STEPHEN REPASCH
Chair

JOHN DIACOGIANNIS
Vice Chair

STEVEN GLICKMAN
Treasurer

BECKY A. BRADLEY, AICP
Executive Director

April 13, 2018

Mr. Paul Levits, Chairman
Plainfield Township Planning Commission
Municipal Building, 6292 Sullivan Trail
Nazareth, Pennsylvania 18064

**RE: Slate Belt Heat Recovery Facility (Grand Central Landfill) – Land Development
Plainfield Township
Northampton County**

Dear Mr. Levits:

The subject application proposes a 20,446 square foot biosolids processing facility within land owned by Grand Central Sanitary Landfill and situated adjacent to a Green Knight Economic Development Corporation landfill gas to energy plant. The site is located off of Rt. 512 Access Road and along Pen Argyl Road. The proposed facility would produce a Class-A biosolid that can be used as a fertilizer and/or renewable fuel. The site is in an area designated for Rural Development in the *Comprehensive Plan the Lehigh Valley...2030*. Recommended land uses in this category include "Mining or public uses needing buffers (like quarries, sanitary landfills and power plants)" (pg. 44). Additionally, the proposed facility supplements the landfill and gas-to-energy uses already existing on the site. Therefore, the subject application is consistent with the County Comprehensive Plan.

The project site is located within the Bushkill Creek watershed. This watershed has a fully implemented Act 167 Stormwater Management Ordinance. Comments relative to our review of the project's stormwater management plan are included as Attachment 1.

The developer should consider documenting bridge locations and their relevant data within a 2-mile vicinity of the study area intersections and roadways. Consider obtaining information regarding when the bridge was built, when the most recent inspection was performed, sufficiency rating, and weight limits. A map of bridge locations is included as Attachment 2. This data may be found using PennDOT's One Map online application (see Attachment 2 for link). In order to maximize truck infrastructure safety and minimize accidents or spillage, the applicant must ensure that the truck routes taken going to and from the site are suitable for truck maneuvering and do not contain sharp turns, winding roads or deficient bridge infrastructure.

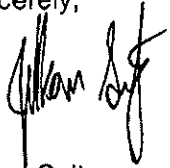
In order to better meet the needs of all involved, the LVPC is now requiring an appointment for plan signings. Please call the office and ask for a Community Planning staff person. Generally, your appointment will be within two business days.

Our review does not include an in-depth examination of the plan relative to subdivision design

standards or ordinance requirements since these items are covered in the municipal review.

Feel free to call me if you have any questions about this review.

Sincerely,

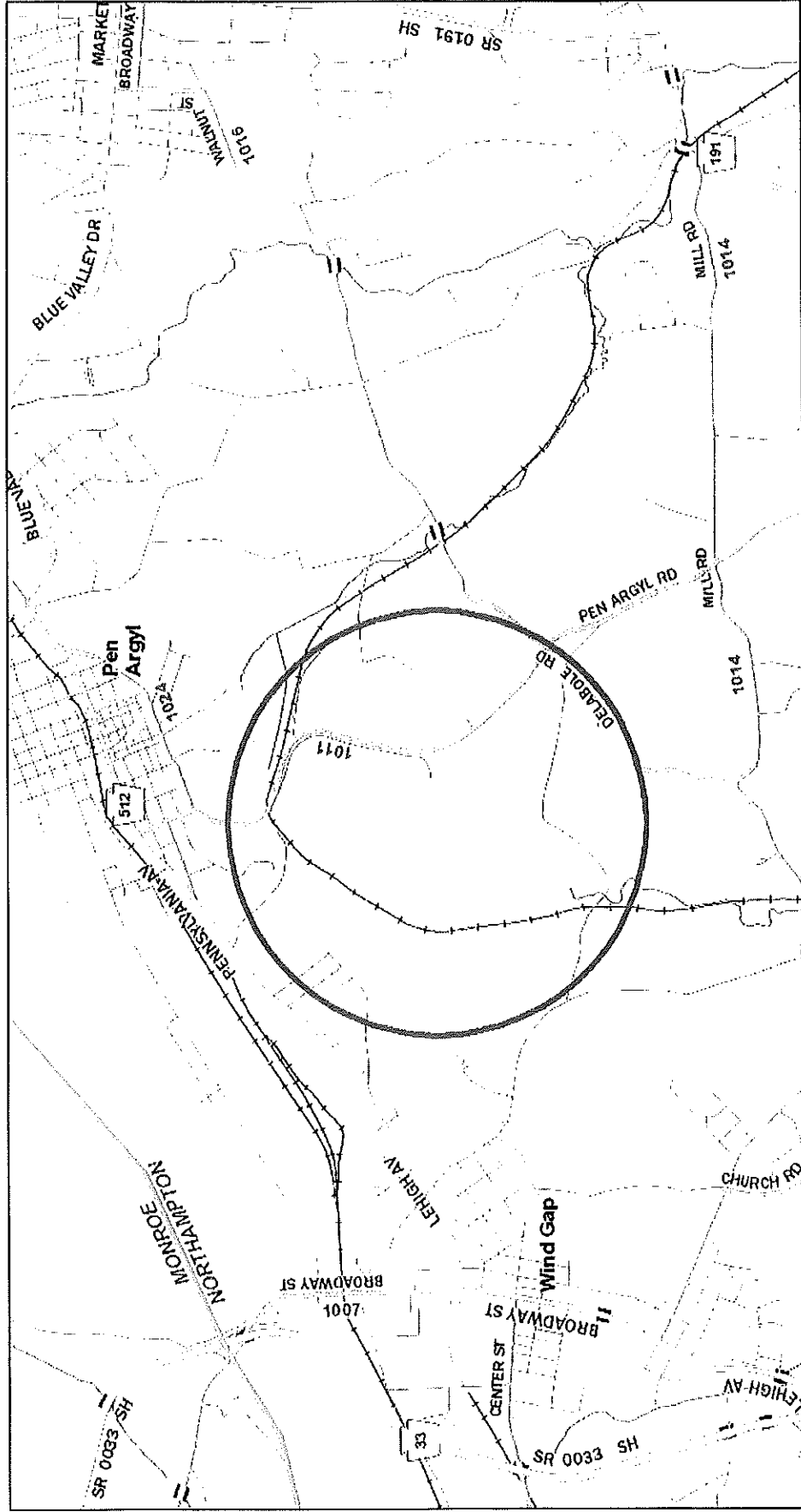
A handwritten signature in black ink, appearing to read "Jillian Seitz". The signature is stylized with a large initial "J" and a long, sweeping underline.

Jillian Seitz
Community Planner

cc: Thomas R. Petrucci, Township Manager
John Lezoche, Zoning Officer
Michael Kukles, PE, Township Engineer
David F. Allen, PE, EarthRes
Northampton County Conservation District
Geoffrey Reese, LVPC
Chandra Parasa, LVPC

Attachment 2

BRIDGE LOCATIONS IN THE VICINITY OF THE SITE



Data Link: <https://www.dot7.state.pa.us/OneMap>

*Slate Belt Heat Recovery Center, LLC
Air Quality Plan Approval Application
March 2018*

***ATTACHMENT E
COMPLIANCE REVIEW FORM***



COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR QUALITY

AIR QUALITY

MAY 22 2018

AIR POLLUTION CONTROL ACT COMPLIANCE REVIEW FORM

Fully and accurately provide the following information, as specified. Attach additional sheets as necessary.

Type of Compliance Review Form Submittal (check all that apply)

- Original Filing
- Amended Filing

Date of Last Compliance Review Form Filing: **MAY 18 2018**

Type of Submittal

- New Plan Approval
- Extension of Plan Approval
- Other:
- New Operating Permit
- Change of Ownership
- Renewal of Operating Permit
- Periodic Submission (@ 6 mos)

FACILITY: _____
PERMIT #: _____
COUNTY: _____

SECTION A. GENERAL APPLICATION INFORMATION

Name of Applicant/Permittee/("applicant")
(non-corporations-attach documentation of legal name)

Slate Belt Heat Recovery Center, LLC

Address 435 Williams Court, Suite 100
Baltimore, MD 21220-2888

Telephone (443) 489-9069 **Taxpayer ID#** 45-4824177

Permit, Plan Approval or Application ID# N/A

Identify the form of management under which the applicant conducts its business (check appropriate box)

- Individual
- Municipality
- Proprietorship
- Public Corporation
- Private Corporation
- Syndicate
- Municipal Authority
- Fictitious Name
- Partnership
- Limited Partnership
- Government Agency
- Joint Venture
- Association
- Other Type of Business, specify below:

Describe below the type(s) of business activities performed.

The proposed project involves the installation of heat recovery equipment, a supplemental thermal oil heater and thermal drying equipment to facilitate processing of imported dewatered biosolids into a Class A dried biosolids product. The Class A biosolids will be marketed as a fertilizer, soil conditioner, and/or renewable fuel product.

SECTION B. GENERAL INFORMATION REGARDING "APPLICANT"

If applicant is a corporation or a division or other unit of a corporation, provide the names, principal places of business, state of incorporation, and taxpayer ID numbers of all domestic and foreign parent corporations (including the ultimate parent corporation), and all domestic and foreign subsidiary corporations of the ultimate parent corporation with operations in Pennsylvania. Please include all corporate divisions or units, (whether incorporated or unincorporated) and privately held corporations. (A diagram of corporate relationships may be provided to illustrate corporate relationships.) Attach additional sheets as necessary.

Unit Name	Principal Places of Business	State of Incorporation	Taxpayer ID	Relationship to Applicant
Synagro-VVWT, Inc.	435 Williams Court. Suite 100 Baltimore, MD 21220	MD	52-1130492	Parent
ST Interco, Inc.	435 Williams Court. Suite 100 Baltimore, MD 21220	DE	90-0114897	Parent
Synatech Holdings, Inc.	435 Williams Court. Suite 100 Baltimore, MD 21220	DE	20-8315544	Parent
Synagro Infrastructure Company, Inc.	435 Williams Court. Suite 100 Baltimore, MD 21220	DE	80-0910866	Parent
Whitemarsh Infrastructure Acquisition, Inc.	435 Williams Court. Suite 100 Baltimore, MD 21220	DE	30-0778279	Parent
STI Infrastructure S.a.r.l.	Foreign Corporation	Luxembourg	N/A	Parent

SECTION C. SPECIFIC INFORMATION REGARDING APPLICANT AND ITS "RELATED PARTIES"

Pennsylvania Facilities. List the name and location (mailing address, municipality, county), telephone number, and relationship to applicant (parent, subsidiary or general partner) of applicant and all Related Parties' places of business, and facilities in Pennsylvania. Attach additional sheets as necessary.

Unit Name	Street Address	County and Municipality	Telephone No.	Relationship to Applicant
Slate Belt Heat Recovery Center, LLC	2100 block of Pen Argyl Road, Pen Argyl, PA 18072	Northampton County Plainfield Township	(443) 489-9069	Self
Philadelphia Project Holding, Inc.	7800 Penrose Ferry Road Philadelphia, PA 19153	Philadelphia County and City of Philadelphia	443-489-9000	Related Party
Philadelphia Project Finance, LLC	7800 Penrose Ferry Road Philadelphia, PA 19153	Baltimore County, MD	443-489-9000	Related Party
Philadelphia Renewable Biofuels, LLC	7800 Penrose Ferry Road Philadelphia, PA 19153	Philadelphia County and City of Philadelphia	443-489-9000	Related Party
Philadelphia Biosolids Services, LLC	7800 Penrose Ferry Road Philadelphia, PA 19153	Philadelphia County and City of Philadelphia	443-489-9000	Related Party
Synagro Central, LLC	435 Williams Court, Suite 100 Baltimore, MD 21220	Baltimore County, MD	443-489-9000	Related Party
Synagro Hypex, LLC	451 N. Cannon Avenue Lansdale, PA 19446	Montgomery County and Lansdale	215-393-7560	Related Party

Provide the names and business addresses of all general partners of the applicant and parent and subsidiary corporations, if any.

Name	Business Address
Synagro-WWT, Inc.	435 Williams Court, Suite 100 Baltimore, MD 21220
ST Interco, Inc.	435 Williams Court, Suite 100 Baltimore, MD 21220
Synatech Holdings, Inc.	435 Williams Court, Suite 100 Baltimore, MD 21220
Synagro Infrastructure Company, Inc.	435 Williams Court, Suite 100 Baltimore, MD 21220
Whitemarsh Infrastructure Acquisition, Inc.	435 Williams Court, Suite 100 Baltimore, MD 21220
STI Infrastructure S.a.r.l.	435 Williams Court, Suite 100 Baltimore, MD 21220

List the names and business address of persons with overall management responsibility for the process being permitted (i.e. plant manager).

Name	Business Address
John Goodwin – Vice President, Engineering	435 Williams Court, Suite 100 Baltimore, MD 21220
Herbert Hingley – Vice President, Operations Dryers	435 Williams Court, Suite 100 Baltimore, MD 21220

Plan Approvals or Operating Permits. List all plan approvals or operating permits issued by the Department or an approved local air pollution control agency under the APCA to the applicant or related parties that are currently in effect or have been in effect at any time 5 years prior to the date on which this form is notarized. This list shall include the plan approval and operating permit numbers, locations, issuance and expiration dates. Attach additional sheets as necessary.

Air Contamination Source	Plan Approval/ Operating Permit#	Location	Issuance Date	Expiration Date
None				

Compliance Background. (Note: Copies of specific documents, if applicable, must be made available to the Department upon its request.) List all documented conduct of violations or enforcement actions identified by the Department pursuant to the APCA, regulations, terms and conditions of an operating permit or plan approval or order by applicant or any related party, using the following format grouped by source and location in reverse chronological order. Attach additional sheets as necessary. See the definition of "documented conduct" for further clarification. Unless specifically directed by the Department, deviations which have been previously reported to the Department in writing, relating to monitoring and reporting, need not be reported.

Date	Location	Plan Approval/ Operating Permit#	Nature of Documented Conduct	Type of Department Action	Status: Litigation Existing/Continuing or Corrected/Date	Dollar Amount Penalty
N/A – Facility is proposed.						
						\$
						\$
						\$
						\$
						\$
						\$
						\$
						\$
						\$

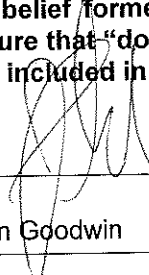
List all incidents of deviations of the APCA, regulations, terms and conditions of an operating permit or plan approval or order by applicant or any related party, using the following format grouped by source and location in reverse chronological order. This list must include items both currently known and unknown to the Department. Attach additional sheets as necessary. See the definition of "deviations" for further clarification.

Date	Location	Plan Approval/ Operating Permit#	Nature of Deviation	Incident Status: Litigation Existing/Continuing Or Corrected/Date
See above.				

CONTINUING OBLIGATION. Applicant is under a continuing obligation to update this form using the Compliance Review Supplemental Form if any additional deviations occur between the date of submission and Department action on the application.

VERIFICATION STATEMENT

Subject to the penalties of Title 18 Pa.C.S. Section 4904 and 35 P.S. Section 4009(b)(2), I verify under penalty of law that I am authorized to make this verification on behalf of the Applicant/Permittee. I further verify that the information contained in this Compliance Review Form is true and complete to the best of my belief formed after reasonable inquiry. I further verify that reasonable procedures are in place to ensure that "documented conduct" and "deviations" as defined in 25 Pa Code Section 121.1 are identified and included in the information set forth in this Compliance Review Form.



Signature

3/13/2018

Date

John Goodwin

Name (Print or Type)

Vice President - Engineering

Title

*Slate Belt Heat Recovery Center, LLC
Air Quality Plan Approval Application
March 2018*

ATTACHMENT F
BEST AVAILABLE TECHNOLOGY (BAT) ANALYSIS

Attachment F **Best Available Technology (BAT) Analysis**

Process Overview

This application is being submitted to the Pennsylvania Department of Environmental Protection (PADEP) Northeast Regional Office (NERO) Air Quality Program for the installation of the Slate Belt Heat Recovery Center, LLC (SBHRC). The SBHRC proposes to permit and construct a biosolids processing facility which will be sited on a parcel of land owned by Grand Central Sanitary Landfill (GCSL) in Plainfield Township, Northampton County, Pennsylvania (see Figure 1 – Site Location Map).

The proposed project involves the installation of heat recovery equipment, a supplemental thermal oil heater and thermal drying equipment to facilitate processing of imported dewatered biosolids into a Class A dried biosolids product. The Class A biosolids will be marketed as a fertilizer, soil conditioner, and/or renewable fuel product. The thermal dryer process will consist of two (2) fully enclosed indirectly heated belt dryers in parallel, each with a biosolids input capacity of approximately 200 wet tons per day, for a facility total throughput of 400 wet tons (containing an average of approximately 21% solids) per day.

The project location was chosen based on a desire to harness the currently unused heat source provided by the existing GKEDC landfill gas to energy (LFGTE) plant. The LFGTE plant was designed specifically to allow for the future use of waste heat. The existing turbine stacks located at the LFGTE plant will be modified to recover waste heat to a thermal oil loop for use in the belt dryers without adding or subtracting from the GKEDC potential to emit. A Request for Determination (RFD) is being submitted by GKEDC separately to address the modifications to the existing turbine stacks at the GKEDC facility. During normal expected operations there may be a need for supplemental heat that will be provided by a stand-alone thermal oil heater supplying approximately 6.1 MMBTU/hr. The supplemental thermal oil heater may utilize natural gas or excess / available landfill gas as a fuel use. The total maximum heat demand of the supplemental thermal oil heater, assuming GKEDC turbine outage, is currently estimated to be 36.7 MMBTU/hr to support the dryer system capacity rating without the GKEDC waste heat. Burner design firing rate may increase to 50.3 MMBTU/hr to allow for variability in fuel types and heating values. The only combustion emission point for the project will be from the supplemental thermal oil heater.

Drying facility details are presented in the attached Figure 2 - Process Flow Diagram. Each belt dryer will have an inlet chamber and associated drying chambers arranged in series. The dryer belts and all associated processing equipment will be enclosed and the dryers will be held under slightly negative pressure to contain and capture all evaporated moisture, heat and odor. All process air will be directed to a non-contact condenser for moisture reduction. The normally enclosed receiving units, covered aboveground process wastewater storage tank, covered product conveyance system, and covered

product storage will be ventilated with air flow maintained by the odor control system fan. A dust collector will remove dust from the enclosed product storage and conveyance steps. The dryer process air, along with the dust collector and other odor sources, are directed to the two-stage odor control system prior to release to the atmosphere. The only exhaust point from the thermal drying process and associated equipment will be at the facility odor control system stack (control device).

This BAT determination is being provided as part of the Plan Approval Application for the biosolids processing facility to be submitted to the Pennsylvania Department of Environmental Protection (PADEP) Northeast Regional Office (NERO) Air Quality Program. The purpose of the determination is to evaluate the technical and economic feasibility of commonly used control technologies to determine which, if any, can be applied to the current project.

Scope of BAT Analysis

The BAT analysis is a “top down” approach consisting of the following steps as discussed with PADEP during the pre-application meeting held on November 28, 2017:

- Step 1: Identify all Potential Equipment Options
- Step 2: Identify all Potential Control Options
- Step 3: Evaluate Technical & Economic Feasibility of the Control Options
- Step 4: Rank Remaining Control Technologies according to Control Effectiveness
- Step 5: Consider BAT by Technical and Economic Feasibility

In order to be considered BAT, a control option must be both technically and economically feasible.

Step 1: Identify all Potential Equipment Options

The proposed equipment includes the following:

- Heat Exchanger(s)
- Thermal Oil Heater (“Supplemental Heater”)
- Conveyors
- Belt Dryers
- Facility Odor Control System (Control Device)
 - Non-Contact Condenser Unit(s)
 - Dust Collector
 - Ammonia Scrubber Unit

- Hydrogen Sulfide Scrubber Unit
- PLC Control System

Please refer to the attached process flow diagram (PFD) for a complete process schematic. This equipment has been proven to be effective at biosolids processing/drying in several case studies for operating installations.

Step 2: Identify all Potential Control Options

Potential pollutants from the proposed biosolids processing facility include:

- Pollutants resulting from LFG or natural gas combustion (nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOC), sulfur oxides (SOx), particulate matter (PM (PM₁₀ and PM_{2.5})), formaldehyde (HCOH), hazardous air pollutants (HAPs), and carbon dioxide equivalents (CO_{2e}));
- Potential dust, odor and other dryer process emissions (PM, CO, VOC, ammonia (NH₃), and hydrogen sulfide (H₂S)) resulting from the conveyance/drying and storage of material in the product silo(s); and
- Fugitive dust emissions (PM) resulting from hauling activity on paved and unpaved roadways.

Please note that the pollutants of concern for the SBHRC facility include PM, NOx, SOx, CO, and odors (as NH₃ and H₂S). Odors are regulated as a nuisance. Potential emissions of VOC, HCOH, and HAPs are minimal from the proposed dryer process and therefore are not addressed further in this BAT Analysis.

The table below summarizes commonly used emission control methods and the pollutants which they control. For convenience, the information is divided into two (2) source groups: combustion emissions from the supplemental heater, and odor and dust emissions from the dryer process. Each control option is evaluated for technical and economic feasibility in the following section. A search of EPA's RACT/BACT/LAER Clearinghouse (RBLC) Database was conducted for biosolids processing facilities, specifically, belt dryers, over the past 10 years yielded no results. Results of the RBLC Database for supplemental thermal oil heaters and natural gas-fired heaters over the past 10 years were reviewed and are tabulated and included with this report. See the attached table. Knowledge of similar projects and facilities was also utilized.

**Table F-1
Combustion Emissions Control Device Options**

Pollutant	Control Device Option			
	Low NOx Burner (LNB)	LNB with FGR or ULNB	Combustion Control	Wet Scrubber
NOx	X	X	X	
CO			X	
SOx			X	X

**Table F-2
Dryer Process Emissions Control Device Options**

Pollutant	Control Device Option						
	Dust Collector	Air Classifier / Cyclone / Knockout Box	Baghouse / Fabric Filter	ESP	Incineration	Wet Scrubber	Road Wetting / Sweeping
PM	X	X	X	X			X
VOC					X		
NH ₃						X	
H ₂ S						X	

Step 3: Evaluate Technical & Economic Feasibility of the Control Options

The following is a discussion of the mechanism of each control option by pollutant, as well as its technical and economic feasibility. Methods that are deemed technically infeasible are also assumed to be economically infeasible, since the technology itself is prohibitive and would require significant maintenance/technology development to be used in this biosolids processing facility.

Combustion Emissions

PADEP BAT for Natural Gas Combustion

Current PADEP BAT requirements for combustion units with a rated capacity equal to or greater than 10 MMBTU/hr are:

- 30 ppmdv NO_x at 3% O₂; and
- 300 ppmdv CO at 3% O₂.

The supplemental thermal oil heater will meet the above emission limits. Manufacturer's data can be provided upon request

Low NO_x Burner

The supplemental thermal oil heater will be equipped with a low NO_x burner (LNB). Low NO_x burners inhibit the formation of NO_x by controlling the mixing of fuel and air.

The process will be primarily fueled by waste heat from the GKEDC turbines. The supplemental heater will operate at a heat input of approximately 6.1 MMBTU/hr. The heater will also be able to fire natural gas and/or landfill gas (LFG). When the turbine plant is offline, the heat load on the supplemental heater will increase to a maximum of 36.7 MMBTU/hr. Natural gas is considered a "clean fuel" due to its low sulfur and particulate content. LFG combustion is also considered a low emitter of criteria

pollutants, notably SO_x. Burner design firing rate may increase to 50.3 MMBTU/hr to allow for variability in fuel types and heating values.

For this size supplemental heater firing natural gas, capital costs are typically in the range of \$160,000 - \$350,000 total or \$15-600 USD per ton of NO_x removed.

Low NO_x burners are a technically and economically feasible option for this supplemental heater.

LNB with FGR

Flue Gas Recirculation (FGR) is typically used where high NO_x removal efficiencies are required that are not achievable by LNB (for example, boilers firing residual oil) or where combustion controls are not suitable to the process type (for example, nitric acid production plants). Technologically, this is not the case for this biosolids processing facility; therefore, FGR does not apply.

Ultra-Low NO_x Burner

Ultra-low NO_x burners (ULNB) can be used to reduce NO_x emissions to extremely low NO_x concentrations, in some instances down to 5 ppm. ULNB can replace SCF or low temperature oxidation. ULNB may be appropriate in cases where compliance with Lowest Achievable Emission Rate (LAER) or California BACT requirements are necessary, as opposed to demonstrating BAT which is less stringent. The proposed supplemental heater equipped with a LNB already meets the PADEP BAT requirement of 30 ppmvd of NO_x at 3% O₂. Therefore, while technically feasible, ULNB is unnecessary.

While technically feasible, ULNB can cost in the range of \$75,000-\$250,000 USD (\$10,000-\$15,000 USD per ton of NO_x removed) for new units or up to \$2,000,000 U.S. Dollars (USD) for retrofits, making them cost prohibitive.

Combustion Control

Combustion control and good operating practices can be used to minimize emissions of NO_x, CO, and SO_x from the supplemental thermal oil heater. Specific requirements include inspection of the burner, burner cleaning, replacement of burner parts, flame pattern inspection and adjustment, inspection and calibration of the air to fuel ratio (AFR) control system, measurement of NO_x, CO, and O₂ in the effluent stream, and operation of the burner in conjunction with manufacturer' specifications.

Note that SNCR, SCR, and oxidation catalysts are designed for larger combustion sources and are not appropriate control technologies for a heater of this relatively small heat capacity. Therefore, these technologies are not discussed further herein.

Wet Scrubber

Wet scrubbers are typically only used for combustion control when SO_x emissions are of concern – for example, with coal-fired utility boilers. SO_x emissions are not of concern for the supplemental heater and therefore this option is not technically feasible.

Combustion Emissions – Other

Note that SNCR, SCR, and oxidation catalysts are designed for larger combustion sources and are not appropriate control technologies for a supplemental heater of this relatively small heat capacity. Therefore, these technologies are not discussed further herein.

Dryer Facility Emissions

Dust Collector/Condenser

The moisture-loaded drying air leaving the belt dryer will be cooled by an arrangement of an air cooler and an indirect non-contact condenser. The air cooler generates cooling water on a closed loop. The non-contact condenser will remove water (moisture) via cooling of the exhaust gas, primarily for recirculating the air in the dryer system, while simultaneously achieving dust removal of wet dust material. The non-contact condenser will use a spray system to condense moisture and remove dust. A portion of the condensed water will be cooled by a non-contact cooling source and reused as condensing water. Condensate drains from the system to prevent accumulation.

The dust collector will remove dust from the enclosed product storage and conveyance steps. This control option is custom designed for this proposed dryer process and is expected to have a dust removal efficiency of at least 90%. This technology has been successfully installed and operated at numerous other Synagro facilities and therefore is technically feasible.

Also, please note that the exhaust gas from the proposed dryer process is expected to be at a relative humidity of 100%, with a moisture content of 35-50%. Due to the high moisture content of the exhaust gas, dust emissions are expected to be minimal.

Costs for the dust removal are expected to be approximately \$30,000 USD, with an annual operating cost of \$50,000 USD for electricity, making it economically feasible. The capital cost of the total belt drying system including dust removal is expected to be \$3,924,525 USD, with annual operating costs of \$300,308 USD.

Air Classifier / Cyclone / Knock-out Box

Air classifiers or cyclones can be used to separate materials using gravity and centrifugal forces along with pressure drop to separate materials based on a combination of size,

shape, and density, and is often used as a first stage removal for particulates in the mineral processing industry. They are also used in recycling centers. An air classifier is used to control particulate emissions from a waste to fuel processing facility in Southeastern Pennsylvania; however, that facility's potential to emit of PM is very low compared to other processes. While cyclones have low capital cost and low maintenance requirements due to their simple technology, these units, also called "knock out boxes", have low efficiencies and high operating costs. This technology is best suited as a first stage control and is not for biosolids processes that, due to process air conditions, have high amounts of product carry over from the drying unit that is required to be removed prior to downstream treatment. This technology is not necessary for the low product carryover from a belt dryer. Therefore, it is not technically feasible.

Baghouse / Fabric Filter

Baghouses are used for dust control in a wide variety of industries, and can achieve very high collection efficiencies even for small particles. However, they require large floor areas and cannot operate in moist environments due to fabric blinding. The exhaust gas from the proposed process is expected to be at a relative humidity of 100%, with a moisture content of 35-50%. Additionally, the fabric filters can be harmed by corrosive substances, which include H₂S. Therefore, this is a technically infeasible option.

Electrostatic Precipitator

Electrostatic precipitators (ESPs) are more suitable for processes with vary large gas volumes. They take up a lot of space and cannot control gaseous emissions; therefore, they are technically infeasible for this dryer process.

Incineration

Incineration (including thermal oxidizers, catalytic oxidizers, flares, or afterburners) can be used for control of process VOCs; however, literature does not discuss in detail whether these devices are suitable for odor control. In addition, a gas scrubber or adsorber may still be required. Therefore, this option is technically and economically infeasible.

Wet Scrubber

Various forms of gas adsorption and gas absorption can be used for control of VOC and odors. Absorption is a process where one or more soluble components of a gas mixture are dissolved in a liquid (i.e., solvent). A wet scrubber (also referred to as a wet collector) is a specific type of absorption device that removes acid gases (such as H₂S). Wet scrubbers have the following advantages: small space requirements, no secondary dust sources, capable of handling high-temperature, high-humidity gas streams, minimal fire and explosion hazards, and the ability to collect both gases and PM. Disadvantages

include corrosion problems, necessitating proper construction materials, and high power requirements.

The wet scrubber will be used to control if not completely eliminate nuisance odors as H₂S and ammonia (NH₃) associated with the dryer facility. An odor study undertaken by the dryer facility indicates the wet scrubber will reduce emissions of H₂S and NH₃ by 99%, specifically reducing the H₂S from 12 ppm to 0.12 ppm, and the NH₃ from 89 to 0.89 ppm.

The wet scrubber, integral to odor control from this process, is technically and economically feasible. Vendor proposals indicate the scrubber cost to be in range of \$200,000-\$250,000 USD. The actual capital cost for the scrubber system is \$212,000 USD, with an additional freight cost of \$10,000 USD. The chemical packing material has a lifespan of 5-7 years. The NH₃ and H₂S scrubber packing material each have a cost of \$2,000 USD (material only).

Road Wetting / Sweeping

All roads used by trucks will be paved in order to minimize dust, and SBHRC will be responsible for their own dust control. However, GCSL also operates a street sweeper along the entrance road leading from the site entrance to the scales. If needed, GCSL's water trucks will be available to spray down the areas surrounding the SBHRC, minimizing the potential for dust emissions.

The proposed air pollution control for dust suppression will be a water spray. The proposed road and parking areas associated with the proposed biosolid recycling facility will either be paved or stoned. Additionally, an onsite water truck will be available to run in order to further improve dust suppression on site.

Vehicle speeds on paved and unpaved roads will be restricted to minimize dust.

EPA RACT/BACT/LAER Clearinghouse Database Review

A review of the EPA RACT/BACT/LAER Clearinghouse (RBLC) Database was performed to review methods of control used by biosolids processing facilities since January 1, 2008 (i.e., the past 10 years). No results were found for these types of facilities. Results from the Database for thermal oil heaters and natural gas-fired heaters (Process type 19.600: Misc. Boilers, Furnaces, Heaters) are attached as Table F-3. Selective Catalytic Reduction (SCR) technology, good combustion practices, annual tune-up, low-NO_x burners, restricted use of pipeline-quality natural gas, and efficient design were shown to be BAT for these heaters.

Step 4: Rank Remaining Control Technologies according to Control Effectiveness

The control technologies, ranked by effectiveness, are summarized for each pollutant. Only NOx has more than one possible technically feasible control technology. For the other pollutants, each has only one technically feasible combination of controls.

Table F-4 Control Technologies Ranked by Effectiveness

NOx	SOx / CO	H₂S / NH₃	PM
1. ULNB & Combustion Controls / Good Operating Practices / PADEP BAT NOx Emission Concentration Limit	Combustion Controls / Good Operating Practices / PADEP BAT CO Emission Concentration Limit	Wet Scrubber	Clean Fuel Types; Dust Collector; High Material Moisture Content & Road Wetting / Sweeping
2. LNB & Combustion Controls / Good Operating Practices / PADEP BAT NOx Emission Concentration Limit			

Step 5: Consider BAT by Technical and Economic Feasibility

Based on the above steps, control of NOx emissions via ULNB is economically infeasible. Therefore, control of NOx emissions will be achieved via a LNB and control of SOx, CO and NOx emissions will be achieved by combustion controls and good operating practices. Control of dryer process odor emissions including H₂S (which may also be in LFG combustion emissions) and NH₃ will be achieved by the wet scrubber. Combustion particulate emissions will be minimized by the use of clean fuel types. A dust collector will remove dust from the enclosed product storage and conveyance steps. Road wetting and sweeping will be conducted to control roadway dust. Finally, the expected high moisture content of the exhaust gas implies that dust emissions from the dryer process will be minimal.

References

Synagro website. <http://www.synagro.com/>

Commonwealth of Pennsylvania Department of Environmental Protection Bureau of Air Quality. General Plan Approval and/or General Operating Permit BAQ-GPA/GP-1 Small Gas and No. 2 Oil Fired Combustion Units. Condition #017a. 2700-PM-AQ0201. Rev. 7/2004.

EPA Air Pollution Control Cost Manual. Sixth Edition. EPA/452/B-02-001. January 2002.

EPA RACT/BACT/LAER Clearinghouse (RBLC) Database. <https://cfpub.epa.gov/rblc>

Cooper, C. David and F.C. Alley. *Air Pollution Control: A Design Approach*. Third Edition. 2002.

State of New Jersey Department of Environmental Protection Air Quality Permitting Element. State of the Art (SOTA) Manual for Boilers and Process Heaters. Revision Date: February 22, 2004.

California Air Resources Board (CARB) website. <https://ww2.arb.ca.gov/>