APPENDIX 9H

GLASS FURNACE TECHNOLOGY
MINERGY PROPOSALS

PRELIMINARY TECHNICAL AND ECONOMIC EVALUATION FOR VITRIFICATION OF MILORGANITE USING MINERGY'S GLASSPACK® PROCESS

PREPARED FOR:
MILWAUKEE METROPOLITAN SEWAGE DISTRICT

PREPARED BY:

MINERGY®
GLASSPACK | LLC

JULY 12, 2005

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1 INTRODUCTION

Wastewater treatment systems, both industrial and municipal, produce large quantities of sludges and biosolids that require disposal. Disposal often poses significant environmental liabilities, logistical problems, and economic burdens. Minergy Corp. has developed and implemented several technologies for the recycling of such high volume wastes as sludge, biosolids, ash, and foundry sand.

Vitrification is one technology that Minergy has developed and implemented on a commercial scale to recycle high volume wastes. Vitrification technologies perform energy and mineral recovery from the waste material, converting it into construction material and industrial feed stocks which are inert, marketable products. With a continuously operating processing system installed at the waste source, these technologies reduce handling, eliminate downstream liabilities, and reduce disposal costs. Vitrification provides a sustainable solution to recycle biosolids and establish a true low-cost, long term, beneficial re-use.

GLASSPACK® is Minergy's second generation vitrification technology and is unmatched by other biosolids disposal technologies. GLASSPACK® is flexible, compact, and efficient, and when configured in Minergy's patented closed-loop oxygen enhanced combustion process, offers advances in thermal efficiency and emissions reductions that until recently seemed impossible.

This technical and economic evaluation describes the process and equipment necessary to convert Milwaukee Metropolitan Sewage District's (MMSD) Milorganite into a beneficially reusable glass aggregate. The document delineates the most advanced solid waste thermal oxidation technology featuring Minergy's state-of-the-art GLASSPACK® vitrification technology.

1.1 ECONOMIC BENEFITS

During the review of relevant project information and development of this document, we have concluded that application of a GLASSPACK® solution will have significant economic benefits. GLASSPACK® benefits include:

- Eliminates the need to purchase large volumes of natural gas to operate the existing combustion turbines as the heat source for the Milorganite drying operation
- Eliminates on-going combustion turbine maintenance activities and future capital outlays for combustion turbine replacement
- Allows for the sale of the emissions credits via significant reduction of VOC (volatile organic compounds) and NOx (nitrous oxide) emissions
- Reduces MMSD's product and regulatory liability on the sale and use of Milorganite
- Recovers Milorganite's energy content while converting the inorganic faction into glass aggregate and achieving more than a 90% volume reduction. All of the glass aggregate produced can be sold into existing local aggregate markets without upsetting the local supply and demand forces
- Eliminates the need to supplement Milorganite production with ferric chloride

- Eliminates the need to operate the Milorganite screening and product sizing operations as the GLASSPACK® vitrification process does not require stringent product sizing

1.2 ENVIRONMENTAL BENEFITS

During the review of relevant project information and development of this document, we have concluded that application of a GLASSPACK® solution will have the following environmental benefits. GLASSPACK® results in:

- Significant reduction in nitrous oxide (NOx) emissions with retirement of the combustion turbine
- Significant reduction in volatile organic compound emissions (VOC's) by integrating the GLASSPACK® heat recovery process into the dryer system. By making a modification to the dryer process it becomes economically feasible to add cost effective VOC controls on the exhaust of the Milorganite dryer process.
- Eliminates nutrient runoff into lakes, streams and groundwater resulting from Milorganite applications

2 BASIS OF DESIGN

The following Basis of Design is for the future case that represents the total waste activated sludge and primary sludge production rates for the year 2020. The existing dryer operation would dry all of the waste activated sludge and primary sludge produced at the Jones Island and South Shore facilities. In this scenario MMSD would continue to operate the digesters for all primary sludge, generated at Jones Island and South Shore, to reduce volume and accomplish drying within existing dryer plant capacity.

BASIS OF DESIGN	
Milorganite input	240 dry tons per day
Milorganite moisture	8 %
Milorganite Gross Calorific Value (GCV)	7,500 Btu/lb
Milorganite ash content	30 %
Temperature requirement to dryer plant	950 ° F
High temperature thermal viscosity (T_{250}) of inorganic ash fraction	< 2300 ° F
PROCESS SPECIFICATIONS	
Process technology	Minergy GLASSPACK® closed-loop oxygen enhanced combustion
Number of GLASSPACK® process lines	3
Processing capacity per line	80 dry tons per day
Oxygen source	On site production
Oxygen production technology	Non-cryogenic vacuum swing absorption (VSA)
Number of oxygen production lines	3
Oxygen purity	92 -95 %
Thermal energy recovery (total for all 3 lines)	105 mmBtu/hr
Thermal energy recovery technology	Tubular gas to gas heat exchanger

In addition to the information directly supplied to Minergy, this proposal reflects a significant amount of direct experience Minergy has gained vitrifing Milorganite. Minergy routinely uses Milorganite as a standardized feed stock during product research and testing conducted in the commercial-scale GLASSPACK® unit located at our Vitrification Technology Center. To date, Minergy has conducted more than three dozen trial melts of municipal biosolids, with conservatively, at least a dozen using Milorganite.

3 PROCESS DESCRIPTION

Biosolids play critical beneficial roles in Minergy's GLASSPACK® vitrification process. First, the biosolids' organic fraction contains a significant amount of thermal energy. The organics are essentially biomass fuel, renewable through the cycle of water use and wastewater treatment. Secondly, the mineral content (ash, clays, and mineral fillers) in the biosolids form the basis of a glass aggregate product that is beneficially reused in construction and industrial applications, eliminating the need for disposal.

GLASSPACK's unique process is unmatched by other biosolids disposal technologies. The GLASSPACK® system is a combination of two innovative concepts. The first innovation is Minergy's patented closed-loop oxygen enhanced combustion process that uses enriched oxygen to improve melter temperatures, provide complete destruction of organic compounds, and greatly reduce the amount of exhaust gases. The high process temperatures completely melt the inorganic fraction providing the added benefit of melting biosolids without the need for costly and careful flux addition.

The second innovation is the GLASSPACK® modular melter concept. The melter is a shop-fabricated unit that can be delivered to the construction site on a single truck shipment. The entire process can be highly modularized to minimize field installation costs and construction schedule.

3.1 PROCESS DESCRIPTION - GLASSPACK®

Minergy Drawings No. 240-1000-FD01 and 240-1000-PD10, provided at the end of Section 3, presents an overall general Process Flow Diagram.

The GLASSPACK® process starts with dry granulate from the dryer operation delivered to the granulate surge bin. Volumetric feeders (4 per line) discharge granulate from the surge bin to roller mills that reduce the granulate size to the specified range for proper melter operation. The crushed granulate is then charged into the melter through rotary airlocks.

The GLASSPACK® melter features a 3-zone operation, comprised of separate but interconnected chambers (Figure 1):

- Zone 1: Melting Zone
- Zone 2: Phase Separation Zone
- Zone 3: Gas Cooling Zone

Zone 1: Melting Zone. Feedstock that has been pre-dried to approximately 90% solids or more is injected along with synthetic air (a more detailed description of synthetic air is set forth below) into the Zone 1 chamber. In this zone, the organic component of the sludge is completely combusted, liberating a significant amount of heat energy and

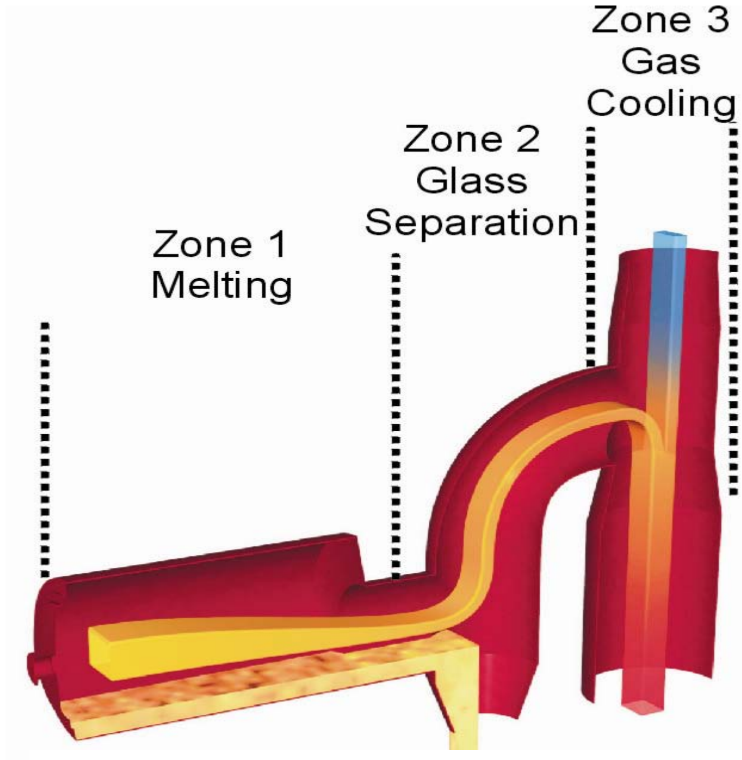


Figure 1. Three Zone Operation of GLASSPACK.

resulting in temperatures between 2400 and 2700^o F (1315 and 1482 ^{o} C). At these high temperatures, the mineral (ash) component of the feedstock melts to form a pool of molten glass at the bottom of the Zone 1 chamber. The high temperature environment is designed to provide very high destruction efficiencies of organic compounds that may be contained in the feedstock. In a typical municipal biosolids application, once the operating temperature is reached, the energy released from combustion of the biosolids is adequate to keep the process going, eliminating the continued need for co-fire fuel.

Zone 2: Phase Separation Zone. Phase separation of the molten glass and exhaust gas occurs by gravity draining the molten glass from Zone 1 through a drain port on the bottom of the Zone 2 chamber. The molten material drops into a water quench tank and is cooled into the glass aggregate product. The hot combustion gases are directed out of Zone 2 through a refractory lined duct into Zone 3.

Zone 3: Gas Cooling Zone. In this zone, hot exhaust gas is cooled through dilution mixing with lower temperature gases obtained external to the melter. A typical source of lower temperature dilution gas is recirculation flow from a closed–loop installation. The two primary benefits of reducing the exhaust temperature are to eliminate expensive refractory-lined ductwork exterior to the melter, and to cool any particulate carryover below the softening point, thus eliminating ductwork fouling. The temperature of the Zone 3 exit gas varies depending on the temperature and quantity of the dilution gas, but is typically in the range of 700 to 1400 ^{o} F (371 to 760 ^{o} C) and is usually dictated by the thermal energy recovery technology employed. Higher temperature exit gas can provide for higher efficiencies in heat recovery.

3.2 PROCESS DESCRIPTION – MELTER SUPPORT EQUIPMENT

Hot exhaust gases from the discharge of Zone 3 are ducted into a heat exchanger to recover thermal energy. For the MMSD application, thermal energy recovery will be accomplished using a tubular heat exchanger that will deliver 950^{o} F gas into the existing dryer operation.

Although most of the inorganic material is melted in the GLASSPACK® melter, a fraction of dust can be present in the gas stream. This particulate matter will be captured and removed from the system in a fabric filter located downstream of the heat exchanger. An exhaust fan is used to maintain draft and induce flow through the process.

The exhaust is further cooled and water vapor, produced during combustion, is condensed in a direct packed tower style condenser. The exhaust gas is cooled to 90^{o} to 120^{o} F (32 to 49^{o} C) and directed into the gas recycle header. A portion of the recycle gas is exhausted out of the process to advanced air quality control equipment. For the MMSD application, air quality control equipment includes a wet scrubber for SO_2, Selective Catalytic Reduction (SCR) for NOx, and bag filter for particulate matter.

The remainder of the recycled gas is boosted in pressure through a recycle fan and enriched with oxygen. The end result is synthetic air which is injected back into Zone 1 of the GLASSPACK® melter. Unlike normal air which is only 21% oxygen, synthetic air can be mixed to any ratio of oxygen necessary. This allows simultaneous optimization of melting temperatures, combustion conditions and emissions control that can not be done with conventional air fired combustion technology.

3.3 ON-SITE OXYGEN SUPPLY

On-site generation of an oxygen supply will be accomplished using non-cryogenic vacuum swing adsorption (VSA) technology. This system consists of a skid mounted production plant that contains compressors, vacuum pumps and a molecular sieve to separate oxygen from the nitrogen in ambient air. First, an air blower draws ambient air through the inlet filter where particulates are captured. The clean compressed air is then cooled and fed to the molecular sieve adsorbers. As the air passes through the molecular sieve, water and other non-oxygen gases are retained and high purity oxygen (90+%) passes out of the adsorber. When the adsorbent capacity of the molecular sieve is reached, switching valves divert feed air to the second adsorber and the first adsorber is taken off line. While off-line, the first adsorber is connected to the vacuum pump and the vacuum pump draws off the adsorbed water and other gases. Once the vacuum pump has evacuated the adsorbed water and other gases, the first adsorber is placed in a standby mode until the second adsorber requires regeneration and the process is repeated.

3.4 MASS BALANCE

Figure 2 presents a preliminary mass balance for one of the three identical GLASSPACK® processing lines.

3.5 HEAT BALANCE

Figure 3 presents a preliminary heat balance for one of the three identical GLASSPACK® processing lines.

3.6 GLASSPACK® SYSTEM SAFETY

The GLASSPACK® closed-looped combustion system has instrumentation that is calibrated and functionally checked at start-up. The control system provides numerous interlocks that are intended to prevent the system from operating outside its normal design parameters. Both the oxygen supply system and the start-up natural gas supply system use double block valves, which are intended to isolate the energy supply to the melter in the event that any critical process parameter exceeds the limitations.

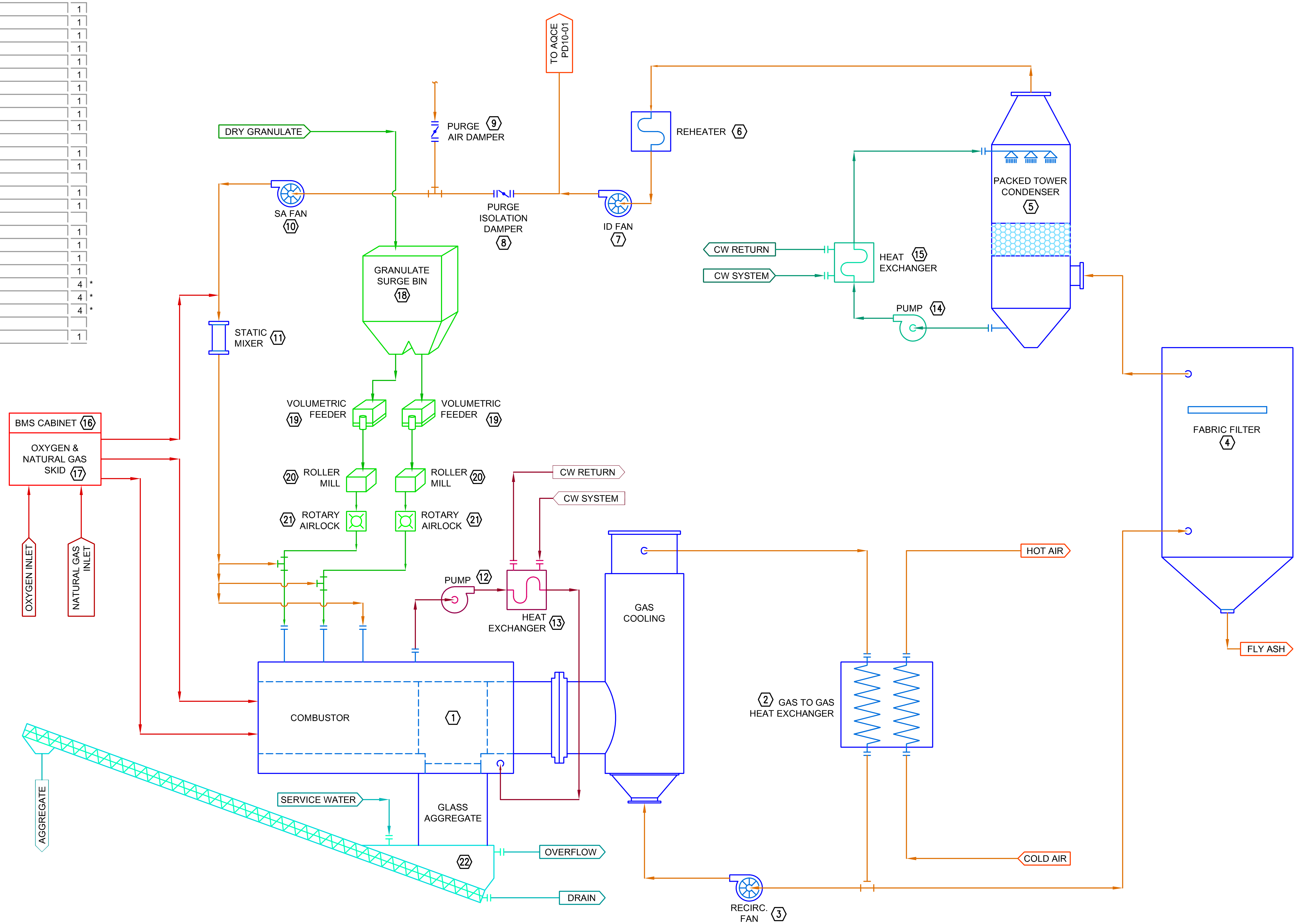
Both the oxygen supply system and the natural gas supply system employ double block valves to guarantee isolation of the energy supply. Interlocks are also utilized that terminate granulate feed to the melter during abnormal conditions. Combustion ceases almost immediately upon trip because the melter system carries a very low inventory of granulate. The following process trips are employed to stop oxygen, gas, and granulate feed:

- GLASSPACK®
  - Melter static pressure high and low
  - Inlet oxygen high and low (double redundant)
  - Outlet combustibles high (triple redundant)
  - Outlet oxygen high and low (triple redundant)
  - Main flame failure
  - Pilot flame failure
  - Melter optical pyrometer high or low
- GLASSPACK® Cooling System
  - Door cooling water temperature high
  - Melter cooling water tank temperature high
- Natural Gas & Oxygen Control System
  - Instrument air pressure low
  - Gas and oxygen pressure high or low
- Heat Recovery Heat Exchanger
  - Heat exchanger over temperature
- Packed Tower Condenser
  - Condenser gas outlet temperature high
- Fans
  - ID fan fault
  - EGR fan fault
  - SA fan fault

SCHEDULE OF SUPPLIED EQUIPMENT

Item	Description	Drawing Number	Quan.
	GLASSPACK PROCESS - SUPPLIED EQUIPMENT LIST		
	COMBUSTION GAS / SYNTHETIC AIR		
1	GlassPack Melter		1
2	Gas to Gas Heat Exchanger		1
3	Recirculation Fan		1
4	Fabric Filter		1
5	Packed Tower Condenser		1
6	Reheater		1
7	ID Fan		1
8	Purge Isolation Damper		1
9	Purge Air Damper		1
10	SA Fan		1
11	Static Mixer		1
	MELTER TANK COOLING SYSTEM		
12	Pump		1
13	Heat Exchanger		1
	MELTER FLUE GAS COOLING SYSTEM		
14	Pump		1
15	Heat Exchanger		1
	OXYGEN & NATURAL GAS SYSTEM		
16	BMS Cabinet		1
17	Oxygen & Natural Gas Control Skid		1
	GRANULATE FEED SYSTEM		1
18	Granulate Surge Bin		1
19	Volumetric Feeder		4 *
20	Roller Mill		4 *
21	Rotary Airlock		4 *
	AGGREGATE HANDLING SYSTEM		
22	Quench Tank & Conveyor		1

NOTE:
* - TWO (2) LINES SHOWS FOR CLARITY



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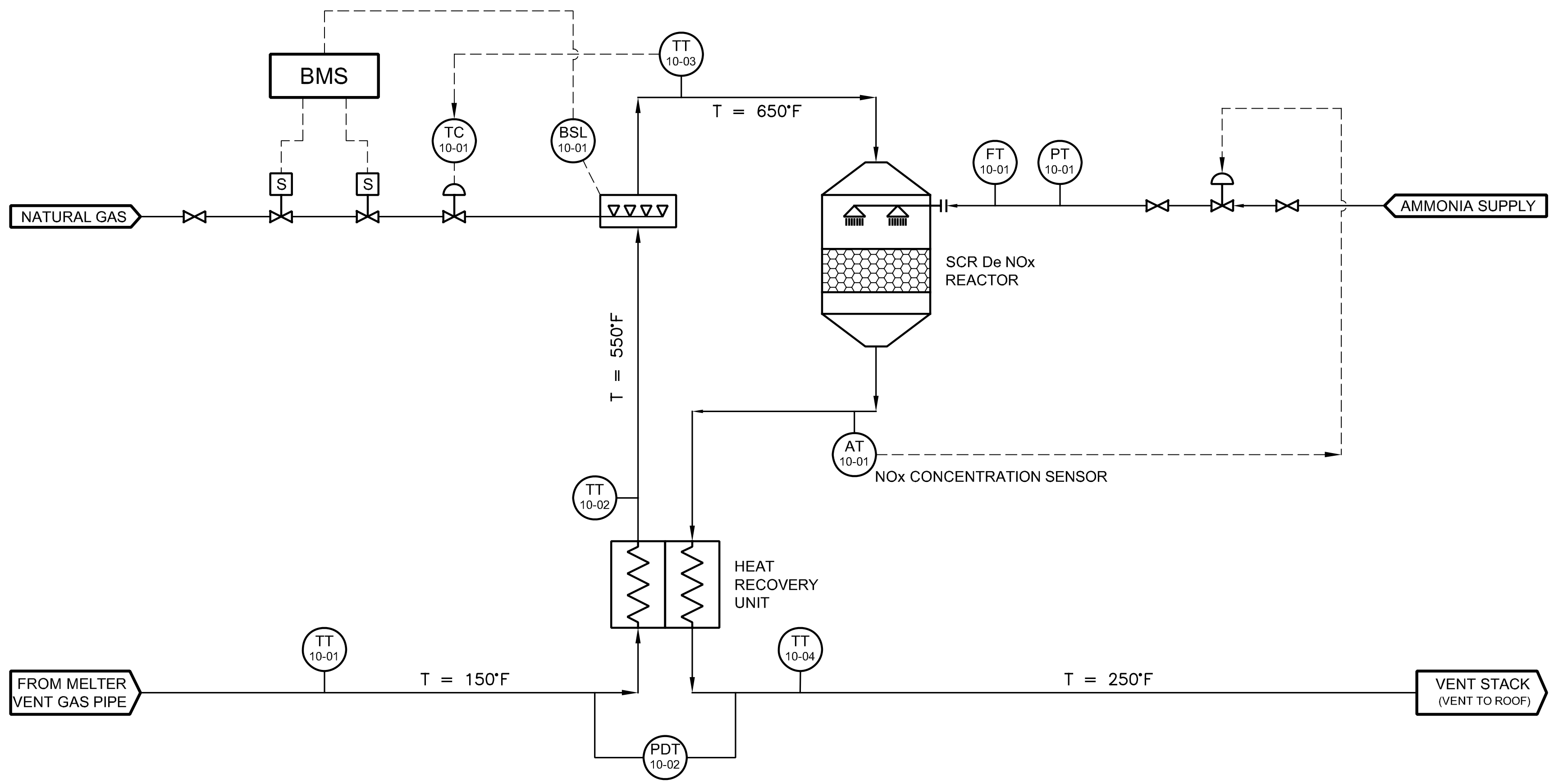
PROCESS FLOW DIAGRAM
GLASSPACK PROCESS
SCOPE OF SUPPLIED EQUIPMENT

Date: JULY 2005

Drawing No.: 240-1000-FD01

Sheet 01 of 01 Rev. -



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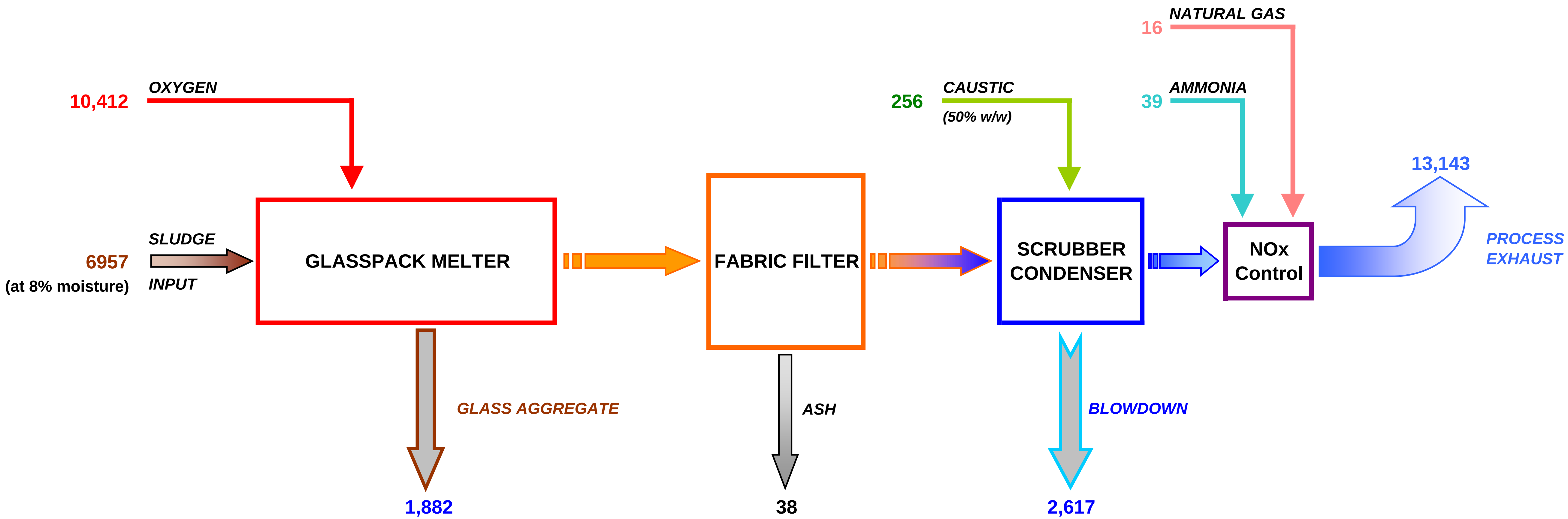
MINERGY MELTER FACILITY
- PRELIMINARY -
MILWAUKEE, WI

PROCESS & INSTRUMENTATION DIAGRAM
AIR QUALITY CONTROL SYSTEM (AQCE)
GLASSPACK MELTER PLANT

Date: JULY 2005
Drawing No.: 240-1000-PD10
Sheet 01 of 01 Rev. 0



BASIS OF DESIGN:

Processing Rate:	80 tons per day (Dry Basis)
Ash Content:	30%

NOTES:

* Heat Balance for 1 of 3 lines
* All units are in lbs/Hr

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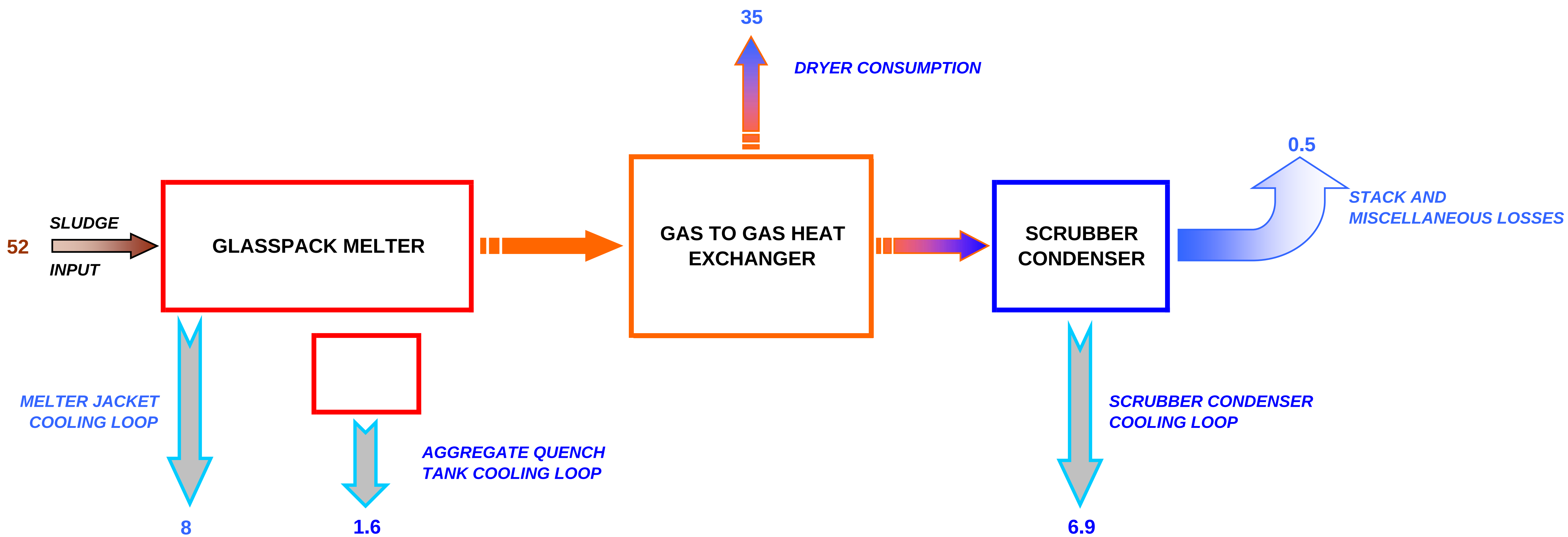
FIGURE 2
Mass Balance
GlassPack Melter Facility
Milwaukee Metropolitan Sewage District



BASIS OF DESIGN:

Processing Rate:	80 tons per day (Dry Basis)
Sludge GCV:	7500 Btu/lb

NOTES:

* Heat Balance for 1 of 3 lines
* All units are in Million Btu/Hr

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FIGURE 3
Heat Balance
GlassPack Melter Facility
Milwaukee Metropolitan Sewage District

4 PROCESS CONSUMPTION AND OUTPUT ESTIMATES

GLASSPACK® process consumption and output estimates provided below are sum totals for all three (3) processing lines assuming the Basis of Design specified in Section 2.0. This data is based on Minergy's experience with certain municipal biosolids including Milorganite.

GLASSPACK® COMSUMPTIONS		
Natural gas used during start up (peak flow)	100,000	SCFH
Natural gas used during normal operations (to maintain process temperatures for emission control purposes)	1,150	SCFH
Electric power for oxygen generation	3,450	kW
Electrical power for balance of GLASSPACK® process	750	kW
Sodium Hydroxide (NaOH) for SO_2 control (anhydrous mass basis)	385	lb/hr
Ammonia for NOx control (anhydrous mass basis)	40	lb/hr
Service water for melter auxiliary equipment cooling	5,000	GPM
GLASSPACK® OUTPUTS		
Exhaust gas	8,500	ACFM
NOx	75 20	ppm tons/year
SO_2	25 9	ppm tons/year
Particulate Matter (PM)	0.02 6	grains/dscf tons/year
Volatile Organic Compounds (VOC)	25 2	ppm tons/year
Carbon monoxide (CO)	100 15	ppm tons/year
Glass aggregate	2.8	tons/hr
Fly ash	0.058	tons/hr
Hot air (waste heat) flow available to dryer process	555,000	lb/hr
Service water (non-contact; 20° F rise from supply temperature)	5,000	GPM
Maximum service water temperature for melter cooling	86	° F
SO_2 scrubber blowdown (contact water)	16	GPM
GLASSPACK® operating temperature	2400 - 2700	° F
GLASSPACK® heat recovery air supply temperature to dryer operation	950	° F
GLASSPACK® final exhaust temperature	140	° F

5 SCOPE OF EQUIPMENT SUPPLY AND INSTALLATION

This budget estimate includes the following:

EQUIPMENT	NUMBER PER GLASSPACK® LINE	TOTAL SUPPLIED
GLASSPACK® GP-80 melter with refractory	1	3
Oxy-fuel control skids	1	3
Burner management systems	1	3
Quench tanks and aggregate handling	1	3
Melter refractory cooling systems	1	3
Gas to gas tubular high temperature heat exchangers	1	3
Dry sludge day hoppers	1	3
Dry sludge roller mills	4	12
Dry sludge volumetric feeder system	4	12
Induced draft fan	1	3
Synthetic air booster fan	1	3
Exhaust gas recirculation fan	1	3
NOx emission control system	1	3
PLC based control system	---	1
Operator work station	---	1
Instrumentation packages for melter and melter support system	1	3
GLASSPACK® off-gas scrubber condenser	1	3
GLASSPACK® off-gas fabric filter	1	3
Oxygen supply system	1	3
Liquid oxygen back-up system	---	1

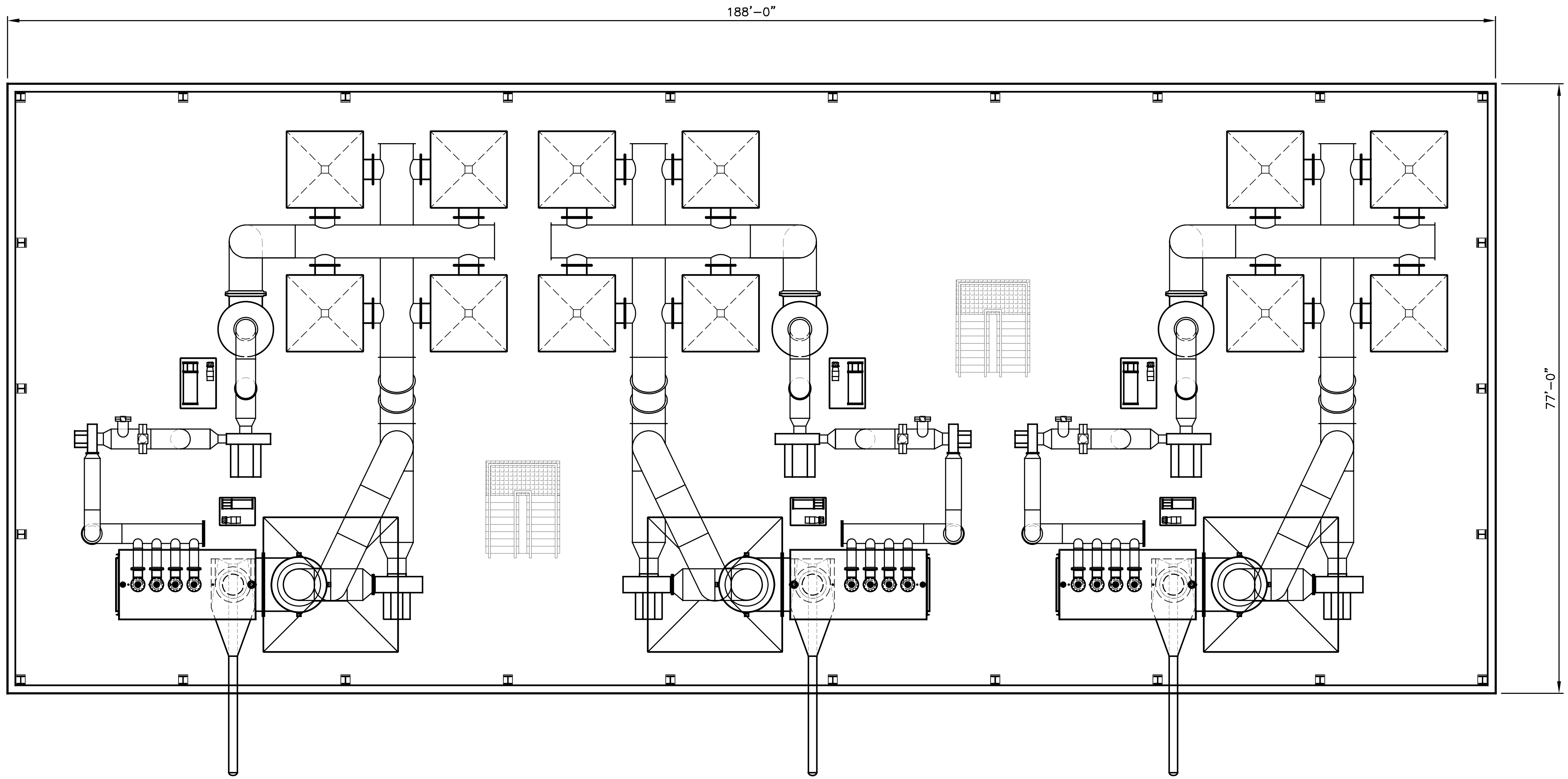
The following list identifies the limits of the installation included in this proposal:

- 190’ x 80’ pre-engineered building
- Electrical installation
- Mechanical installation
- Piping
- Equipment installation
- Motor control centers
- Variable speed drives
- Melter process exhaust stacks

6 CONCEPTUAL GENERAL ARRANGEMENT DRAWING

Minergy Drawing 240-1000-GA01 is an approximate footprint required for the GLASSPACK® melter process. The footprint for the melter building to house all three process lines is 80' x 190' or a total of approximately 15,200 square feet of plan area. The gas to gas heat exchangers will drive the building height requirements to about 100 feet above grade. Lower building heights are technically feasible, however building footprint, and possibly project capital costs may increase. The GLASSPACK® melter process will supply heat to the dryer complex in the form of hot gas. The hot gas volume will be significant, and the gas ducts will be equal in size to the existing waste heat gas ducts between the combustion turbines and dryer complex. Therefore, it will be essential to locate the proposed plant near the existing dryer building or the existing combustion turbines for economic reasons.

The oxygen supply operation is a separate footprint (not shown on the above GA drawing). The 3 non-cryogenic oxygen supply systems used in the basis of design will require a footprint of approximately 30,000 square feet. Each oxygen plant has a 100' square footprint. Unlike the melter plant, the oxygen supply can be economically piped considerable distances. The oxygen plant can be located anywhere on the existing site, or perhaps on adjacent sites if necessary. If the required footprint is still a constraint, a single line cryogenic air separation may be an alternative. A single cryogenic process line will be capable of producing the entire volume of oxygen required for all three melter lines with a footprint of approximately 13,300 square feet (133' x 100').



PLAN VIEW @ GRADE ELEVATION

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MINERGY MELTER FACILITY
- PRELIMINARY -
MILWAUKEE, WI

GENERAL ARRANGEMENT
MELTER FACILITY
PLAN VIEW @ GRADE ELEVATION

Date: JULY 2005

Drawing No.: 240-1000-GA01

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7 CAPITAL COST ESTIMATE

Provided in the table below are estimated costs for the equipment and installation scope of supply described in Sections 5 and 6. All costs are provided in 2005 dollars. The equipment cost accuracy is +/- 15% due to the limited degree that the design basis has been developed. Due to a larger number of unknowns, such as soil conditions and other site constraints, the accuracy of the construction costs are not as good as the delivered process equipment costs. An additional project contingency of 10% has been included to cover utility interconnections and other unforeseen project costs.

If the Minergy GLASSPACK® process would appear to be an attractive option for MMSD, engineering drawings and construction estimators could be brought into the process to refine the project cost estimate and help identify project cost items.

EXPENSE	ESTIMATE
Equipment (+/- 15%)	$ 31,400,000
Installation, engineering & project management (+/- 30%)	$ 16,500,000
Contingency (10% of equipment and installation)	$ 4,700,000
Total	$ 52,600,000

8 OPERATING COST ESTIMATE

The table below provides a summary of the annual cost to operate the Minergy GLASSPACK® melting process. The costs are for the operation of all three Minergy GLASSPACK® melter lines, operating 8,000 full load hours per year. The resulting operating cost is approximately $2,450,000 per year or $30.70 per dry ton. This figure does not include credit for heat energy provided by the process that displaces the need to burn natural gas in the combustion turbines currently providing waste heat to the Milorganite dryers.

Natural gas consumptions are a combination of fuel required for both start-up and fuel required for the air emissions control equipment. A natural gas cost of $7.50 per million Btu (often referred to as a decatherm) was assumed for the operating cost estimate.

The electrical equipment in the oxygen production operation is assumed to be supplied with **interruptible** electrical power. This is a common way to provide lower cost oxygen to the process and is typical for the air separation industry. In the event of an electrical interruption, the process would automatically switch over to an on-site liquid back-up system. Costs for the purchase of liquid oxygen inventory and storage are included in the operating cost estimate. The liquid oxygen usage is based on 48 hours of interruption per year.

The average cost for interruptible electrical energy used in the operating cost estimate was assumed to be WE-Energies current rate, Cp-2m (Appendix A). Electrical energy used to operate the balance of the GLASSPACK® process equipment is assumed to remain on **firm** electrical service as all other equipment in the existing waste water treatment and drying operation. The average cost for firm electrical energy used in the operating cost estimate was

Item	Quantity	Unit Cost	Annual cost
Natural gas	19,200 mmBtu/yr	$ 7.50 /mmBtu	$ 144,000
Electrical power for oxygen plant (1) (2)	27,600 MWH/yr	$ 31.50 /MWH	$ 869,400
Electrical power for Minergy process (2)	6,000 MWH/yr	$ 44.70 /MWH	$ 268,200
Liquid oxygen (back-up)	660 ton/yr	$ 70.00 /ton	$ 46,200
Sodium Hydroxide for SO_2 control	1,540 ton/yr	$ 270.00 /ton	$ 415,800
Ammonia for NOx control	160 ton/yr	$ 310.00 /ton	$ 49,600
Equipment maintenance	79,920 dry ton/yr	$ 8.00 /dry ton	$ 639,360
Ash	464 ton/yr	$ 45.00 /ton	$ 20,880
Total O&M			**$ 2,453,440**
	Annual total dry sludge tons processed		79,920
	Average operating cost per dry ton processed		$ 30.70

(1) Assumes oxygen plant is served on interruptible service

(2) Cost of power is the combination of demand charges and energy charges for a 1.2 peak / average load factor ratio

assumed to be WE-Energies current general primary power rate, Cp-1 (Appendix A). In addition, a peak to average power consumption ratio of 1.20 was assumed to calculate the composite cost of demand and energy charges.

All wastewater treatment sludges contain sulfur. When the organic fraction of the sludges are oxidized in GLASSPACK®, sulfur is converted to sulfur dioxide (SO_2). This is a gas that is a regulated pollutant under the Clean Air Act. Sulfur dioxide is easily scrubbed from the process exhaust gases in a scrubber, which is integral to the GLASSPACK® process. Sodium hydroxide (NaOH) is commonly used as the reagent to capture the sulfur dioxide. The reaction produces the inert and water-soluble salt sodium sulfate. This salt passes though the wastewater treatment process and can be discharged along with the existing inert dissolved solids already found in waste water treatment plant effluent. The cost of NaOH has been included in the operating cost estimate.

A second pollutant formed in the process are oxides of nitrogen (also known as NOx). Both NO and NO_2 are formed during the breakdown of nitrogen containing organic compounds. The Clean Air Act also regulates NOx emissions. The emissions can be controlled, and removal efficiencies of 90% to 95% have been demonstrated to be technically feasible with Selective Catalytic Reduction (SCR). The process uses a simple (non-precious metal) catalyst and ammonia to convert NO and NO_2 into nitrogen and water. Since the process gas exhaust flow rates are lower than other sludge incineration processes by an order of magnitude, the size of the catalytic reactor (and the cost), along with ammonia consumption are minor. The cost of ammonia has been included in the operating cost estimate.

Not all of the biosolids' inorganic fraction processed in the melter is converted into glass aggregate. A small portion escapes the melter as fine particulate ash in the exhaust gas and is captured in a fabric filter, an integral component of the GLASSPACK® process.. It is important to note that alternatives such as wet particulate collection, back mixing of fly ash into the sludge dewatering process for re-introduction back into the melting process or other beneficial reuse options could address this waste stream. Since all alternatives involve integration into the existing operating and will require additional investment, it has been assumed at this stage that the ash is disposed of in a local landfill. Ash disposal costs, assumed to be $45.00 per ton, have been included in the operating cost estimate.

The equipment maintenance figure of $8.00 per dry ton processed is an estimated annual average equipment maintenance cost with all equipment associated with the Minergy GLASSPACK® melting process, and includes items such as melter refractory maintenance, rotating equipment lubrication, scheduled preventative maintenance costs and inspections.

Lastly, at this level of analysis, we have not included labor in the operating cost estimate. If comparisons to the existing Milorganite operation are to be prepared, we believe it would be a fair assumption that the GLASSPACK® process would be effectively operated with a staffing level comparable to the operation and maintenance of the existing combustion turbines.

9 ALTERNATIVES FOR INTEGRATING MINERGY PROCESS INTO EXISTING DRYER PLANT DESIGN

During the development of this proposal and review of the current infrastructure at MMSD, it has become obvious that the most important technical consideration will be the method and process of directing the energy released in the GLASSPACK® process to the existing Milorganite dryer operation. As the Milorganite dryers presently use waste heat from natural gas fired combustion turbines, there is considerable capital and operational knowledge already invested in this operation. Therefore, it is essential that the interconnection with the GLASSPACK® process be achieved with as little modification as possible. Completing this interconnection will allow energy released from the GLASSPACK® process to be directed to the dryers and allow the combustion turbines to be retired, or operated only as back-up.

Minergy has initially identified 3 ways to interconnect the processes:
1) Direct exhaust from the GLASSPACK® melter directly to the dryers
2) Open loop indirect heating
3) Closed loop indirect heating

Each option is briefly discussed below. However for the purposes of this study, we have assumed the open loop indirect heating option would be implemented.

9.1 DIRECT EXHAUST

Direct exhaust will have the lowest capital cost, since no indirect heat exchanger will be required. However a wide number of technical issues must be reviewed and very detailed information about the dryers will be required in order to integrate the processes. This option is still viable, however to keep the capital cost projections conservative, this study has focused on the indirect heat exchanger options to provide a degree of separation between the processes. Direct exhaust could be evaluated in the detailed engineering phase of the project.

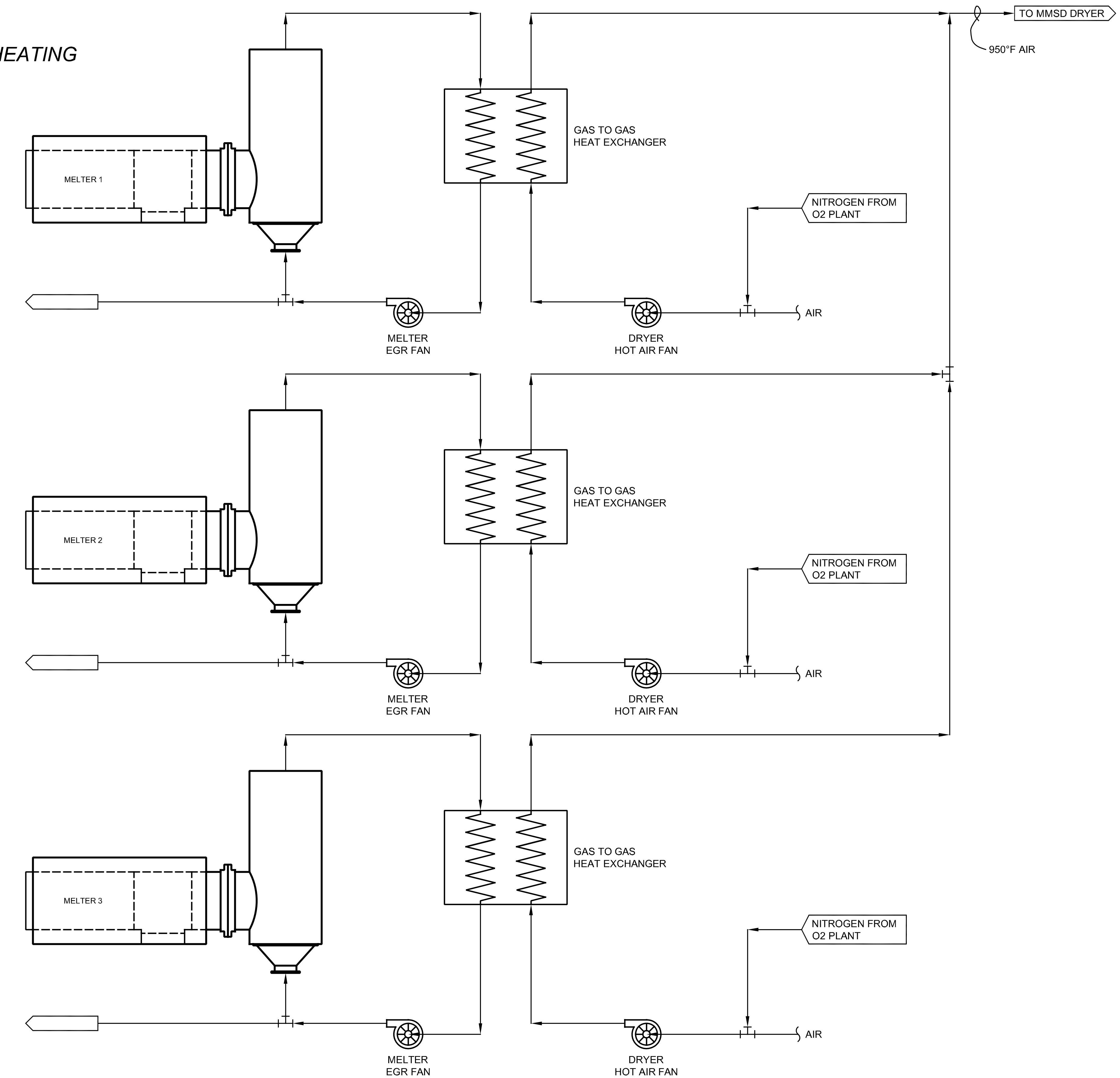
9.2 OPEN LOOP INDIRECT HEATING

The open loop indirect heating alternative is shown on Drawing No.160-1000-FD-01 (Sheet 1 of 2). In this alternative, hot gas from the Minergy GLASSPACK® melter travels through a tubular gas-to-gas heat exchanger. Heat is transferred to an air/nitrogen mixture blown into the tubular heated media side of the heat exchanger. The air is heated to 950^{o} F, or approximately equal to the temperature of the combustion turbine exhaust. The heated air is directed to the dryer operation in the existing exhaust gas ducts. The injection of waste nitrogen from the oxygen separation plant reduces the oxygen content in the air. The oxygen content in the heated gas will be very similar in composition to the existing combustion turbine exhaust, 15% to 18% by volume.

9.3 CLOSED LOOP INDIRECT HEATING

Lastly, the closed loop indirect heating alternative is shown on Drawing No.160-1000-FD-01 (Sheet 2 of 2). This option incorporates the same tubular heat exchangers however the dryer exhaust gas loop is now "closed" and a packed tower condenser is installed in the dryer exhaust flow stream. The packed tower condenser condenses the water vapor liberated from the dryer process, back to the liquid state. The dry gas is then recirculated back to the gas-to-gas heat exchangers to be reheated back to 950^{o} F. This option offers environmental, economic and safety benefits that should be evaluated before making a final design selection. The first benefit is that this option results in an order of magnitude reduction in dryer exhaust stack flow. This reduction allows for an economical installation of a regenerative thermal oxidizer (RTO) on this exhaust gas flow stream that will significantly reduce odorous compounds, volatile organic compounds (VOC's) and carbon monoxide emissions. This could provide an opportunity for the entire Jones Island facility to become a "minor source" from an air permitting perspective. Regardless, a net reduction in actual VOC emissions will allow MMSD to sell VOC emission credits to a very tight VOC market in the greater Milwaukee area. Finally, although difficult to quantify economically, the introduction of a controlled volume of waste nitrogen from the oxygen production process will reduce the oxygen content of the air in the dryer loop. Lower oxygen concentrations in the dryer loop equates to a reduced fire risk.

OPTION 1:
OPEN-LOOP INDIRECT AIR HEATING



Rev. No.	Revision Description	Date	Drwn.	Chk'd
0	ISSUE FOR INTERNAL REVIEW	06/22/06	RDK	TJB

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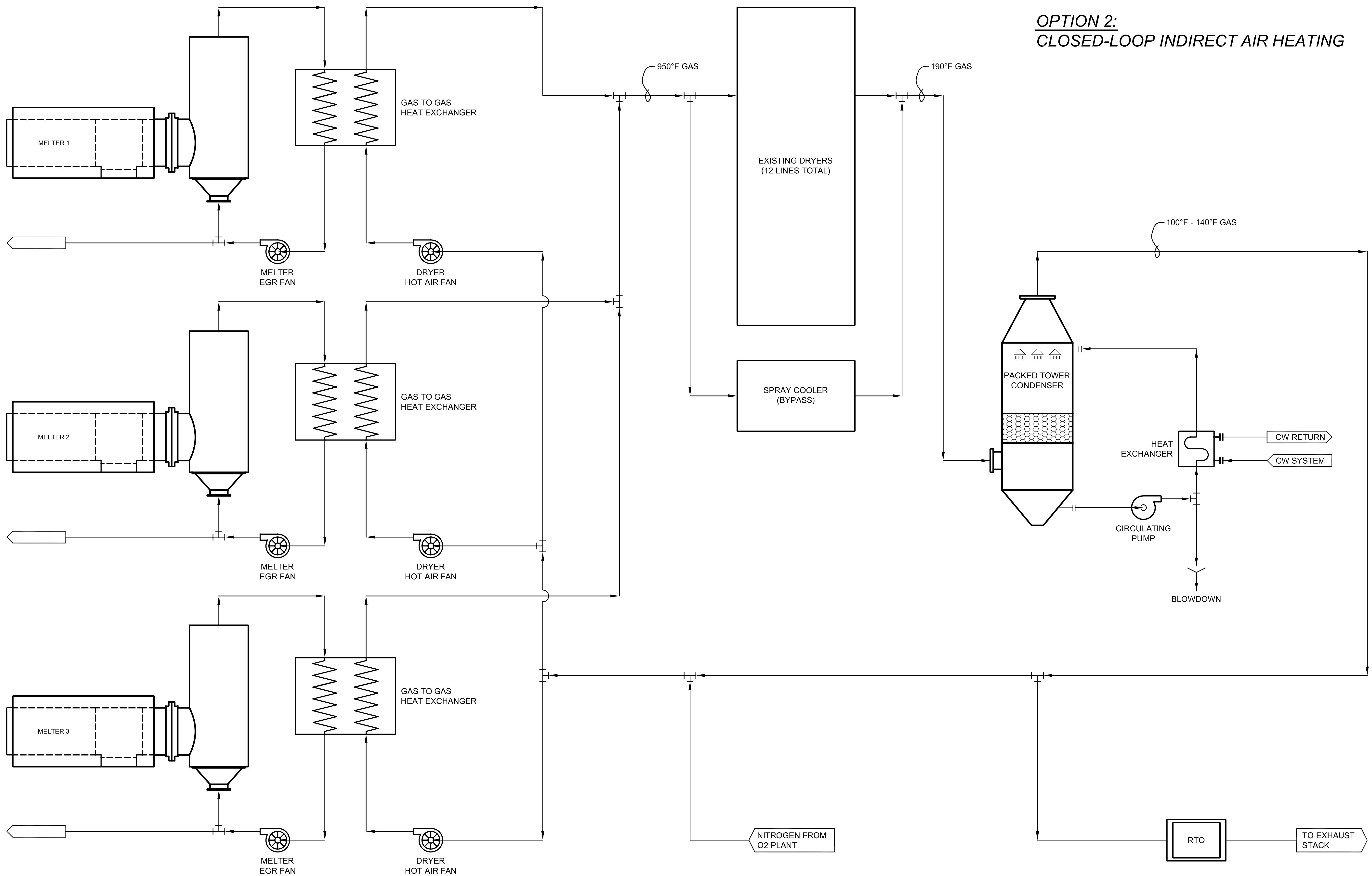
MINERGY
A WISCONSIN ENERGY CORPORATION
in association with
GLASSPACK | LLC

MILWAUKEE METROPOLITAN SEWERAGE DISTRICT
MINERGY MELTER FACILITY
- PRELIMINARY -
MILWAUKEE, WI

FLOW DIAGRAM
OPTION 1: OPEN-LOOP INDIRECT AIR HEATING
MINERGY MELTER FACILITY

Date: JULY 2005
Drawing No.: MSSD-FD01
Sheet 01 of 02 Rev. 0

OPTION 2:
CLOSED-LOOP INDIRECT AIR HEATING



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MILWAUKEE METROPOLITAN SEWERAGE DISTRICT
MINERGY MELTER FACILITY
- PRELIMINARY -
MILWAUKEE, WI

FLOW DIAGRAM
OPTION 2: CLOSED-LOOP INDIRECT AIR HEATING
MINERGY MELTER FACILITY

Date: JULY 2005
Drawing No.: MSSD-FD01
Sheet: 02 OF 02
Rev.: 0

10 GLASS AGGREGATE

Markets for the glass aggregate product are large and diverse. More than 2.5 million tons per year of the material is currently produced, in an industry otherwise known as slag marketing. Virtually all of this material is sold into construction markets such as roofing shingle granules, sand blasting grit, mineral cement, road base aggregate, asphalt aggregate, and chip seal aggregate.

Minergy's philosophy and success in beneficial reuse of glass aggregate has been concentrate marketing efforts on high volume applications. Although these markets typically offer low return value, it is unlikely that entering into these markets will upset existing forces of supply and demand. Minergy's experience has been that obtaining and maintaining a small market share of multiple high volume markets will be more successful at beneficially reusing the glass aggregate than domination of one or two high value markets. For this reason, glass aggregate sales offsets have not been included in the operating cost estimate. Minergy is willing to assist MMSD with marketing glass aggregate produced from Milorganite.

Minergy's Fox Valley Glass Aggregate Plant produces amber grade glass. For the first two years of operation, Minergy sold 100% of its glass production to a Neenah-based construction company. This company builds warehouses which are elevated above grade and require fill material below the floor. Because of the large size of the warehouses that are built today, the building footprints are large, and the construction company desired an aggregate that is inert, compacts well, and is non-cohesive (i.e., drains water). They found the glass aggregate material well suited for the application.

By far the largest market is for application in building roads. To provide a one-foot base for 10 miles of a four-lane road, over 50,000 tons of aggregate could be required. In September 2003, Minergy completed full scale field-testing of Hot Mix Asphalt (HMA) mixtures produced with glass aggregate. The asphalt mix was sampled and tested in general accordance with Wisconsin Department of Transportation (WisDOT) Quality Management Program specifications for quality control testing of HMA mixtures. Because of the grading and angularity of the glass aggregate, it was primarily used as a substitute for washed manufactured sand. These mix designs demonstrated that the glass aggregates included in these asphalt mixes can be successfully used as an aggregate component in WisDOT verified asphalt mix designs as well as commercial asphalt mix designs.

Results from leach tests on glass aggregate produced from processing municipal biosolids (see table below) meet criteria established by the Wisconsin Department of Natural Resources for beneficial reuse of industrial byproducts (NR538). Testing of the glass aggregate produced by Minergy's vitrification technologies has resulted in WDNR granting Minergy Conditional Grant of Solid Waste Exemption for several different feedstocks (Appendix B). Minergy has also received Beneficial Use Determinations (BUD) from Illinois and Michigan regulatory agencies for use of glass aggregate produced from biosolids (Appendix B). Approved uses identified in these BUDs include roadbed construction, blended cements, construction backfill, roofing shingles and asphalt pavement.

Comparison of results from ASTM water leach testing of glass aggregate produced from New York, NY dry granulate with Wisconsin beneficial reuse criteria.

Parameter	NR 538 Category 2 and 3 Criteria (mg/L)	ASTM Water Leach Test Results (mg/L)
Aluminum	15	0.88
Antimony	0.012	<0.042
Arsenic	0.05	<0.0008
Barium	4	0.006
Beryllium	0.004	<0.0020
Cadmium	0.005	<0.00012
Chromium	0.1	0.002
Copper	1.3	0.016
Iron	1.5	0.21
Lead	0.015	0.0065
Manganese	0.25	<0.00018
Mercury	0.002	<0.0031
Nickel	0.2	<0.0009
Selenium	0.1	<0.0011
Silver	0.1	0.0005
Thallium	0.004	<0.0014
Zinc	25	0.0059

11 SPECIAL CONSIDERATIONS

During the development of this proposal several technical issues have come to light that require additional analysis. We present them here as a means to keep them visible during further refinement and evaluation of GLASSPACK® and other options. The issues are:

- Existing dryer capacity limitations
- Granulate formation with high ratio of digested biosolids
- Upgrades to electrical utilities for reliable power supply
- Optimization of oxygen supply.

11.1 EXISTING DRYER CAPACITY

The table below illustrates two important issues. The first issue is the future case sludge throughput of 240 dry tons per day. Presently the Milorganite throughput is about 45,000 dry tons per year (or a daily average of 123 tons per day). The future design case results in the need for high dryer throughputs, energy demand and availability than present operations. One key factor will be the need to maintain higher dry solids content from the belt presses. The preliminary calculations indicate that a minimum dry solids content of 20% is required to maintain a positive energy balance with the GLASSPACK® melter heat output and to prevent the requirement to add additional dryers to the operation. Existing dryer plant capacity is assumed to be 1152 ton/day evaporation at 100% on-line availability of all 12 dryer lines.

Total solids	16%	18%	20%	22%	25%	28%	30%
Daily input (tons per day)	1500	1333	1200	1091	960	857	800
Hot air mass flow required (lbs/hr)	715,158	619,602	543,158	480,612	405,558	346,586	313,825
Number of additional dryer lines	3	1	0	0	0	0	0
Required dryer plant availability	87%	87%	82%	73%	61%	52%	48%
Hot air flow avail from GlassPack (lbs/hr)	562,000	562,000	562,000	562,000	562,000	562,000	733,650
Supplemental gas required (mmBtu/hr)	37	14	0	0	0	0	0
Hot gas vented (lbs/hr)	0	0	18,842	81,388	156,442	215,414	419,825

11.2 HIGH RATIO OF DIGESTED BIOSOLIDS

An operational issue that will need to be addressed with regard to the future operating case involves dryer outlet dust loadings that occur when higher mass ratios of digested primary sludge are blended into the dryer feed. This phenomenon can cause significant operational problems and will need to be addressed.

At this time approximately 5000 dry tons per year of digested primary sludge is disposed of through the Agrilife land spreading program. In the future GLASSPACK® melter case this mass flow will be diverted to the dryers, giving rise to the dust carry over problem.

One possible solution is to install additional equipment in the dryer facility to promote the formation of granulate before the material is feed into the dryer. This strategy has proven to be successful in other drum dryer applications processing high volumes of digested wastewater treatment sludges. The capital costs and impact to energy consumptions have not been included in this evaluation.

11.3 UTILITY UPGRADES

The retirement of the combustion turbine generators raises concerns over electrical reliability. At this time there is insufficient electrical capacity to provide the level of redundancy necessary to assure the facility is not interrupted. The worst case scenario would be a dryer fire that could occur when the dryers stop turning do to a sudden loss of electrical power.

A detailed study involving electrical supply options and costs are beyond the scope of this study. Preliminary discussions with utility electrical engineers indicate that with the proper combination of utility distribution system modifications along with a modification to MMSD's switchyard design (additional transformers) will allow for a "closed transition" switching operation. This type of design has been implemented at other locations, however each situation is unique. While the is little doubt that a highly reliable electrical supply is technically feasible, a signification level of communications and coordination will be required to determine if this is economically feasible.

11.4 OXYGEN SUPPLY OPTIONS

This study has assumed the use of three separate non-cryogenic VSA type oxygen systems to furnish all of the oxygen necessary for the GLASSPACK® melter process. Due to the size of the oxygen system, there may be economic advantages to a single cryogenic air separation system. This type of system can produce argon gas, which has a high value in the industrial gas market. Argon gas makes up approximately 0.93% of ambient air. This type of system is generally owned and operated by an industrial gas company. Revenues realized by the industrial gas company can help offset some of the operating costs of the facility and can be passed on through lower oxygen costs. Benefits of this type of facility include:

- A smaller footprint
- Little or no capital investment to the oxygen user
- All oxygen plant operations and maintenance is assumed by the industrial gas company

It will be necessary to have a long term contract with the industrial gas company in order to facilitate this type of arrangement.

A detailed economic life cycle cost analysis should be conducted for both owner supplied oxygen and third party supplied oxygen should be conducted if the GLASSPACK® technology is selected for detailed study.

APPENDIX A

ELECTRIC RATE CALCULATIONS

WE-Energies Interruptible / General Primary Rates

On Peak	$30.56	/MW-Hr
Off peak	$18.87	/MW-Hr
Demand	$5.14	/kWMo

Avg -on	1000	3066	3,066,000	$93,697
Avg -off	1000	5694	5,694,000	$107,446
Peak	1200	12	14400	$74,016

Annual	8,760,000	$275,159

Total, as all average energy	$31.41

Annual peak to average ratio 1.200

Percent on peak usage 35.00%

WE-Energies Firm / General Primary Rates

On Peak	$37.06	/MW-Hr
Off peak	$22.85	/MW-Hr
Demand	$10.25	/kWMo

Avg -on	1000	3066	3,066,000	$113,626
Avg off	1000	5694	5,694,000	$130,108
Peak	1200	12	14400	$147,600

Annual	8,760,000	$391,334

Total, as all average energy	$44.67

Annual peak to average ratio 1.200

Percent on peak usage 35.00%

APPENDIX B

BENEFICIAL USE DETERMINATIONS

WISCONSIN
DEPT. OF NATURAL RESOURCES

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Tommy G. Thompson, Governor
George E. Meyer, Secretary

PO Box 7921
101 South Webster Street
Madison, Wisconsin 53707-7921
TELEPHONE 608-266-2621
FAX 608-267-3579
TDD 608-267-6897

FILE REF: FID# 471013840
SW/APPR

JUN 04 1996

Mr. Kris McKinney
Environmental Licensing
Minergy Corporation
231 W. Michigan Street
Milwaukee, WI 53201

SUBJECT: Conditional Grant of Exemption for the Minergy Corporation Fox Valley Glass Aggregate Facility

Dear Mr. McKinney:

I am pleased to inform you that the department has completed its review of your request for an exemption from solid waste regulations for the processing of paper mill sludge into glass aggregate at the proposed Minergy facility in Neenah. Based on our review of the information you have submitted, the department hereby grants an exemption from the state's solid waste regulations for the processing facility and the glass aggregate product, subject to the conditions enumerated in the attached approval.

Based on our review, we are satisfied that the proposed facility and the glass aggregate product will not adversely affect the environment so long as you carefully follow the conditions in the attached approval and other applicable department permits. We also believe that the proposed facility will conserve valuable landfill space and virgin energy and mineral resources by reusing significant quantities of paper mill sludge. The department considers this project to be an excellent example of beneficial use of materials that would otherwise require disposal as solid waste.

Your request for exemptions under ss. NR 504.07(8) and 506.08(5), Wis. Adm. Code, for construction on a closed landfill, will be addressed in a separate response. Any construction documentation and annual reports required under that response may be combined with those required under the attached approval, so as to avoid unnecessary duplication of effort on your part.

On April 30, we sent Minergy a draft of this letter and the attached approval to provide you with an opportunity for comment. On May 30, you responded with 3 comments. The first comment, on Condition 5a, concerned the timeframe for documenting that the glass aggregate meets marketing specifications; we have increased the timeframe to 90 days and clarified that the product need not meet specifications for more than one potential market. Your second comment indicated that it will be necessary to stockpile aggregate between construction seasons when it can be more readily marketed; we have changed Condition 8 to focus on unwarranted accumulations of aggregate that might constitute a nuisance. Lastly, you indicated that it would not be possible to quantify the amount of flyash reinjected to the boiler; we have changed Condition 10a to require a general description of flyash reinjection efforts.

If you have any questions regarding this letter or the attached approval, please contact Jon Brand at (414) 492-5867 or Brad Wolbert at (608) 266-2151.

Sincerely,

Lakshmi Sridharan

Lakshmi Sridharan, Ph.D., P.E., Chief
Solid Waste Management Section
Bureau of Solid & Hazardous Waste Management

enc.
cc: Jon Brand - LMD
Dave Misterek - Oshkosh
Gene Mitchell - SW/3

PROJECT SUMMARY

General Information:

Facility Contact: Kris McKinney, Environmental Licensing
Minergy Corporation
231 W. Michigan Street
Milwaukee, WI 53201
Phone: (414) 221-2157

Description of Facility:

The Minergy Corporation Fox Valley Glass Aggregate facility will manufacture a commercial grade glass aggregate material and steam by combusting paper mill sludge in a natural-gas-fired cyclone boiler. The steam will be supplied to a nearby paper mill, P.H. Glatfelter, for use in its papermaking processes. The glass aggregate will be marketed for several uses including abrasives, architectural aggregates, mineral fillers, road base and asphalt aggregates, and chip and slurry seal aggregates.

Facility Location:

The facility will be constructed in the city of Neenah on a city-owned parcel of land along the south shore of Little Lake Butte des Morts. The parcel is adjacent to the P.H. Glatfelter paper company plant and is currently used by Glatfelter for truck trailer parking. The land on which the facility will be built is a closed paper mill sludge landfill.

Generators to be Served:

Sludge feedstock for the Minergy facility will be supplied by the following six paper mills (percent of total in parentheses):

Wisconsin Tissue, Neenah	(50%)
P.H. Glatfelter, Neenah	(30%)
Ponderosa Pulp, Oshkosh	(10%)
Kimberly Clark-Neenah Paper, Neenah	(5%)
Kimberly Clark-Lakeview, Neenah	(3%)
Kimberly Clark-Whiting, Whiting	(2%)

Capacity of the Facility:

The facility will process approximately 350,000 tons of paper mill sludge per year to produce 80,000 tons of glass aggregate annually, and can be operated 24 hours per day for approximately 350 days per year.

Construction and Operation of the Facility:

The Minergy facility will utilize a cyclone boiler capable of burning up to 50 percent paper mill sludge along with its base fuel of natural gas. The sludge will be trucked in from the source paper mills, offloaded for temporary storage in silos, partially dried using process heat, and fed to the boiler. Boiler temperatures of up to 3000 degrees Farenheit will burn the organic fraction of the sludge and will cause the sludge's inorganic contents to melt.

When cooled, the molten liquid will form a glassy solid material that will be stockpiled and sold as aggregate.

Gases generated from the boiler will be passed through air emission control equipment, resulting in the accumulation of a flyash. Part or all of this flyash will be reinjected into the boiler for conversion to glass aggregate.

The facility will be designed to produce steam using the heat from the cyclone boiler. P.H. Glatfelter Company will purchase this steam for use in its papermaking processes, replacing steam formerly produced in its own boilers.

BEFORE THE
STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

CONDITIONAL GRANT OF EXEMPTION
FOR THE
MINERGY CORPORATION
FOX VALLEY GLASS AGGREGATE FACILITY
NEENAH, WISCONSIN

FINDINGS OF FACT

The department finds that:

1. On August 28, 1995, Minergy Corporation ("Minergy") submitted a request for an exemption from solid waste regulations governing the processing of paper mill sludge into glass aggregate.

2. The glass aggregate production facility is proposed to be located in the SE 1/4, Section 21, T20N, R17E, City of Neenah, Winnebago County.

3. The department received the $500 plan review fee on September 28, 1995.

4. On September 27, 1995, the department's district high-volume industrial waste specialist performed an initial site inspection at the proposed facility location.

5. The department considered the following documents in reviewing the exemption request:

    a. A report prepared by STS Consultants Ltd., dated June 2, 1995, entitled "Summary of Existing Conditions at the Arrow Head Park Site, Neenah, Wisconsin".

    b. A letter with attachments from Minergy to Kevin Kessler of the department's Bureau of Solid & Hazardous Waste Management, dated August 1, 1995, providing information on the rationale for the plant.

    c. The August 28, 1995 exemption request letter and accompanying "Environmental Report" submitted by Minergy.

    d. Results of physical and chemical testing performed on glass aggregate, submitted with the exemption request as Attachment 2, pages 1-4.

    e. A letter from Minergy to Marjorie Devereaux of the department's Bureau of Water Regulation and Zoning, dated August 29, 1995, responding to a list of questions concerning the proposed facility.

    f. A letter from Minergy to Brad Wolbert of the department's Bureau of Solid & Hazardous Waste Management, dated September 25, 1995, providing additional information requested in a department letter to Minergy dated September 11, 1995.

g. A report prepared by Minergy dated December, 1995, entitled "Solid Waste Exemption Request," containing additional information requested by the department in its September 11, 1995 letter.

h. A December, 1995 stipulation and settlement agreement between the department, P.H. Glatfelter Corporation, Minergy Corporation and the City of Neenah relating to the use of Arrow Head Park in Neenah as a location for the Minergy facility.

i. An initial site inspection letter from Jon Brand of the department's Lake Michigan District, dated January 19, 1996.

j. An environmental analysis and decision issued by the department on April 22, 1996.

k. A Waste Reduction Grant Report, No. 95-29, dated April 1996, describing the results of a market analysis performed for glass aggregate, submitted to the department by Minergy.

6. Additional facts relevant to the department's review of the exemption request include the following:

   a. The proposed project would divert from landfills a substantial proportion of the waste generated in Winnebago County, for beneficial use and energy recovery.

   b. The project was developed in response to an initiative by Winnebago County to reduce the amount of paper mill sludge being disposed of in the county landfill, and was selected by the county among 11 other projects as the preferred alternative.

7. On April 30, 1996, the department sent Minergy a draft grant of exemption for comment. The department received comments from Minergy on May 30, 1996.

8. The conditions set forth below are needed to ensure that the Minergy facility and the glass aggregate product will not cause environmental pollution, that the environmental impacts of the proposed facility are minimized and that the facility is operated in a nuisance-free manner.

CONCLUSIONS OF LAW

1. The department has the authority under s. 144.44(7)(f), Stats. and s. NR 500.08(5), Wis. Adm. Code, to grant an exemption from ss. 144.43 to 144.47, Stats., for the purpose of allowing the recycling of any

high-volume industrial waste, if the exemption would not inhibit compliance with the applicable provisions of chs. 30, 31, 144, 147, 160, 162, and ss. 1.11, 23.40, 59.974, 61.351, 61.354, 62.231, 62.234 and 87.30, Stats.

2. The department has the authority to grant an exemption with conditions if the conditions are needed to ensure compliance with chs. 30, 31, 144, 147, 160, 162, and ss. 1.11, 23.40, 59.974, 61.351, 61.354, 62.231, 62.234 and 87.30, Stats.

3. The conditions set forth below are needed to ensure compliance with the applicable provisions of chs. 30, 31, 144, 147, 160, 162, and ss. 1.11, 23.40, 59.974, 61.351, 61.354, 62.231, 62.234 and 87.30, Stats.

4. In accordance with the foregoing, the department has the authority under s. 144.44(7), Stats. and NR 500.08(5), Wis. Adm. Code to grant the following exemption.

CONDITIONAL GRANT OF EXEMPTION

The department hereby exempts the Minergy Corporation's Fox Valley Glass Aggregate facility from the applicable provisions of ss. 144.43 to 144.47, Stats., for the beneficial use of paper mill sludge in the manufacture of glass aggregate and steam, subject to the following conditions:

General

1. This approval allows for the installation of a glass aggregate/steam manufacturing facility with an approved production capacity of up to 90,000 tons of aggregate per year. Written department approval is required prior to any increase in capacity. This approval applies only to the facility proposed in the August, 1995 Environmental Report. This approval does not replace other department approvals, including a conditional grant of exemption to allow construction on a closed landfill and an air pollution discharge permit, which also apply to this proposed facility.

2. This approval does not relieve Minergy from compliance with any other local, state or federal regulations (e.g., noise ordinances, safety standards for workers, building code requirements).

Construction

3. Minergy shall complete all items of construction as described in the August, 1995 Environmental Report, the December, 1995 Solid Waste Exemption Request, and other relevant submittals by Minergy to the department. Any significant design changes must be approved in writing by the department prior to their implementation.

4. Minergy shall notify the department's district high-volume industrial waste specialist a minimum of one week prior to the initial shakedown of the facility, to allow department representatives to inspect the facility and observe its operation. The department reserves the right to inspect additional construction events.

5. Within 30 days of the start of the shakedown period, Minergy shall provide test results to the department demonstrating that:

   a. The glass aggregate product does not pose a risk of groundwater contamination or other environmental pollution. Bulk composition, TCLP and ASTM water leach tests shall be performed on at least two independent representative samples of glass aggregate obtained from the facility during the shakedown period.

   b. The flyash is acceptable for disposal at a municipal solid waste landfill. TCLP tests shall be performed on at least two independent representative samples of flyash obtained from the facility during the shakedown period.

   The parameters and detection limits for the bulk composition and ASTM water leach tests shall be the same as indicated in "Attachment 2" of the exemption request documents sent by Minergy to the department on August 28, 1995.

6. Within 90 days after the completion of construction, Minergy shall submit to the department a construction documentation report that meets the general submittal requirements of s. NR 500.05, Wis. Adm. Code. At a minimum, the report shall include the following information:

   a. A narrative discussing all major aspects of facility construction, any unanticipated field conditions encountered, results of all testing performed, and any design changes that were made during construction.

   b. A plan drawing of the final layout after construction and the flow of all materials from start to finish.

   c. Cross-sections of the unit showing location of major components and major design features.

   d. Appropriate construction details.

   e. Test results demonstrating that the glass aggregate product consistently meets generally accepted quality assurance standards for the roofing shingle granule, abrasives, or asphalt paving markets. These tests shall be performed on at least five independent representative samples obtained from the facility during the shakedown period.

f. A series of properly labeled 35 millimeter color prints showing all major components of the processing plant.

Operation

7. Minergy shall ensure that hauling of papermill sludge to or from the Minergy facility is performed only by operators possessing a department license for collection and transportation of solid waste.

8. Minergy shall properly dispose of all product it is unable to market. The department may establish a time limit for disposal of nuisance quantities of stockpiled material.

9. Minergy shall develop a contingency plan for handling sludge on site due to a sudden shutdown of the processing facility, and shall develop a written agreement with a landfill which will accept the onsite and bypassed sludge during a shutdown. Minergy shall provide a copy of the contingency plan and the landfill agreement to the department prior to initial operation of the facility.

10. Each year, Minergy shall submit an annual report to the department by March 31 for the preceding calendar year. The report shall include the following information:

a. A general overview of operations, including the amount of papermill sludge consumed in production; the amount of aggregate produced; the distribution of product by type of use; the average and maximum amount of aggregate in on- and off-site storage during the year and the location of any off-site storage; the total amount of flyash produced and a summary of ash reinjection efforts; sludge bypassed to disposal due to facility downtime or insufficient capacity; and the amounts of flyash, off-spec sludge and off-spec aggregate disposed of as waste.

b. A discussion of any operational problems that were encountered and any significant plant or operational modifications that were made.

c. Identification of any proposed modifications or additions to the facility affecting the capacity of the facility, the quantity or quality of its products or waste streams, or the manner in which papermill sludges are handled.

d. Results of annual bulk analysis and ASTM water leach tests performed on representative samples of glass aggregate and flyash. The parameters for the ASTM water leach tests shall be the same as indicated in "Attachment 2, Page 1" of the exemption request package sent by Minergy to the department on August 28, 1995. In addition, if a process or equipment change having the potential to alter the characteristics of the facility's products or waste streams has occurred, a TCLP test performed on a representative sample of the product or waste stream(s) affected by the change.

The department may require the submittal of additional information and may modify this exemption at any time, if in the department's opinion modifications are necessary. Unless specifically noted, the conditions of this exemption do not supersede or replace any previous conditions of approval for this facility.

NOTICE OF APPEAL RIGHTS

If you believe that you have the right to challenge this decision, you should know that Wisconsin statutes and administrative rules establish time periods within which requests to review department decisions must be filed.

For judicial review of a decision pursuant to section 227.52 and 227.53, Stats., you have 30 days after the decision is mailed or otherwise served by the department to file your petition with the appropriate circuit court and serve the petition on the department. Such a petition for judicial review shall name the Department of Natural Resources as the respondent.

This notice is provided pursuant to section 227.48(2), Stats.

Dated JUN 04 1996

DEPARTMENT OF NATURAL RESOURCES
For the Secretary

Lakshmi Sridharan

Lakshmi Sridharan, Ph.D., P.E., Chief
Solid Waste Management Section
Bureau of Solid & Hazardous Waste Management

Brad Wolbert, P.G., Hydrogeologist
Solid Waste Management Section
Bureau of Solid & Hazardous Waste Management

Section 5 - Table 3
Minergy - Fox Valley Glass Aggregate Plant
Glass Aggregate Product
ASTM D 3987 Shake Extraction Test Results

Parameter	Units	DNR Detection Limit	Actual Detection Limit	3/9/98 FV GAP-1	3/11/98 FV GAP-2	3/16/98 FV GAP-3	Groundwater Quality Stds: Enforcement Standard	Groundwater Quality Stds: Preventive Action Limit	GAP Value Less Than: ES ?	GAP Value Less Than: PAL ?
Aluminum	mg/l	0.1	0.011	3.8	3.3	3.9	-	-	-	-
Antimony	mg/l	0.005	0.011	ND	ND	ND	-	-	-	-
Arsenic	mg/l	0.005	0.0012	ND	ND	ND	-	-	-	-
Barium	mg/l	0.04	0.0009	ND	0.004	0.032	2	0.4	YES	YES
Beryllium	mg/l	0.001	0.00023	ND	ND	ND	-	-	-	-
Cadmium	mg/l	0.0002	0.0001	ND	ND	ND	0.005	0.0005	YES	YES
Calcium	mg/l	1.0	0.012	25	14	17	-	-	-	-
Chloride	mg/l	1.0	0.0047	0.053	0.44	1.1	250	125	YES	YES
Chromium	mg/l	0.003	0.0005	0.0026	0.002	0.0012	0.1	0.01	YES	YES
Copper	mg/l	0.003	0.0012	0.0016	0.0023	0.0029	1.3	0.13	YES	YES
Fluoride	mg/l	0.02	0.0028	ND	0.027	0.019	4	0.8	YES	YES
Iron	mg/l	0.1	0.0007	ND	0.024	0.02	0.3	0.15	YES	YES
Lead	mg/l	0.003	0.001	ND	ND	ND	0.015	0.0015	YES	YES
Magnesium	mg/l	1.0	0.0084	0.39	0.39	0.45	-	-	-	-
Manganese	mg/l	0.01	0.0015	ND	ND	ND	0.05	0.025	YES	YES
Mercury	mg/l	0.0002	0.00018	ND	ND	ND	0.002	0.0002	YES	YES
Nickel	mg/l	0.01	0.0044	ND	ND	ND	-	-	-	-
Nitrite & Nitrate	mg/l	-	0.01	ND	0.29	ND	10	2	YES	YES
Phosphorus	mg/l	0.02	0.0039	0.08	0.19	0.26	-	-	-	-
Potassium	mg/l	1.0	0.11	ND	ND	ND	-	-	-	-
Selenium	mg/l	0.001	0.0007	ND	ND	0.0012	0.05	0.01	YES	YES
Silicon	mg/l	10.0	0.0043	7	2.9	3.1	-	-	-	-
Silver	mg/l	0.001	0.00014	ND	ND	ND	-	-	-	-
Sodium	mg/l	1.0	0.022	0.088	1.6	1.3	-	-	-	-
Strontium	mg/l	1.0	0.0022	0.0044	0.0036	0.0065	-	-	-	-
Thallium	mg/l	0.003	0.0012	ND	ND	ND	0.005	0.0025	YES	YES
Zinc	mg/l	0.02	0.0013	ND	ND	ND	5	2.5	YES	YES
pH	N/A	0.1	0.1	10.3	9.3	9.7	-	-	-	-
Conductivity	umhos/cm	10	0.01	167	71	79	-	-	-	-
TDS	mg/l	5	36	58	58	54	-	-	-	-
Sulfate	mg/l	1.0	0.017	0.031	1.2	1.1	250	125	YES	YES
TOC	mg/l	1.0	0.24	0.54	2.9	4.6	-	-	-	-
Total Hardness	mg/l	1.0	1	64	37	44	-	-	-	-
Total Alkalinity	mg/l	1.0	7	79	57	58	-	-	-	-

WISCONSIN
DEPT. OF NATURAL RESOURCES

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Jim Doyle, Governor
Scott Hassett, Secretary
Ronald W. Kazmierczak, Regional Director

Northeast Region Headquarters
1125 N. Military Ave., P.O. Box 10448
Green Bay, Wisconsin 54307-0448
Telephone 920-492-5800
FAX 920-492-5913
TTY 920-492-5912

April 4, 2003

Mr. Terrence W. Carroll
Regional Manager
Minergy
1512 S. Commercial Street
P.O. Box 375
Neenah, WI 54957

Subject: Conditional Grant of Solid Waste Exemption

Dear Mr. Carroll:

I am pleased to inform you that the Department has approved your request for a conditional grant of exemption to exempt river sediments that have been treated using Minergy's oxy-fueled melter technology. Enclosed you will find the official approval document.

Please be advised that this conditional grant of exemption does not relieve you of the obligation to comply with all other applicable federal, state, and local regulations.

If you have any questions or concerns, please feel free to contact me at 920-492-5870.

Sincerely,

Len Polczinski

Len Polczinski
Waste Program Team Manager

Encl.

BEFORE THE
STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

CONDITIONAL GRANT OF SOLID WASTE EXEMPTION
FOR THE
Minergy Neenah Corporation

FINDINGS OF FACT

The Department finds that:

1. Minergy Neenah Corporation (Minergy) is proposing to beneficially use river sediments as raw materials for construction activities or products. These river sediments will be decontaminated using glass furnace melter technology. In 2001, Minergy, under contract with the Department on Natural Resources (WDNR) and under the supervision of the U.S. EPA's Superfund Innovative Technology Evaluation group, successfully demonstrated that sediment can be melted in an oxy-fueled melter with high destruction of contaminants.

2. Minergy, as of April 3, 2003, has not located nor built a full scale facility for processing sediments.

3. Minergy has submitted a request for an exemption from solid waste regulatory requirements in s. 289, statutes, dated November 15, 2002 and received by the Department on November 18, 2002.

4. On February 28, 2003 Minergy submitted a letter that responded to Department concerns discussed during a February 4, 2003 meeting. The purpose of the meeting was to discuss the November 15, 2002 submittal.

5. Additional documents considered in the review of the exemption request includes the following:

   a. Minergy Corporation Glass Furnace Technology Evaluation Draft Report, prepared for the U.S. EPA Office of Research & Development National Risk Management Research Laboratory, Cincinnati, Ohio. Prepared by Tetra Tech Em, Inc. Brookfield, WI February 2003.

   b. Permitting Review For Sediment Melter Facility, February 2003 Report. Prepared for the the WDNR by Minergy.

6. The Department has considered the environmental impacts of the proposal and has complied with the requirements of ch. NR 150 and s. 1.11. Stats., and, consistent with social, economic, and other essential considerations, the Department has adopted all practical means to avoid or minimize environmental harm.

7. If the conditions set forth below are complied with, the beneficial use of sediments processed in an oxy-fueled melter facility will not result in environmental pollution as defined in s. 289.01 (8), Stats.

8. The Department has conducted a continuing review of the potential hazard to public health and the environment of solid waste disposal facilities in general as well as this specific proposal. Based upon this review, the Department finds that regulation under s. 289, Stats. is not warranted in light of the low potential hazard to public health or the environment.

9. The Department has waived the $500 plan review fee because the proposed processing facility has a primary purpose of converting solid waste into useable materials or products.

CONCLUSIONS OF LAW

1. Based upon the foregoing, the Department has authority under s. 289.43 (8), Stats., to grant the conditional exemption set forth below.

2. The conditions set forth below are needed to ensure that the beneficial use of processed river sediments, as proposed, and in accordance with the conditions of this approval, will not result in environmental pollution as defined in s. 289.01 (8), Stats.

CONDITIONAL GRANT OF EXEMPTION

The Department hereby exempts river sediments that have been treated, using Minergy's oxy-fueled melter technology, from solid waste regulations subject to the following conditions:

1. Minergy is subject to all applicable state, federal, and local requirements for the siting,construction, licensing, operations, and maintenance of a full scale oxy-fueled melter facility.

2. Minergy, following the "shake-down" period and at the time full scale operation of the sediment melter project begins, shall test/characterize the processed sediment for the same parameters as completed in the demonstration project and listed in Minergy's November 15,2002 letter to the Department. These test results shall be submitted to the Department for review and comment prior to the processed sediments being beneficially used. The Department reserves the right to require annual or more frequent characterization of the processed sediment.

3. Use of Minergy's processed sediments is limited to commercial construction activities such as general fill, use in cement/concrete, road building, asphalt pavement, mine reclamation, or in the production of such products like floor tiles.

4. Minergy shall maintain records of where the processed river sediments have been used. These records shall be maintained and be accessible to Department staff upon request, for 5 years after the use of the material.

The Department retains the jurisdiction to either require the submittal of additional information or to modify this approval at any time if, in the Department's opinion, conditions warrant further modifications. Unless specifically noted, the conditions of this approval do not supersede or replace any previous conditions of approval for this facility.

NOTICE OF APPEAL RIGHTS

If you believe that you have a right to challenge this decision, you should know that Wisconsin Statutes and Administrative Rules establish time periods within which requests to review Department decisions must be filed.

For judicial review of a decision pursuant to ss. 227.52 and 227.53, Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to file your petition with the appropriate circuit court and serve the petition on the Department. Such a petition for judicial review shall name the Department of Natural Resources as the respondent.

Dated: 4/7/03

DEPARTMENT OF NATURAL RESOURCES
For the Secretary

Waste Management Supervisor
DNR-NER

APPENDIX C

MINERGY REFERENCE PLANTS

Fox Valley Glass Aggregate Plant, Neenah, Wis., U.S.A.

Minergy Corp. built and operates the world's first **vitrification** facility to recycle sludge from wastewater treatment systems into an environmentally benign glass aggregate product. Minergy's vitrification technology has solved a significant sludge disposal problem for several local paper mills while producing two high-demand products, steam and glass aggregate, and at the same time improving local air quality.

The Fox Valley Glass Aggregate Plant receives and processes sludge from several area paper mills allowing them to meet their long-term sludge disposal and environmental goals.

Energy from the process is recovered and converted into steam that is sold to local paper mills, used to generate electricity and consumed internally by the process.

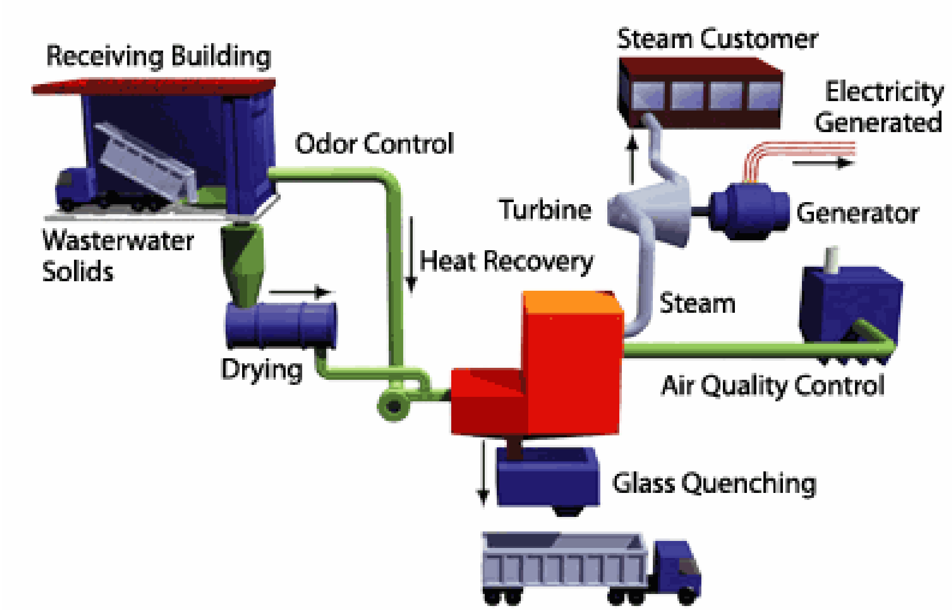
Minergy's Fox Valley Glass Aggregate Plant

In addition to manufacturing a marketable product, the glass aggregate technology provides a complete solution to the disposal problem of sludge. Because the process incorporates very high combustion temperatures with excellent fuel and air mixing, high destruction efficiencies of organic compounds are achieved, and trace metals contained in the sludge are permanently stabilized in the glass aggregate matrix.

Markets for the glass aggregate that is produced from the process are large and include uses in sandblasting grit, roofing shingles, asphalt and chip seal aggregate, and construction.

The facility was developed in part in response to a request by the Winnebago County Solid Waste Management Board. From a field of several dozen firms, the Board endorsed Minergy's glass aggregate technology and chose Minergy's vitrification technology as their preferred alternative to landfilling paper mill sludge.

By recycling the sludge into a usable product instead of placing it in a landfill, the Fox Valley Glass Aggregate Plant preserves 10 acres of green space per year. The plant's steam production has allowed the adjacent paper mill to curtail operation of older less efficient boilers, thus reducing their air emissions. In addition, local truck traffic and the resulting emissions have been reduced by more than 450,000 miles per year.



Fox Valley Glass Aggregate Plant material flow diagram

PLANT SPECIFICATIONS

Owner: Minergy Corp.
Commercial Operation: May 1998
On-line availability: > 93%

Feed
Paper mill sludge
Capacity
1300 tons/day (as received)
500 dry tons/day
On-site storage: 1000 wet tons and 500 dry tons

Drying Technology
Technology: Rotary steam tube (2)
Evaporative capacity: 27 tons/hour

Vitrification Technology
Open air fired
2 Babcock & Wilcox cyclone combustors
Operating temperature: 2700 – 2900^{o} F
Heat input: 400 mmBtu/hr
Co-fire fuel: Coal

Thermal Energy Recovery
Waste heat boiler
Output: 300,000 pounds/hour
Pressure: 350 psig
Temperature: 580º F
Steam Usage: 40% sold to local paper mills
15% to dryer operation
25% to generating turbine

Emission Control
Wet scrubber
Selective Non-Catalytic Reduction (SNCR)
Bag filter house

Outputs
300,000 pounds/hour steam
6,500 kW
200 ton/day glass aggregate

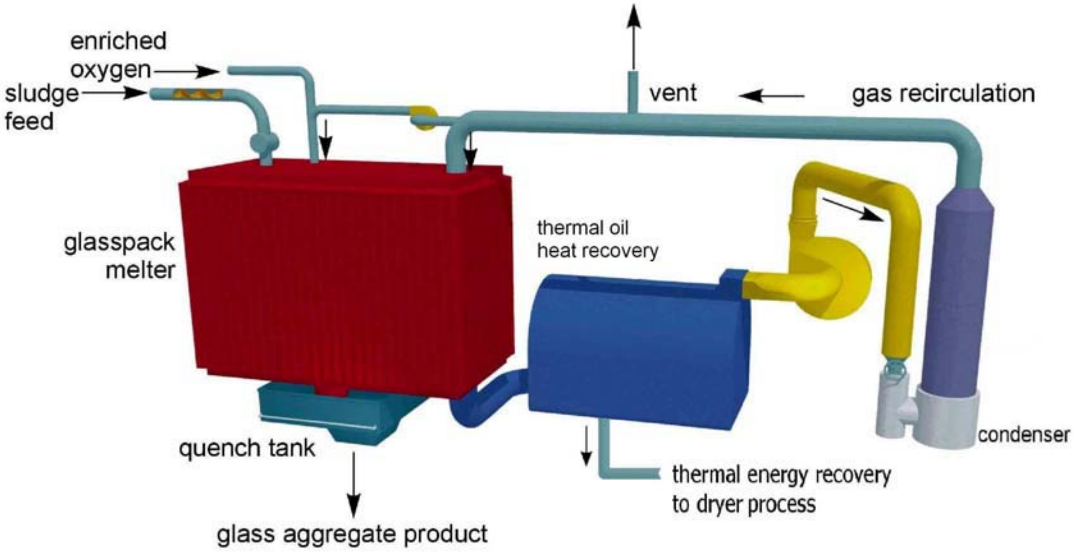
Biosolids Reclamation Facility
North Shore Sanitary District, Zion, Ill., U.S.A.

North Shore Sanitary District (NSSD) selected Minergy's GLASSPACK® system as the technology of choice for sustainable biosolids management at their new Biosolids Reclamation Facility (under construction) located in Zion, Ill., U.S.A. NSSD's Biosolids Reclamation Facility incorporates the Minergy's GLASSPACK® vitrification technology to recover and use the energy contained in biosolids to create an inert beneficially reusable glass aggregate product.

The Sludge Processing Facility integrates both the GLASSPACK® closed-loop oxygen enhanced combustion process and thermal energy recovery into processing biosolids from the District's three wastewater treatment plants. Heat energy, required by a fluidized bed dryer to produce dry granulate, is recovered from the GLASSPACK® flue gas using a thermal oil heat transfer system.

From: Water Matters: The Newsletter of the North Shore Sanitary District (Summer 2005)

"…The many economic advantages are bolstered by the environmental benefits of the facility. The cutting edge biosolids technology will take the 52,600 tons of solids the District disposes of each year and, through a drying and melting process, turns it into a marketable product. The new facility removes the need to landfill solids produced through the wastewater treatment process, thereby removing the risk of leaking landfill polluting our soil and water supply. There will also be no new landfills to occupy precious open land. Preserving open land has been at the forefront of North Shore community issues and the District shares the community's desire to maintain and protect this valuable resource."



NSSD GLASSPACK® Closed-Loop System Configuration

PLANT SPECIFICATIONS

Owner: North Shore Sanitary District
Commercial Operation: 2006

Feed
Material: Municipal biosolids
Capacity: 200 wet tons/day (as received)
Biosolids feed: 17 to 20% solids
On-site storage: 800 wet tons and 150 dry tons

Drying Technology
Technology: Fluid bed
Evaporative capacity: 6.4 tons/hour
Granulate production: 35 dry tons/day
Granulate solids content: 90%

Vitrification Technology
GLASSPACK® GP-35 Closed-Loop Oxygen Enhanced System
Operating temperature: 2200 – 2600° F
Heat input: 26 mmBtu/hr

Co-fire fuel: natural gas (start-up only)

Oxygen Supply
On-site Vacuum Pressure Swing Adsorption (VPSA) production
Purity: 90%
Capacity: 66.6 tons/day

Thermal Energy Recovery
Thermal oil
Output: 16.5 mmBut/hr
Temperature: 482º F

GLASSPACK® Emission Control
Condenser
Bag filter

Outputs
7.5 ton/day glass aggregate

Vitrification Technology Center, Winneconne, Wis., U.S.A.

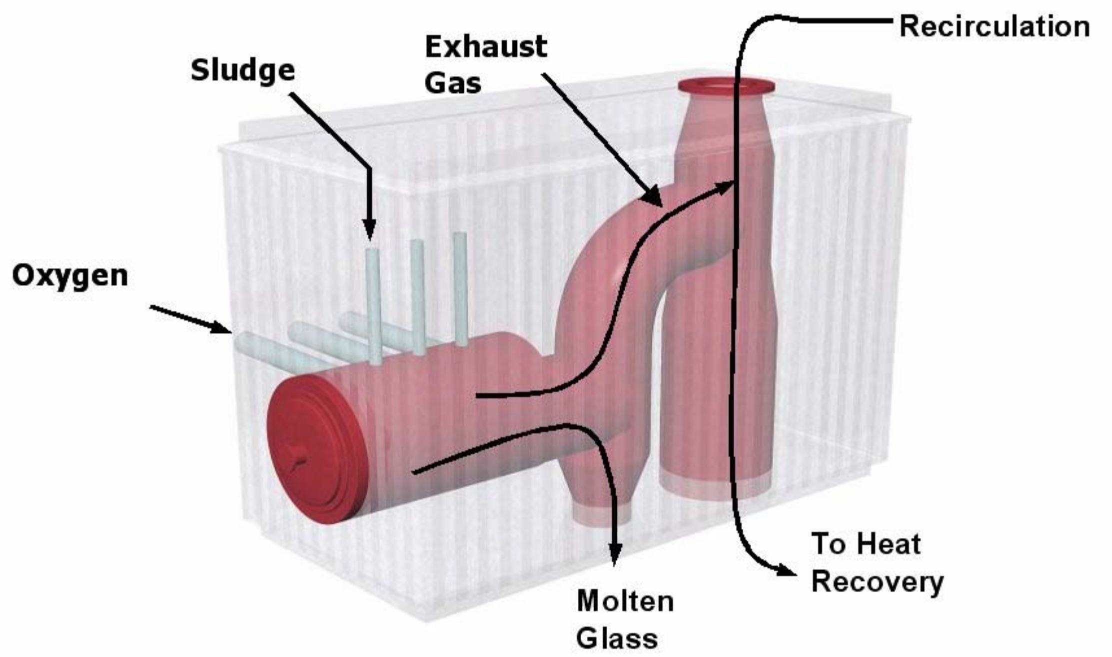
Minergy's Vitrification Technology Center (VTC) houses several Minergy vitrification technologies. The VTC is home to a commercial-scale GLASSPACK® unit designed to fully demonstrate Minergy's smaller-scale vitrification technology. The unit was built to provide a dedicated facility for conducting technology development, product testing, making commercial guarantees for various technology applications and materials, while demonstrating to prospective customers how their material responds to vitrification.

GLASSPACK® Demonstration Unit

The GLASSPACK® Demonstration Unit can be configured to accept a wide variety of material and process conditions. The Unit can simulate the Glass Furnace Technology without the expense of constructing a custom unit for a limited duration test of a particular material. The Unit can be configured to operate in both an open air-fired mode or in Minergy's patented closed-loop oxygen enhanced combustion mode.

The GlassPack® Demonstration Unit has been in service since March 2000, and is available for testing and customer demonstrations. More than 36 trial melts have been successfully completed including vitrification of:

- Biosolids
  - Milwaukee Metropolitan Sewerage District (MMSD) Milorganite
  - New York, N.Y.
  - Pensacola, Fla.
  - Ocean County, N.J.
  - Mt. Holly, N.J.
  - Detroit, Mich.
- Manufactured Gas Plant (MGP) remediation waste
- Paper mill sludges
- Contaminated river sediments
- Spent refractory castings
- Renewable biomass fuels
  - Dry distillers grain (ethanol industry)
  - Corn Stover



Internal view of GlassPack® Demonstration Unit

PLANT SPECIFICATIONS

Owner: Minergy Corp

Sludge type: Variable (testing purposes)

Melter: GlassPack® GP12

Heat input: 9 mm Btu/hour

GlassPack® System configuration: Can be run in both closed-loop oxygen enhanced or open air fired modes

Sludge capacity: 1 dry ton per hour (equivalent to 22,000 wet tons/year paper sludge or 45,000 wet tons/year municipal biosolids)

Thermal energy recovery system: None

Oxygen technology: On-site cryogenic liquid storage

Footprint: 4,000 square feet

Operating status: Operational March 2000

VITRIFICATION OF MILORGANITE

GLASSPACK® - HYBRID OPTION

BUDGETARY PROPOSAL

PREPARED FOR:

MILWAUKEE METROPOLITAN SEWAGE DISTRICT

PREPARED BY:

MINERGY®
GLASSPACK | LLC

November 14, 2006

TABLE OF CONTENTS

1 INTRODUCTION

Wastewater treatment systems, both industrial and municipal, produce large quantities of sludges and biosolids that require disposal. Disposal often poses significant environmental liabilities, logistical problems, and economic burdens. Minergy Corp. has developed and implemented several technologies for the recycling of such high volume wastes such as sludge, biosolids, ash, and foundry sand.

Vitrification is one technology that Minergy has developed and implemented on a commercial scale to recycle high volume wastes. Vitrification technologies perform energy and mineral recovery from the waste material, converting it into construction material and industrial feed stocks which are inert, marketable products. With a continuously operating processing system installed at the waste source, these technologies reduce handling, eliminate downstream liabilities, and reduce disposal costs. Vitrification provides a sustainable solution to recycle biosolids and establish a true low-cost, long term, beneficial re-use.

GLASSPACK® is Minergy's second generation vitrification technology and is unmatched by other biosolids disposal technologies. GLASSPACK® is flexible, compact, and efficient, and when configured in Minergy's patented closed-loop oxygen enhanced combustion process, offers advances in thermal efficiency and emissions reductions that until recently seemed impossible.

This budgetary proposal describes the process and equipment necessary to convert off-spec Milorganite into a beneficially reusable glass aggregate. The document delineates the most advanced solid waste thermal oxidation technology featuring Minergy's state-of-the-art GLASSPACK® vitrification technology.

2 BASIS OF DESIGN

The following Basis of Design for MMSD is based on information previously provided to Minergy via email and therefore is preliminary and subject to revision as additional information is made available. **MINERGY HAS GENERATED A LIMITED DATA SET RELATIVE TO THE EXPECTED FEEDSTOCK CHARACTERISTICS FOR THIS SYSTEM. THEREFORE, THE LISTED DATA SHOULD BE CONSIDERED TARGET DESIGN DATA BASED ON ASSUMED FEEDSTOCK CHARACTERISTICS.**

BASIS OF DESIGN	
Granulate input	100 dry tons per day
Granulate moisture	8 %
Granulate Gross Calorific Value (GCV)	6500 Btu/lb
Granulate ash content	40 %
Granulate size furnished to GlassPack	100% passing # 4 sieve and 90% passing # 8 sieve
High temperature thermal viscosity (T_{250}) of inorganic ash fraction	< 2300 ° F
Operating time	8000 hr/yr
PROCESS SPECIFICATIONS	
Process technology	Minergy GLASSPACK® closed-loop oxygen enhanced combustion
Number of GLASSPACK® process lines	1
Thermal energy available	36.8 mmBtu/hr
Thermal energy recovery technology	High temperature melter exhaust to air shell & tube heat exchanger
Air temperature to dryer operation	950 ° F

In addition to the information directly supplied to Minergy, this proposal reflects a significant amount of direct experience Minergy has gained vitrifying biosolids. Minergy routinely uses Milorganite as a standardized feedstock during product research and testing conducted in the commercial-scale GLASSPACK® unit located at our Vitrification Technology Center.

3 PROCESS DESCRIPTION

Biosolids play critical beneficial roles in Minergy's GLASSPACK® vitrification process. First, the biosolids' organic fraction contains a significant amount of thermal energy. The organics are essentially biomass fuel, renewable through the cycle of water use and wastewater treatment. Secondly, the mineral content (ash, clays, and mineral fillers) in the biosolids form the basis of a glass aggregate product that is beneficially reused in construction and industrial applications, eliminating the need for disposal.

GLASSPACK's unique process is unmatched by other biosolids disposal technologies. The GLASSPACK® system is a combination of two innovative concepts. The first innovation is Minergy's patented closed-loop oxygen enhanced combustion process that uses enriched oxygen to improve melter temperatures, provide complete destruction of organic compounds, and greatly reduce the amount of exhaust gases. The high process temperatures completely melt the inorganic fraction providing the added benefit of melting biosolids without the need for costly and careful flux addition.

The second innovation is the GLASSPACK® modular melter concept. The melter is a shop-fabricated unit that can be delivered to the construction site on a single truck shipment. The entire process can be highly modularized to minimize field installation costs and construction schedule.

3.1 PROCESS DESCRIPTION - GLASSPACK®

Minergy Drawing Nos. 100-1100-PD01 and 100-1100-PD10, provided at the end of this section, present an overall general Process Flow Diagram.

The GLASSPACK® process starts with dry granulate from the dryer operation delivered to the granulate surge bin. Volumetric feeders discharge granulate from the surge bin to roller mills that reduce the granulate size to the specified range for proper melter operation. The crushed granulate is then charged into the melter through rotary airlocks.

The GLASSPACK® melter features a 3-zone operation, comprised of separate but interconnected chambers (Figure 1):

- Zone 1: Melting Zone
- Zone 2: Phase Separation Zone
- Zone 3: Gas Cooling Zone

Zone 1: Melting Zone. Feedstock that has been pre-dried to approximately 92% solids or more is injected along with synthetic air (a more detailed description of synthetic air is set forth below) into the Zone 1 chamber. In this zone, the organic component of the sludge is completely combusted, liberating a significant amount of heat energy and

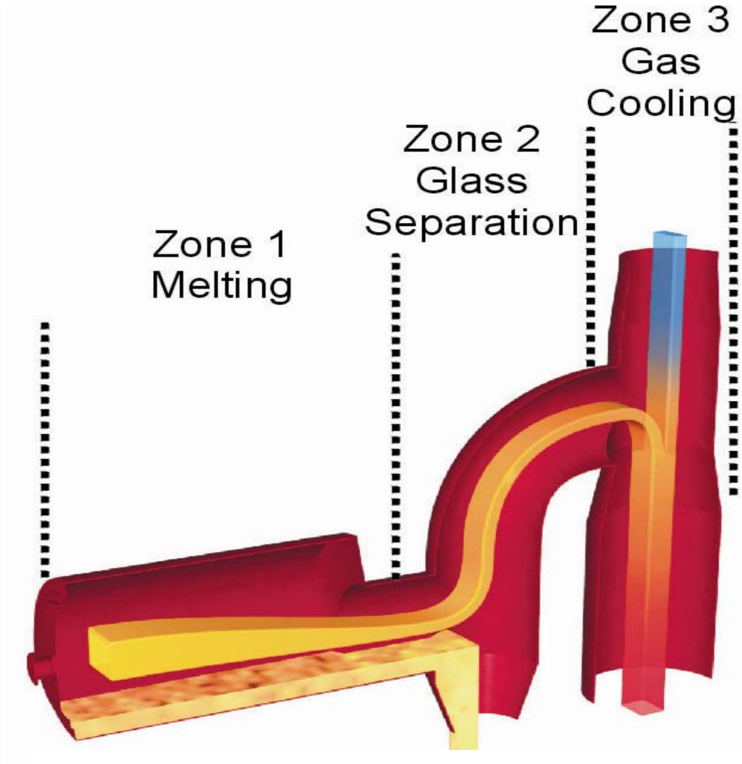


Figure 1. Three Zone Operation of GLASSPACK.

resulting in temperatures between 2400 and 2700^{o} F (1315 and 1482^{o} C). At these high temperatures, the mineral (ash) component of the feedstock melts to form a pool of molten glass at the bottom of the Zone 1 chamber. The high temperature environment is designed to provide very high destruction efficiencies of organic compounds that may be contained in the feedstock. In municipal biosolids applications, once the operating temperature is reached, the energy released from combustion of the biosolids is adequate to keep the process going, eliminating the continued need for co-fire fuel.

Zone 2: Phase Separation Zone. Phase separation of the molten glass and exhaust gas occurs by gravity draining the molten glass from Zone 1 through a drain port on the bottom of the Zone 2 chamber. The molten material drops into a water quench tank and is cooled into the glass aggregate product. The hot combustion gases are directed out of Zone 2 through a refractory lined duct into Zone 3.

Zone 3: Gas Cooling Zone. In this zone, hot exhaust gas is cooled through dilution mixing with lower temperature gases obtained external to the melter. A typical source of lower temperature dilution gas is recirculation flow from a closed–loop installation. The two primary benefits of reducing the exhaust temperature are to eliminate expensive refractory-lined ductwork exterior to the melter, and to cool any particulate carryover below the softening point, thus eliminating ductwork fouling. The temperature of the Zone 3 exit gas varies depending on the temperature and quantity of the dilution gas, but is typically in the range of 700 to 1400 ^{o} F (371 to 760 ^{o} C) and is usually dictated by the thermal energy recovery technology employed. Higher temperature exit gas can provide for higher efficiencies in heat recovery.

3.2 PROCESS DESCRIPTION – MELTER SUPPORT EQUIPMENT

Hot exhaust gases from the discharge of Zone 3 are ducted into a heat exchanger to recover thermal energy. For the MMSD application, thermal energy recovery will be accomplished using a melter exhaust gas to air heat exchanger system.

Although most of the inorganic material is melted in the GLASSPACK® melter, a small fraction of dust can be present in the gas stream. This particulate matter will be captured and removed from the system in a fabric filter located downstream of the heat exchanger. An Induced Draft (ID) fan is used to maintain draft and induce flow through the process.

The exhaust is further cooled and water vapor, produced during combustion, is condensed in a direct packed tower style condenser. The exhaust gas is cooled to 90^{o} to 120^{o} F (32 to 49^{o} C) and directed into the gas recycle header. A portion of the recycle gas is exhausted out of the process to advanced air quality control equipment if necessary. For the MMSD application, air quality control equipment includes a wet scrubber for SO_2, bag filter for particulate matter and Selective Catalytic Reduction (SCR) for NOx control.

The remainder of the recycled gas is boosted in pressure through a recycle fan and enriched with oxygen. The end result is synthetic air which is injected back into Zone 1 of the GLASSPACK® melter. Unlike normal air that is generally only 20% oxygen, synthetic air can be mixed to any ratio of oxygen necessary. This allows simultaneous optimization of melting temperatures, combustion conditions and emissions control that can not be done with conventional atmospheric air fired combustion technology.

3.3 ON-SITE OXYGEN SUPPLY REQUIREMENT

An on-site supply of oxygen is required to operate the GLASSPACK® system in the closed-loop mode. The following are the design specifications for the oxygen supply:

ON-SITE OXYGEN SUPPLY DESIGN SPECIFICATIONS	
Maximum oxygen flow output rating, pure oxygen basis	12,100 lb/hr
Design basis oxygen purity	90 %
Minimum allowed oxygen purity	85 %
Design output pressure at terminal point	5 psig
On-site liquid back up system	24 hr capacity required

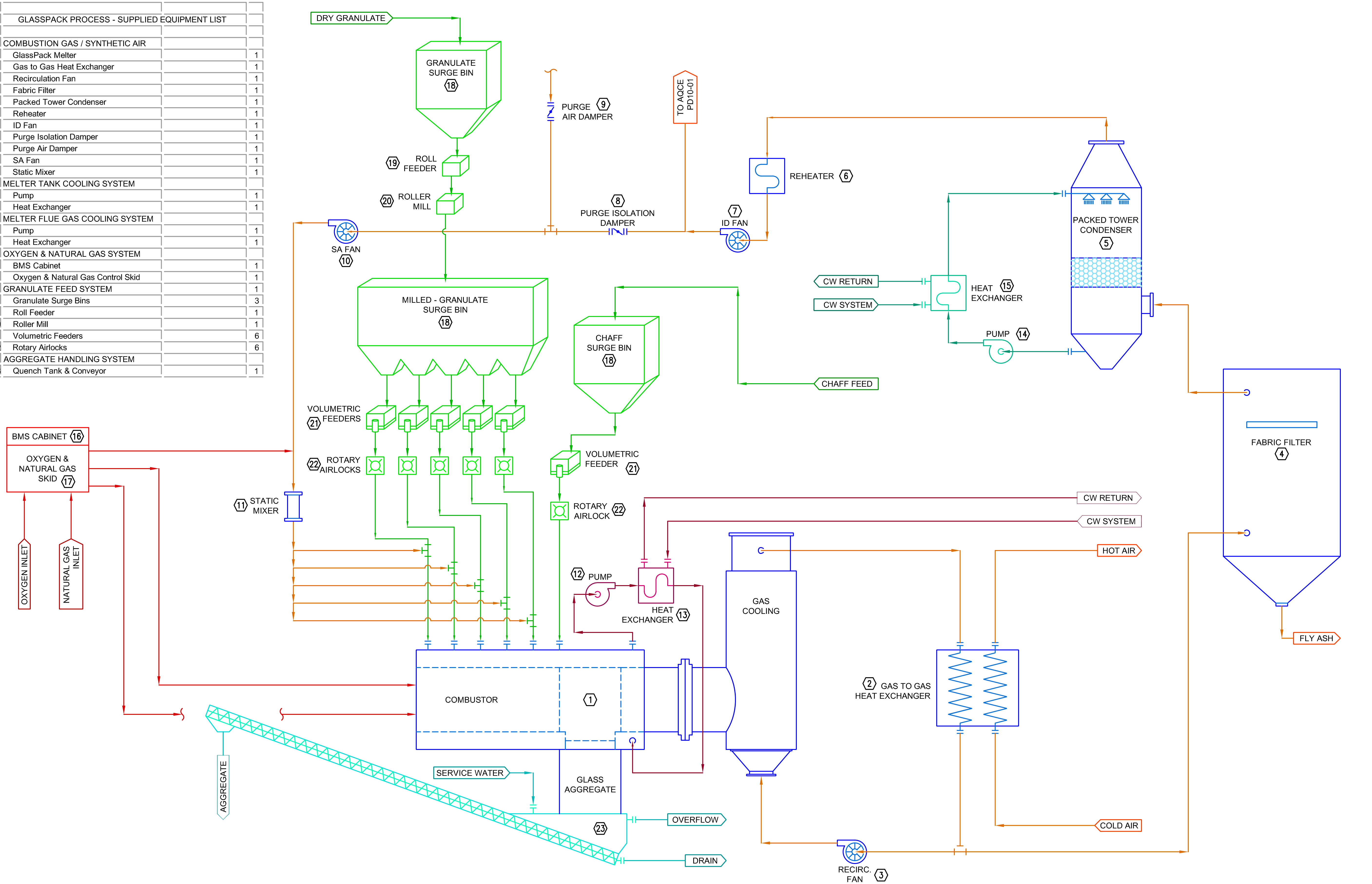
3.4 GLASSPACK® SYSTEM SAFETY

The GLASSPACK® closed-looped combustion system has instrumentation that is calibrated and functionally checked at start-up. The control system provides numerous interlocks that prevent the system from operating outside its normal design parameters. Both the oxygen supply system and the start-up natural gas supply system use double block valves, that isolate the energy supply to the melter in the event that any critical process parameter exceeds the limitations. Interlocks are also utilized that terminate granulate feed to the melter during abnormal conditions. Combustion ceases almost immediately upon trip because the melter system carries a very low inventory of granulate (fuel) at any given time. The following process trips are employed to stop oxygen, gas, and granulate feed:

- GLASSPACK®
  - Melter static pressure high and low
  - Inlet oxygen high and low (double redundant)
  - Outlet combustibles high (triple redundant)
  - Outlet oxygen high and low (triple redundant)
  - Main flame failure
  - Pilot flame failure
  - Melter optical pyrometer high or low
- GLASSPACK® Cooling System
  - Door cooling water temperature high
  - Melter cooling water tank temperature high
- Natural Gas & Oxygen Control System
  - Instrument air pressure low
  - Gas and oxygen pressure high or low
- Heat Recovery Heat Exchanger
  - Heat exchanger over temperature
- Packed Tower Condenser
  - Condenser gas outlet temperature high
- Fans
  - ID fan fault
  - EGR fan fault
  - SA fan fault

SCHEDULE OF SUPPLIED EQUIPMENT

Item	Description	Drawing Number	Quan.
	GLASSPACK PROCESS - SUPPLIED EQUIPMENT LIST		
	COMBUSTION GAS / SYNTHETIC AIR		
1	GlassPack Melter		1
2	Gas to Gas Heat Exchanger		1
3	Recirculation Fan		1
4	Fabric Filter		1
5	Packed Tower Condenser		1
6	Reheater		1
7	ID Fan		1
8	Purge Isolation Damper		1
9	Purge Air Damper		1
10	SA Fan		1
11	Static Mixer		1
	MELTER TANK COOLING SYSTEM		
12	Pump		1
13	Heat Exchanger		1
	MELTER FLUE GAS COOLING SYSTEM		
14	Pump		1
15	Heat Exchanger		1
	OXYGEN & NATURAL GAS SYSTEM		
16	BMS Cabinet		1
17	Oxygen & Natural Gas Control Skid		1
	GRANULATE FEED SYSTEM		1
18	Granulate Surge Bins		3
19	Roll Feeder		1
20	Roller Mill		1
21	Volumetric Feeders		6
22	Rotary Airlocks		6
	AGGREGATE HANDLING SYSTEM		
23	Quench Tank & Conveyor		1



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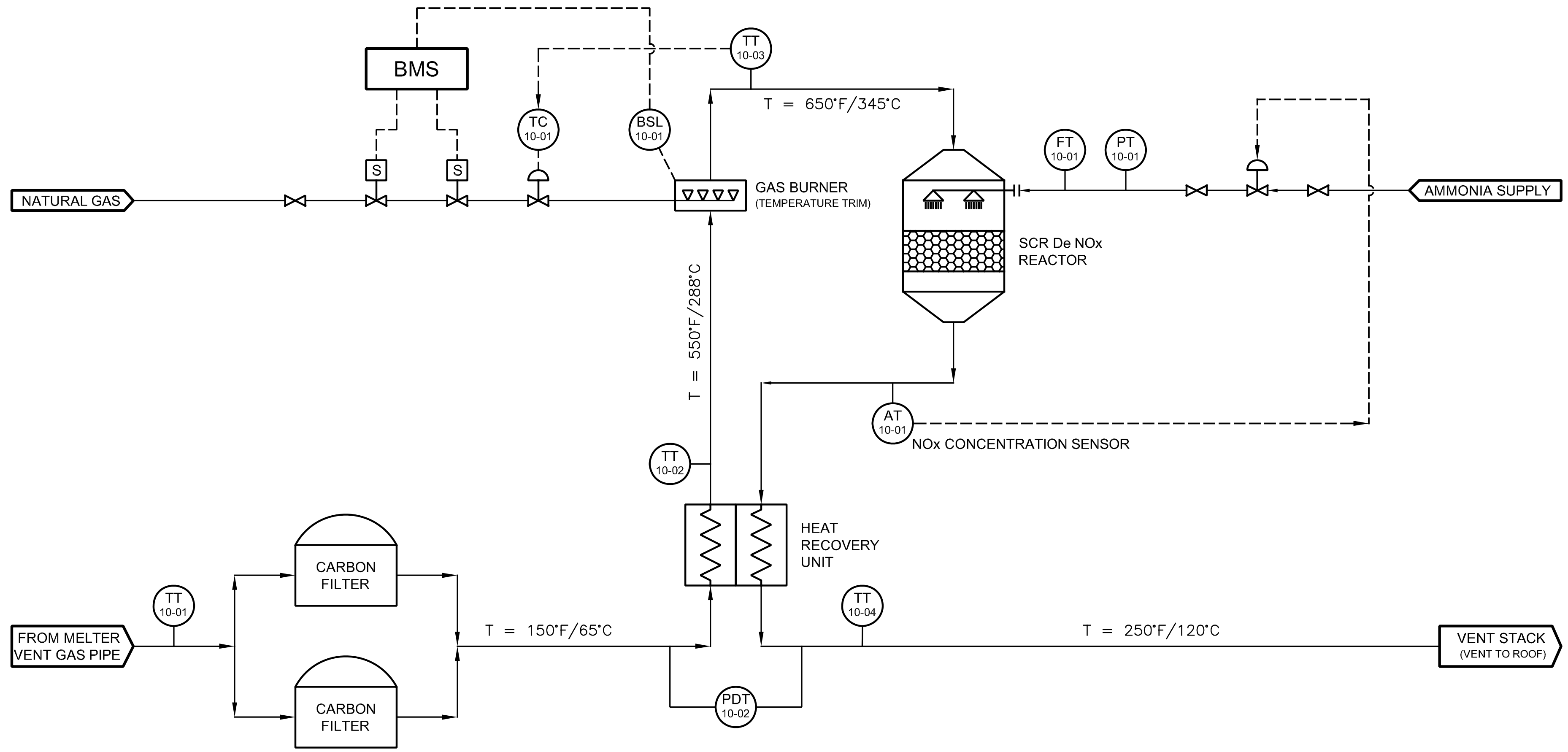
MINERGY MELTER FACILITY
- PRELIMINARY -
MILWAUKEE, WI

PROCESS FLOW DIAGRAM
GLASSPACK PROCESS
SCOPE OF SUPPLIED EQUIPMENT

Date: NOVEMBER 2006

Drawing No.: 100-1100-PD01

Sheet 01 of 01 Rev. -



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PROCESS & INSTRUMENTATION DIAGRAM
AIR QUALITY CONTROL SYSTEM (AQCE)
GLASSPACK MELTER PLANT

Date: NOVEMBER 2006

Drawing No.: 100-1100-PD10

Sheet 01 of 01 Rev. -

4 PROCESS CONSUMPTION AND OUTPUT ESTIMATES

GLASSPACK® process consumption and output estimates provided below are totals for the processing line assuming the Basis of Design specified in Section 2.0.

GLASSPACK® COMSUMPTIONS		
Natural gas used during start up (peak flow)	20,000	scfh
Natural gas used during normal operations (to maintain process temperatures for emission control purposes)	390	scfh
Electrical power for balance of GLASSPACK® process	359	kW
Sodium Hydroxide (NaOH) for SO_2 control (anhydrous mass basis)	167	lb/hr
Ammonia for NOx control (anhydrous mass basis)	13.5	lb/hr
Service water for melter auxiliary equipment cooling	1700	Gpm
GLASSPACK® OUTPUTS		
Exhaust gas	2400	Acfm
Recommended stack diameter	16	inches
NOx	75	Ppm
SO_2	25	ppm
Particulate Matter (PM)	.02	ppm
Carbon monoxide (CO)	25	ppm
Glass aggregate	3260	lb/hr
Fly ash	66	lb/hr
Maximum service water return temperature for melter cooling based on 86° F supply temperature	106	° F
SO_2 scrubber blowdown (contact water)	5.4	gpm
GLASSPACK® operating temperature	2400 - 2600	° F
GLASSPACK® final exhaust temperature	250	° F

5 SCOPE OF EQUIPMENT SUPPLY AND INSTALLATION

This budget estimate is based on the following scope and division of supply:

Work Breakdown Structure	Description	Minergy	A/E, General Contractor or Owner
01	**Minergy Engineering**		
01.01	P&ID's for Minergy scope of supply	X	
01.02	General arrangement drawings (for Minergy scope of supply)	X	
01.03	ISA data sheets (for Minergy scope)	X	
01.04	Instrument list (for Minergy scope)	X	
01.05	Motor list (for Minergy scope)	X	
01.06	Structural steel (for work platforms to Minergy Equipment)	X	
01.07	Piping design (internal to Minergy plant)	X	
01.08	Electrical drawings, cable and conduit schedules (internal to Minergy plant)	X	
01.09	Instrument loop drawings (for Minergy equipment)	X	
01.10	Logic functional control descriptions (on Minergy scope)	X	
02	**BOP Engineering**		
02.01	P&ID's for balance of plant design		X
02.02	Footings and foundations design		X
02.03	Architectural design		X
02.04	Building design (including building steel)		X
02.05	Fire protection		X
02.06	Logic functional control descriptions for balance of plant equipment		X
02.07	Contractor plans and specifications		X
02.08	Air permitting		X
03	**Melter Structure**		
03.01	Building permits		X
03.02	Piling		X
03.03	Foundations		X
03.04	Building structural		X
03.05	Building architectural		X
03.06	Plumbing		X
03.07	Lighting		X
03.08	Fire Protection		X
03.09	HVAC		X
03.10	Transformer and fused disconnects		X
03.11	Sound proofing, sound enclosures		X
04	**Oxygen Structure**		
04.01	Building permits		X
04.02	Piling		X
04.03	Foundations		X

Work Breakdown Structure	Description	Minergy	A/E, General Contractor or Owner
04.04	Lighting		X
04.05	Fire Protection		X
04.06	HVAC		X
04.07	Transformer and fused disconnects		X
05	**Site work and Utilities**		
05.01	Demolition of existing parking lot		X
05.02	New roads and parking		X
05.03	Landscaping		X
05.04	Aggregate pad		X
05.05	Interconnection of granulate supply from MMSD's existing supply to Minergy fuel surge bins		X
05.06	Liquid oxygen back-up system (leased tanks and vaporizers)	X	
05.07	Service water supply system		X
05.08	Potable water supply		X
05.09	Waste water treatment systems		X
05.10	Equipment offloading and laydown area		X
05.11	Communications		X
05.12	Utility interconnections		X
06	**Minergy Equipment**		
06.01	Instrumentation integral to Minergy furnished skid mounted control systems	X	
06.02	Field mounted instrumentation	X	
06.03	Control system Input/Output cards	X	
06.04	Control system MMI interface	X	
06.05	Control system software, programming and screen design	X	
06.06	Granulate surge bins	X	
06.07	Chaff Feed bin	X	
06.08	Volumetric fuel feeders	X	
06.09	Fuel sizing equipment	X	
06.10	Oxy-fuel skid with PLC based BMS/SIS	X	
06.11	One (1) G100 GlassPack melter	X	
06.12	Melter jacket cooling system	X	
06.13	Melter exhaust gas scrubber condenser system	X	
06.14	Synthetic air fan and drive motor	X	
06.15	Induced draft fan and drive motor	X	
06.16	Exhaust gas recirculation fan and drive motor	X	
06.17	Stack booster fan and drive motor	X	
06.18	Hot air transport fan and drive motor	X	
06.19	Gas to gas main air heat exchangers	X	
06.20	Slag quench tank and removal screw	X	
06.21	Fabric filters	X	
06.22	SCR technology NOx control system	X	

Work Breakdown Structure	Description	Minergy	A/E, General Contractor or Owner
06.23	Exhaust gas Mercury control system (activated carbon scrubber vessels)	X	
06.24	Delivery of equipment to Job site (Minergy scope of supply)	X	
06.25	Fly ash transport blowers and storage silo	X	
06.26	Oxygen supply system	X	
06.27	Ammonia storage tank and pumps	X	
06.28	Sodium hydroxide solution storage tanks and pumps	X	
06.29	Expansion joints	X	
06.30	Interconnecting ducts (internal to melter plant)	X	
06.31	Piping, hangers, flanges and valves (internal to melter plant)	X	
06.32	CEM system"(assumed not required under present regulations)		
06.33	Stack and air test ports	X	
06.34	Motor control centers, motor starters	X	
06.35	Variable speed drives	X	
06.36	Cables, conduit, and cable tray	X	
06.37	Supply and install all melter process equipment related structural steel, access platforms, hoists and monorails	X	
07	**BOP Equipment**		
07.01	Instruments and controls for balance of plant equipment		X
07.02	Air compressors, air dryers, compressed air storage and air distribution systems		X
08	**Minergy Installation**		
08.01	Piping and hanger installation	X	
08.02	Truck unloading stations	X	
08.03	Equipment installation (Minergy scope of supply)	X	
08.04	Electrical installation (Minergy scope)	X	
08.05	Equipment Insulation	X	
09	**BOP Installation**		
09.01	Equipment installation (Balance of plant)		X
09.02	Electrical installation (Balance of plant)		X
10	**Commissioning and Startup**		
10.01	Commissioning of non-Minergy scope		X
10.02	Commissioning of Minergy equipment	X	
10.03	Consumables required during commissioning		X
10.04	Vibration testing		X
10.05	Initial equipment lubrication		X
10.06	Hydrostatic testing		X
10.07	Chemical cleaning		X
10.08	Field instrumentation installation & calibration (Minergy scope)	X	
10.09	Personal protective equipment (for O&M)		X
10.10	Air emissions testing		X
10.11	Training (Minergy supplied equipment)	X	

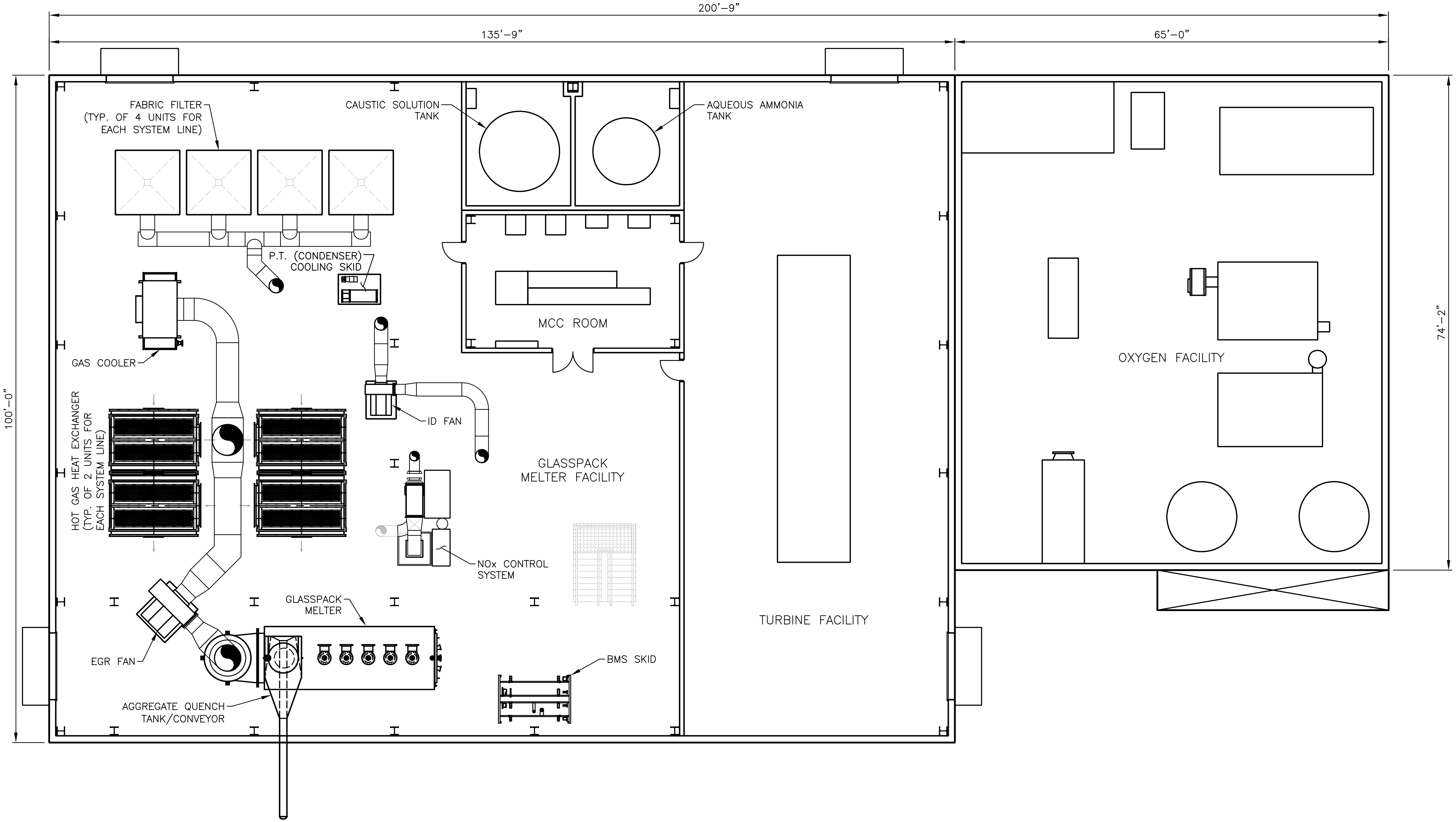
Work Breakdown Structure	Description	Minergy	A/E, General Contractor or Owner
10.12	Training (Balance of plant)		X
10.13	O&M Manuals (Minergy scope of supply)	X	
10.14	O&M Manuals (Balance of equipment scope)		X
11	**Construction and Project Management**		
11.01	Project management		X
11.02	Construction management		X
12	**New Site Electrical Feed**		X

6 CONCEPTUAL GENERAL ARRANGEMENT DRAWING

Minergy Drawing 100-1100-GA00 presents an approximate footprint required for the GLASSPACK® melter process. The footprint for the melter building to house all GLASSPACK® process equipment is approximately 100 ft x 95 ft or a total of approximately 9,500 square feet of plan area. The on-site oxygen production area will require an additional 65 ft x 75 ft area that does not need to be directly adjacent to the melter process. In addition, some components of the oxygen system will be located external but adjacent to the building.

NOTES:

1. OXYGEN FACILITY NEED NOT LIE ADJACENT TO MELTER FACILITY IF SITE CONSTRAINTS EXIST.



PLAN VIEW @ GRADE ELEVATION

0 1' 8'

NOTES:

1. MELTER FACILITIES STRUCTURAL BUILDING ELEVATION @ 60'–0"

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MILWAUKEE METROPOLITAN SEWERAGE DISTRICT
MINERGY MELTER FACILITY
- PRELIMINARY -
MILWAUKEE, WI

GENERAL ARRANGEMENT
MELTER & OXYGEN FACILITY
PLAN VIEW @ GRADE ELEVATION

Date: NOVEMBER 2006

Drawing No. 100-1100-GA00

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7 OPERATING COST ESTIMATE

The table below provides a summary of the annual cost to operate the Minergy GLASSPACK® melting process. The costs are for the operation of the single Minergy GLASSPACK® melter line, operating 8,000 full load hours per year. The resulting operating cost is approximately $ 982,000 per year or $ 40.25 per dry ton excluding labor. However when factoring in the reduced natural gas consumption, the result is an overall $ 80/ton savings from the current practice.

Natural gas consumptions are a combination of fuel required for both start-up and fuel required for the air emissions control equipment. A natural gas cost of $9.25 per decatherm was assumed for the operating cost estimate.

Item	Quantity	Unit Cost	Annual cost
Natural gas (start up and NOx control)	5,000 DT/yr	$ 9.25 /DT	$ 46,250
Electrical power for Minergy process	2,025 MWH/yr	$ 59.71 /MWH	$ 120,913
Electrical power for oxygen	7,830 MWH/yr	$ 47.62 /MWH	$ 372,865
Sodium Hydroxide for SO_2 control	490 ton/yr	$ 300.00 /ton	$ 147,000
Ammonia for NOx control	36 ton/yr	$ 300.00 /ton	$ 10,800
Liquid oxygen tank & vaporizor rental		$ 25,000.00 /yr	$ 25,000
Liquid oxygen usage	635 ton/yr	$ 80.00 /ton	$ 50,800
Equipment maintenance	24,400 dry ton/yr	$ 8.00 /dry ton	$ 195,200
Ash disposal	295 ton/yr	$ 45.00 /ton	$ 13,275
		Total Annual O&M	**$ 982,102**
		Annual total dry sludge tons processed	24,400
		Average operating cost/dry ton processed	$ 40.25
Value of thermal energy recovered realized by reduced natural gas consumption	317,300 DT/yr	$ 9.25 /DT	**$ 2,935,000**
		Overall Annual O&M Cost (savings)	$ (1,952,898)
		Overall operating cost (savings)/dry ton processed	$ (80.04)

All wastewater treatment sludges contain sulfur. When the organic fraction of the sludges are oxidized in GLASSPACK®, sulfur is converted to sulfur dioxide (SO_2). This is a gas that is a regulated pollutant under the Clean Air Act. Sulfur dioxide is easily scrubbed from the process exhaust gases in a scrubber, which is integral to the GLASSPACK® process. Sodium hydroxide (NaOH) is commonly used as the reagent to capture the sulfur dioxide. The reaction produces the inert and water-soluble salt sodium sulfate. This salt passes though the wastewater treatment process and can be discharged along with the existing inert dissolved solids already found in waste water treatment plant effluent. The cost of NaOH has been included in the operating cost estimate.

A second pollutant formed in the process are oxides of nitrogen (also known as NOx). Both NO and NO_2 are formed during the breakdown of nitrogen containing organic compounds. The emissions can be controlled, and removal efficiencies of 90% to 95% have been demonstrated to be technically feasible with Selective Catalytic Reduction (SCR). The process uses a simple (non-precious metal) catalyst and ammonia to convert NO and NO_2 into nitrogen and water. Since the process gas exhaust flow rates are lower than other sludge incineration processes by an order of magnitude, the size of the catalytic reactor (and the cost), along with ammonia consumption are minor. The cost of ammonia has been included in the operating cost estimate.

Not all of the biosolids' inorganic fraction processed in the melter is converted into glass aggregate. A small portion escapes the melter as fine particulate ash in the exhaust gas and is captured in a fabric filter, an integral component of the GLASSPACK® process. It is important to note that alternatives such as wet particulate collection, back mixing of fly ash into the sludge dewatering process for re-introduction back into the melting process or other beneficial reuse options could effectively address this waste stream.

The equipment maintenance figure of $ 8.00 per dry ton processed is an estimated annual average equipment maintenance cost related to the total GLASSPACK® melting process, and includes items such as melter refractory maintenance, rotating equipment lubrication, scheduled preventative maintenance costs and inspections.

In addition to the routine equipment maintenance costs, major maintenance frequency and estimated cost are summarized in the table below.

Item	Frequency	Estimated Cost (2006 $)
Major unit refractory replacement	Every 10 yr	$ 185,000
Fabric filer bag replacements	Every 5 yr	$ 32,000
Complete re-tubing of the main gas to gas heat exchangers	Every 20 yr	$ 150,000

At this level of analysis, we have not included labor in the operating cost estimate. It is our experience to date that the GlassPack process, by itself, can be efficiently and effectively managed with one operator per shift.

8 BUDGET

8.1 Disclaimer

This budgetary price is solely intended for the use by the 2020 design team for the economic analysis of MMSD biosolids management alternatives. Although the scope of supply does include estimated costs for mechanical and electrical installation, Minergy recommends that this work scope be integrated into the scope of a general contractor that can provide overall coordination of work on the site. Estimates are based on Minergy's best available information at the time, and **not** supported by actual bids that are based on a complete engineering plans and specification package. Minergy has assumed a 10% overhead and general cost and 15% mark-up for all sub-contractor work. In addition, Minergy has assumed a general contractor mark-up of all sub-contracts of 7%.

The budget estimate does include cost for long term performance guarantees.

8.2 Budget Estimate

The budgeted price for the scope of equipment and services described herein is $ 27,500,000 USD.

8.3 Delivery

Delivery of major equipment is estimated at 52 weeks after receipt of purchase order and approval drawings are accepted with 2 weeks after submittal.

8.4 Installation, Start-up Supervision and Training

Contract allows for 140 days of on-site installation and start-up supervision services. All services are limited to the equipment furnished by Minergy. Minergy's role is only advisory and no provision has been made for direct equipment installation or operation beyond the commissioning. A two week (10 day) training period at either Minergy's Vitrification Technology Center and/or other facilities Minergy currently operates has been included for operator training. Assistance beyond this level can be provided, subject to field service representative availability with a flat daily rate to be negotiated including all reasonable and customary travel and living expenses.

8.5 Guarantee

Johnson Controls (JCI) will work with Milwaukee Metropolitan Sewage District (MMSD) to develop a performance guarantee which provides long-term (20 year) assurance that the proposed solution delivers the results expected. These assurances have been discussed and accepted as integral to overall project implementation and success. Separately, JCI will also be responsible for the day-to-day operations and maintenance (O&M) services associated with the proposed Minergy GlassPack process. Beyond initial start-up and commissioning, these comprehensive O&M services will be delivered by JCI to manage the system and associated plant operation risks. An eventual transition of operational responsibility to MMSD and/or its plant operator will be considered. From the initial framework introduced earlier, we have begun the process of defining the key performance measurements that will characterize acceptable performance.

For the infrastructure improvements that MMSD is considering with the proposed Minergy GlassPack solution, JCI expects to develop plant performance guarantees for a specific set of facility outcomes in four general areas.

Those areas are:

1. Capacity
2. Availability
3. Efficiency / Quality, and
4. Emissions

In the area of **Capacity**, we will develop measurements that gauge available capacity of the GlassPack process for the original design requirements of MMSD needs. A minimum throughput of dry granulate processed by the GlassPack melter unit(s) on a per hour or daily basis will be measured to accumulate an average performance level.

Availability will characterize readiness or uptime of the process to support scheduled operation of the GlassPack system. MMSD will be assured that the new system will have available the scheduled capacity to support the process as designed. Through a planned operations and maintenance service strategy, availability of the Minergy GlassPack will be scheduled to meet the requirements of MMSD. Currently, we are assuming a 90% availability factor.

The system **Efficiency and Quality** will have the greatest set of performance measurements associated with critical operation and output of the Minergy GlassPack process. Here, a heat recovery (supply) value from the process will be measured to support the efficient drying of biosolids. A maximum oxygen consumption rate will be monitored for the GlassPack melter process. The oxygen plant electrical energy consumption will also be monitored to ensure efficient generation.

Importantly, **Emission** levels will be monitored or tested for reporting and compliance of critical measurements. Air emissions from the GlassPack melter process will be documented for regular reporting to MMSD and the WDNR in accordance with the related air permit.