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ENGINEERING EVALUATION / FACT SHEET

BACKGROUND INFORMATION

Application No.:	R13-3563
Plant ID No.:	035-00082
Applicant:	Thunder Mountain Environmental Services LLC
Facility Name:	West Virginia Plant
Location:	Ravenswood
NAICS Code:	562219
Application Type:	Construction
Received Date:	June 2, 2022
Engineer Assigned:	Edward Andrews
Fee Amount:	$2000.00
Date Received:	June 6, 2022
Complete Date:	April 7, 2023
Due Date:	July 6, 2023
Applicant Ad Date:	June 24 and 28, 2022
Newspaper:	*The Jackson Herald*
UTMs:	Easting: 430.86 km Northing: 4,308.59 km Zone: 17S

DESCRIPTION OF PROCESS

Thunder Mountain Environmental Services, LLC (TMES) operations are to be located at 5334 Point Pleasant Road, Ravenswood, West Virginia 26164. The facility is located at latitude 38.9231 and longitude 81.791 in northwest Jackson County. TMES will be leasing the property. TMES is proposing to construct a new solid regulated medical waste (RMW) gasification waste to energy facility. This waste to energy facility will consist of a single thermal gasification system, a Vista Thermal Gasifier, that will be used for the treatment of RMW. The thermal gasification system will convert the RMW into high British Thermal Unit (BTU) synthetic gas (synthetic gas). The TMES plant is designed for Waste-To-Energy Generation, so it is classified as a waste management and remediation service under NAICS code 562219.

TMES will receive pre-approved feedstock in properly sealed bags or bins of medical waste from a variety of facilities including, but not limited to, hospitals, doctors offices, dentists, veterinarians' offices, and pharmacies.

Medical Waste (MW)

- Heterogeneous material varies in consistency.
- Any Hydrocarbon-based material from 5,000 BTU/lb to over 15,000 BTU/lb
- Moisture content up to 45%.
- Preferably to have rock/dirt/glass removed from the waste stream.
- Preferably to have feedstock size at 1-2" particle size.
- Feed rate is 1,650 lb/hr at the "TMES" – Gasification System

This medical waste will consist of the following:

- Red Bag Waste: used medical gloves, paper towels, gauzes, bandages, etc.
- This may include some human tissue (i.e. Teeth, cultures, etc.);
- Sharp Containers: containers that contain sharp objects (i.e. needles, syringes, etc.);
- Chemotherapy: tubing, gauzes, gloves, and other supplies used in the administration of chemotherapy medications. This does not include the actual chemotherapy medication other than what trace amounts may be on the supplies.
- Pharmaceutical: expired or tainted pharmaceuticals; TME is not going to accept hazardous pharmaceutical waste.
- Pathology: human or animal tissue or fluids generated during surgery, medical procedures, or autopsies.

These waste streams are considered biohazardous (infectious medical waste) as they potentially can be contaminated with infectious agents that may be a threat to public health if not handled and disposed of properly.

The waste will be directly unloaded into the facility building from trucks at the loading docks and will be processed within 24 hours. Once inside, the contents of the ridge cardboard boxes, which are referred to as gaylord boxes, and plastic containers are unpacked to the (cart) feed hooper at the shredder. From the shredder, material is transferred to the gasifier 24-hour feed hoppers. The hopper is designed to dry the contents by using recirculated flue gas as required.

The medical waste (1,666 lb/hr or 0.825 tons/hour limit) will first be introduced to the gasifier fuel surge hopper. Once in the gasifier, the feedstock will pass through the various parts of the gasification chamber on conveying belts. The speed of the belts is monitored and controlled to optimize the thermal decomposition reaction. The residence time in the chamber is dependent on a number of factors, including feedstock composition, density, and moisture content. As the feedstock temperature reaches approximately 1,600 – 1,800 degrees F., the reaction has completed, and the initial feedstock has been converted into two products: a produced gas (syngas) stream and an ash residue. The syngas stream is converted to steam/electric energy. Note that the gasifier is the main component in the waste-to-energy processing system.

Gasification is a process that uses medical waste as a feedstock for a thermal-chemical conversion of the waste into high BTU synthetic gas. This is done in a low oxygen and high temperature environment and causes material breakdown at the molecular level to carbon monoxide, hydrogen, and carbon dioxide. After treatment, combustion gasses are further treated and synthetic gas is collected.

A water bath is used to remove the ash residue from the bottom of the gasifier. TMES currently plans on transferring the ash residue to an EPA approved landfill. The syngas exits the top of the gasifier and passes through the fire tube, where it is combusted and used to heat the boiler, for steam electric generation. This final (firetube) combustion section with (an igniter or small natural gas pilot burner) carries out the near combustion of organics, carbon, and other combustion gasses with an efficiency of approximately 99.99%. Temperatures achieved during the thermal process range from 1800 to 2200 degrees F. The exhaust is then routed to a boiler, which is used to generate steam.

TMES will divert a portion of this steam to provide the necessary process heat energy for the gasification process with the remaining amount of the steam being routed to a small steam turbine which will be used to generate electricity for the facility. TMES estimates that the steam turbine/generator will generate approximately between 0.5MW to 1.0 MW.

The exhaust exiting the boiler is cooled to 300 - 350 F. Exiting from the boiler, the exhaust will be treated using typical air pollution control devices, which consist of a cyclone, dry scrubber, and fabric filter baghouse.

A cyclone (Identified as C1-2) will be used to remove large particulate matter out of the exhaust stream. Also, a slip stream of the cleaned exhaust can be injected in the cyclone as a means of controlling the exhaust temperature before being routed to the dry scrubber. Sodium bicarbonate will be injected into the exhaust just upstream from the dry scrubber. A dry sorbent scrubber (Identified as C1-3) will be located downstream of the cyclone.

Coupled with controlling acid gasses, activated carbon will be injected immediately downstream of the dry scrubber to remove dioxins and furans (d/f) from the exhaust. These sorbents (sodium bicarbonate and activated carbon will react with the acid gasses and d/f within the dry scrubber to form a particulate that will be precipitated out in the fabric filter baghouse, which is downstream of the dry scrubber (Identified as C1-4).

The collected residue (particulate matter) in the hopper of the fabric filter baghouse will contain a certain amount of unreacted sodium bicarbonate and activated carbon. TMES plans on pulling a slip stream of this matter and adding it in with the activated carbon in the activated carbon feeder.

A variable speed drive fan will be used to create an induced draft which pulls the exhaust through these control devices and discharges the exhaust through the stack to the atmosphere. By selecting a variable speed drive in-duce draft fan, TMES will be able to control the flow rate of the exhaust based on the feed rate and/or process rate of the gasifier, as needed.

TMES plans on collecting the ash/residue from the cyclone, bottom of the dry scrubber, and fabric filter baghouse as waste ash (fly ash). Depending on the classification of the fly ash, TMES plans on sending this waste ash to a facility that is permitted to accept it based on the proper classification under the Resource Conservation and Recovery Act.

SITE INSPECTION

On January 11, 2023, Mr. Gene Coccari of the Small Business Assistance Program of the DAQ and the writer conducted a site inspection of the proposed site. During this visit, Mr. Jim McCoy, the owner of the Belt Transfer Company, and his staff were on hand for this visit. There was no representative of TMES at the facility during this visit.

TMES is leasing 13,000 square feet of warehouse space and common areas at 5334 Point Pleasant Road, Ravenswood, West Virginia from Belt Transfer Company, owner of the site. The Belt Transfer Company will continue to operate their transportation services business at this location while TMES is engaged in their medical waste treating operations.

Belt Transfer Company currently uses the warehouse space to store incoming goods and separate if necessary as part of the transportation services that they offer to their customers. Belt Transfer Company allowed Mr. Coccari and the writer to have access to the warehouse space. At the time of this visit, there was no gasifier or any other associated equipment at the site. Mr. McCoy noted that the only improvement to the building that TMES had performed was having AEP (local electricity provider) install a 3-phase electric hook-up drop next to the warehouse that is leased to TMES.

The site location is approximately 2.4 miles west of Ravenswood. There are several farms that are located around the site with the nearest structure not owned by Belt Transfer Company being less than 200 feet away. Other near-by facilities are the Jackson County Airport, which is just over a mile away, and the Constellium Plant (a secondary aluminum processing mill) which is over a mile and half away from the proposed site. The writer believes that the proposed site is appropriate for the proposed activities.

ESTIMATE OF EMISSIONS BY REVIEWING ENGINEER

Emissions from the proposed facility will mainly be in the form of products of complete and incomplete combustion with particulate matter generated from fugitive sources such as haul roads and material transfer operations.

TMES used emission factors from Chapter 2.3 Medical Waste Incineration of AP-42 to determine the uncontrolled emissions from the fire tube portion of the gasifier and PM emissions due to the material handling operations. Then, TMES applied the appropriate control or removal efficiency for each control device with respect to the pollutant being controlled.

Pollutant	Hourly Rate (lb/hr)	Annual Rate (TPY)
PM	0.19	0.82
PM_{10}	0.16	0.70
$PM_{2.5}$	0.16	0.70
NO_x	0.0693	0.30
CO	0.246	1.25
SO_2	0.00146	<0.01
Pb	5.03E-7	2.2E-6
VOC	0.88	3.85
SO_3	8.76E-4	3.84E-3
H_2SO_4	1.07E-3	4.70E-3
Cd	3.79E-6	1.66E-5
Hg	3.46E-5	1.52E-4

HCl	0.743	3.26
Total TCDF	5.43E-9	2.38E-8
Total TCDD	3.55E-11	1.55E-10
Total CDF	9.22E-9	4.04E-8
Total TCDF	3.35E-8	1.47E-7
Total D/F	4.82E-8	2.11E-7
Total HAP	0.74	3.26

For start up operations, this proposed gasifier will require Zone 1 to be preheated up to approximately 700 C. The required preheating will be performed by utilizing a single 2 MMBtu/hr natural gas fired burner to directly heat Zone 1 of the gasifier. TMES estimates this preheating will occur for 30 up to 60 minutes. A comparison of the emissions from the preheating to normal operations is illustrated in the following table.

Pollutant	Preheating Emissions (lb/hr)	Normal Ops Emissions (TPY)
PM	0.004	0.19
PM_{10}	0.015	0.16
$PM_{2.5}$	0.015	0.16
NO_x	0.20	0.0693
CO	0.16	0.246
SO_2	0.001	0.00146
VOCs	0.01	0.88

The presented preheating emissions are without controls and assumed that the duration of the preheating would occur over a full hour.

Only the NO_x emissions during preheating are greater than emissions from normal operations. This makes sense as the preheating phase is to raise the temperature from ambient up to 700 C in a relatively short time frame. Assuming 24 startups per year, the annual NOx emission rate for start up operations is 4.7 pounds per year.

TMES estimated fugitive emissions from the material handling system to be 0.24 pounds per hour of PM, PM_{10}, and $PM_{2.5}$ before controls. Long-term emissions were estimated based on the maximum operating schedule possible, which yielded an annual fugitive rate of 1.05 tons per year of PM/PM_{10}/$PM_{2.5}$ emissions. The material handling operation will be located within the building. TMES did not propose a control efficiency for the building.

Included with this application, TMES proposed to install an emergency generator. TMES intends to operate this emergency generator for only 100 hours per calendar year, on a non-emergency basis. Thus, annual emissions are based on this limited operating schedule. Emissions for the 240 hp, natural gas fired engine were determined from engine manufacturer published data. The following table is a summary of these emissions due to the operation of the emergency generator.

	Source Name	S-EGS
	Engine Manufacturer	Cummins
	Model	QSJ8.9G
	Model Year	2023
	Fuel Consumption Rate (scfh)	1907.9
	Brake Horsepower (bhp)	240
	Fuel Type	Natural Gas
PM	lb/hr	0.04
	TPY	<0.01
PM_{10}	lb/hr	0.001
	TPY	<0.01
$PM_{2.5}$	lb/hr	0.008
	TPY	<0.01
NO_x	lb/hr	0.94

	TPY	0.05
SO_2	lb/hr	0.03
	TPY	0.01
CO	lb/hr	0.92
	TPY	0.05
HC (VOCs)	lb/hr	0.22
	TPY	0.01
Total HAPs	lb/hr	0.14
	TPY	<0.01

TMES estimated the fugitive PM emissions due to the vehicle traffic at 3.28 tons per year before controls. TMES estimated 6 vehicle miles per day will be traveled on plant controlled roadways with an average weight per vehicle of 27.5 tons. These vehicles will be traveling on paved roadways at the site. TMES proposed to apply water to these roads in effort to reduce the fugitive PM emissions, and therefore, applied 50% control efficiency for the application of water. Thus, the potential emissions are reduced to 1.63 tons of PM per year. Of this 1.63 tons of PM, 0.38 tons is PM_{10} and 0.08 tons is $PM_{2.5.}$

A summary of the facility emissions is presented in the following table.

Pollutant	TPY
PM	3.50
PM_{10}	2.13
$PM_{2.5}$	1.83
NO_x	0.35
CO	1.30

SO_2	0.02
VOCs	3.86
Total HAPs	3.26
HCl (HAP)	3.26

REGULATORY APPLICABILITY

GASIFIER

The proposed gasifier will be treating medical waste to be converted into gaseous fuel which will be combusted as this gas is generated as part of the gasification process. The first stage of the gasifier will be operated like a pyrolysis process in a limited oxygen atmosphere. In the Oxidation and Combustion Zone, the air is going to be introduced into the gasifier to improve the efficiency of reducing the medical waste into a gaseous fuel (synthetic gas) and will no longer be a pyrolysis style process (e.g., energy heat will no longer be added to the process). In a gasifier process, air or other reactant is needed to improve the efficiency of converting the solid material (medical waste) into a synthetic gas.

In the Drying and Gasification Zones, oxygen is insufficient to cause the medical waste feedstock to begin combusting. Air, which contains oxygen, is actually injected or introduced into the Oxidation Zone. The temperature in the Oxidation Zone will be at 1,800 to 2,200°F. Adding/injection air into the Oxidation Zone will aid the gasification process to reduce the solid feedstock into a synthetic gas. However, some level of combustion will occur. The applicant did not provide any information to suggest that external energy is needed to maintain these gasification reactions in reducing the solid feedstock into a synthetic gas.

Therefore, the DAQ cannot conclude that the proposed gasifier meets the definition of pyrolysis in Subpart Ec - Standards of Performance for New Stationary Sources: Hospital/Medical/Infectious Waste Incinerators of 40CFR60 (Subpart Ec). Thus, the gasifier does not qualify for an exclusion as a pyrolysis unit and is subject to the requirements and emission standards of Subpart Ec. Because the gasifier is subject to Subpart Ec, the gasifier is subject to 45CSR18-6, which refers back to the requirements of Subpart Ec.

Under Subpart Ec, the gasifier is subject to the following requirements:

- Emission Standards and Limits for nine pollutants and visible emissions.

- Operator Training and Qualifications
- Siting Requirements
- Waste Management Plan
- Compliance Demonstration and Monitoring Requirements
- Reporting and Recordkeeping Requirements

Emission Standards

Subpart Ec establishes emission standards based on a maximum design burning capacity or charge rate of the Hospital/Medical/Infectious Waste Incinerator (HMIWI). A large HMIWI under this regulation is a unit whose maximum burning capacity or charge rate is greater than 500 lb per hour. TMES has proposed a gasifier that will handle a maximum of 1,650 lb (0.825 tons) of medical waste per hour, which means that the proposed gasifier is classified as a large HMIWI unit.

The following table provides the applicable emissions standards from Table 1B to Subpart Ec of Part 60.

Table X - Applicable Emission Standards from Subpart Ec

Pollutant	Units	Emission Limit for Large HMIWI Units	Averaging Time
Particulate matter	Milligrams (mg) per dry standard cubic meter (dscm) (grains (gr)per dry standard cubic foot (dscf))	18 (0.0080)	
Carbon monoxide	ppmdv	11	3-run average (1-hour minimum sample time per run)
Dioxins/furans	Nanograms per dry standard cubic meter total dioxins/furans (grains per billion dry standard cubic feet) or nanograms per dry standard cubic meter TEQ (grains per billion dry standard	9.3 (4.1) or 0.035 (0.015)	3-run average (4-hour minimum sample time per run)

	cubic feet)		
Hydrogen chloride	ppmdv	5.1	3-run average (1-hour minimum sample time per run)
Sulfur dioxide	ppmdv	8.1	3-run average (1-hour minimum sample time per run)
Nitrogen oxides	ppmdv	140	3-run average (1-hour minimum sample time per run)
Lead	mg/dscm (gr/dscf)	0.00069 (0.00030)	3-run average (1-hour minimum sample time per run)
Cadmium	mg/dscm (gr/dscf)	0.00013 (0.000057)	3-run average (1-hour minimum sample time per run)
Mercury	mg/dscm (gr/dscf)	0.0013 (0.00057)	3-run average (1-hour minimum sample time per run)

The regulation also establishes a visible emission standard for the HWIWI unit at 6 percent opacity on a 6-minute block average. Sources of fugitive visible emissions cannot exhibit visible emissions greater than 5 percent during the observation period using Method 22, which applies to structures or enclosures where the ash conveying systems are located.

Operator Training and Qualifications

Subpart Ec requires operators of HMIWI units to either be on site or within 1 hour of the unit. This regulation defines the training requirements for these operators, which are a minimum of 24 hours of training on several topics that are related to the operation of the HMIWI unit. A qualified operator must either complete a training course or have 6 months of experience as an HMIWI operator.

The regulation requires that these trained and qualified operators undergo at least 4 hours of annual review or a refresher course on several topics such as: update of regulations; startup and shutdown procedures; response to malfunctions; and other problems with unit operations.

TMES must maintain documentation at the facility on the following:

- Summary of the applicable standards under this Subpart Ec;
- Description of basic combustion theory applicable to an HMIWI;
- Procedures for receiving, handling, and charging waste;
- HMIWI startup, shutdown, and malfunction procedures;
- Procedures for maintaining proper combustion air supply levels;
- Procedures for operating the HMIWI and associated air pollution control systems within the standards established under this subpart;
- Procedures for responding to periodic malfunction or conditions that may lead to malfunction;
- Procedures for monitoring HMIWI emissions;
- Reporting and recordkeeping procedures; and
- Procedures for handling ash.

This documentation must be available to the operators at all times and reviewed by TMES on an annual basis.

Siting Requirements

The regulation requires that TMES determine the impacts associated with the emissions from the gasifier and evaluate the controls to determine whether alternatives could minimize, on a site-specific basis, to the maximum extent practicable, potential risks to public health or the environment. In considering such alternatives, the analysis may consider costs, energy impacts, non-air environmental impacts, or any other factors related to the practicability of the alternatives.

Pursuant to the Siting Requirements of Subpart Ec, TMES was required to do an air dispersion modeling analysis to determine the potential impacts from the HMIWI unit. TMES provided a modeling report, which was submitted on December 15, 2022. The pollutants that were modeled were CO, NO_x, $PM_{2.5}$, and PM_{10}, lead (Pb) and $SO_{2.}$

The siting requirements from the subpart also required TMES to demonstrate that there are no alternative control technologies that could minimize the emissions from the gasifier unit. Before going into TMES evaluation of alternative control technologies, first understand that TMES has proposed to gasify the medical waste as a process improvement over incineration. By gasifying the solid waste, combustion control for gaseous fuels (e.g., natural gas) can be utilized. Gasifying the solid medical waste, the combustion air requirements for complete combustion are decreased.

TMES utilized the Top-down Best Available Control Technology (BACT) approach in evaluating the identified control technologies.

Since there are no records found in the BACT database for the use of medical and hazardous waste in a gasifier system, the proposed system was compared to two other facilities known by the agency that used either a gasifier or pyrolysis/gasifier technology to convert medical waste into gaseous stream, which are the following:

Owner/Operator	Monarch Waste Technologies	Aemerge RedPak Services Southern California
Make	Monarch Waste Technologies	Custom Built
Model	Pyromed 550	Carbonizer
Capacity (lb/hr)	554.6	5,800
Location	Santa Fe, New Mexico	Hesperia, California

Both of these units are similar to TMES proposed gasifier in that these other units shredded the medical waste, then gasified the solid waste and combusted the synthetic or produced gas as it is generated. The heat energy released once the synthetic gas is combusted is recovered using a boiler in these other units, which is similar with TMES proposed unit.

The following table is a comparison of control devices of these other gasifiers.

Table Comparison of Control Technologies of the Other Gasifiers

TMES	Monarch	Aemerge
FF Baghouse	Ceramic Cartridge filter system	FF Baghouse
Dry Scrubber using sodium bicarbonate & activated carbon	Dry Scrubber using sodium bicarbonate & activated carbon	DSI w/FF using lime

DSI - Dry Sorbent Injection

FF - Fabric Filter

These other gasifiers were permitted using the same control technologies as proposed by TMES. The ceramic cartridge filter used by Monarch is a reverse air baghouse with ceramic cartridges instead of fabric filter bags or cartridges.

TMES evaluation of other control technologies did not identify any technologies that could not be ruled out based on technological or economic justifications. Therefore, the DAQ finds that TMES evaluation to be sufficient with respect to the Sitting Requirements of Subpart Ec.

Waste Management

This section required TMES to develop a waste management plan and practices to separate certain components of the solid waste from the health care waste system (medical waste). TMES' facility will be a commercial medical waste management facility and will have to work with their customers (medical waste generators) in developing this waste management plan. Therefore, this requirement will be required in the permit for TMES to develop a waste management plan.

Compliance Demonstration and Monitoring Requirements

TMES will be required to demonstrate compliance with the emission standards through performance testing or through use of certified CEMs. During this performance testing, TMES will be required to record operating parameters. The recorded operating parameters will be used to develop operation parameter limits (OPLs) in accordance with the regulation, which will be used to determine compliance with the emission limits.

This section also requires TMES to conduct demonstrations for the fugitive visible emission standard during the initial compliance demonstration and annually thereafter.

TMES is required to monitor the operating parameters of their actual gasifier process and control devices. The parameters to be monitored are based on the type of control devices that TMES proposed to install. TMES has proposed to use dry sorbent injection and activate carbon coupled with a fabric filter baghouse.

Table

Operating Parameters to be Monitored	Data Measurement	Minimum Data Recording Frequency
Maximum Operating Parameter		

Maximum Charge Rate	Continuous	1 x Hour
Maximum Fabric Filter Inlet Temperature	Continuous	1 x Minute
Maximum Flue Gas Temperature	Continuous	1 x Minute
Minimum Operating Parameters		
Minimum Secondary Chamber Temperature	Continuous	1 x Minute
Minimum Dioxin/Furan Sorbent Flow Rate	Hourly	1 x Hour
Minimum HCl Sorbent Flow Rate	Hourly	1 x Hour
Minimum Mercury Sorbent Flow Rate	Hourly	1 x Hour

TMES proposed gasifier configuration does not have a secondary chamber as defined in the subpart and therefore there is no secondary chamber temperature to be monitored. Under 40CFR§60.56c(c)(4)(iii), the regulation allows the use of CO CEMs as a substitute for the CO annual performance test and minimum secondary chamber temperature. Thus, the permit will require the use of CO CEMs to demonstrate compliance with the CO limit.

For compliance with the PM limit under this regulation, HMIWI with fabric filter control devices (e.g., baghouse) has the option to either use PM CEMS or install a bag leak detection system to monitor the fabric filter control device. TMES has elected to install a bag leak detection system.

Reporting and Recordkeeping

The regulation requires TMES to maintain records of the monitoring and testing conducted. In addition to these records, the subpart requires semi-annual and annual reports to be submitted. Semi-annual reports shall include deviations/exceedances that occurred during the six month reporting period of the established operation parameter limits; emissions limits; and actions taken as a result of these deviations/exceedances. Annual reports shall include records of all annual requirements (e.g., annual review, annual operator training, annual inspection of control devices, etc.) and what is required for the semi-annual report.

EMERGENCY GENERATOR

TMES proposed an emergency generator that uses a spark-ignition engine to provide emergency electrical power in the event of interruption of electrical service to the facility. The engine for this emergency generator is subject to the requirements and emission standards of Subpart JJJJ of 40CFR60.

TMES proposed to operate this emergency generator set as a emergency engine outlined in Subpart JJJJ, which limits operation of the generator to 50 hours per calendar year for maintenance and readiness checks and another 50 hours for non-emergency uses other than for peak-shaving, which means that the emergency generator can only operate for up to 100 hours per calendar year for non-emergency uses. There is no limit to the operation of this emergency generator during emergency situations.

TMES proposed to purchase an emergency generator set that is equipped with an engine that the engine manufacturer has certified the model year of the engine as compliant with the emergency engine emission standards under Subpart JJJJ.

Subpart JJJJ requires the engine to be maintained to be performed in accordance with the engine manufacturer and only emission-related settings for the engine can be adjusted in accordance with the manufacturer's written instructions. The subpart requires a non-resettable hour meter to be installed and maintained on the engine. TMES will be required to document the actual hours of operation and purpose of operation of the generator to demonstrate that the engine is operated as an emergency engine.

Other Air Programs

The facility will have a potential to emit after controls less than the major source threshold levels of 45CSR30. However, the EPA has determined that all medical waste incinerators must obtain an operating permit under 40CFR70 (Part 70 Permit or refer as Title V Operating Permit). Therefore, TMES will be required to obtain an operating permit 40CSR30 within 12 months after initial startup of the gasifier. As a result of this, TMES will be subject to the annual fee and certified emission statement requirements of 40CSR30.

TOXICITY OF NON-CRITERIA REGULATED POLLUTANTS

Many non-criteria regulated pollutants fall under the definition of HAPs which, with some revision since, were 187 compounds identified under Section 112(b) of the Clean Air Act (CAA) as pollutants or groups of pollutants that EPA knows, or suspects may cause cancer or other serious human health effects. The following table lists each HAP's carcinogenic risk (as based on analysis provided in the Integrated Risk Information System [IRIS]):

HAP	**Type**	**Known/Suspected Carcinogen**	**Classification**
Metallic HAPs			
Arsenic	PM	Yes	Category A - Known Human Carcinogen
Beryllium	PM	Yes	Category B1 - Probable Human Carcinogen
Cadmium	PM	Yes	Category B1 - Probable Human Carcinogen
Chromium VI	PM	Yes	Category A - Known Human Carcinogen
Cobalt	PM	Yes	Category B1 - Probable Human Carcinogen
Manganese	PM	No	Category D - Not Classifiable

Mercury	PM	No	Category D - Not Classifiable
Nickel	PM	Yes	Category A - Known Human Carcinogen
Selenium	PM	No	Category D - Not Classifiable
Lead	PM	Yes	Category B2 - Probable Human Carcinogen
Organic HAPs			
Benzene	VOC	Yes	Category A - Known Human Carcinogen
Biphenyl	VOC	No	Category D - Not Classifiable
Dichlorobenzene	VOC	No	Category D - Not Classifiable
Ethyl benzene	VOC	No	Category D - Not Classifiable
Formaldehyde	VOC	Yes	Category B1 - Probable Human Carcinogen
Hexane	VOC	No	Inadequate Data

Naphthalene	VOC	Yes	Category C - Possible Human Carcinogen
Toluene	VOC	No	Inadequate Data
Xylenes	VOC	No	Inadequate Data
Other HAPs			
Hydrochloric Acid	Inorganic		Inadequate Review
Hydrofluoric Acid	Inorganic		No Review
Non-HAPs			
Hydrogen Sulfide	Inorganic		Inadequate Data

Dioxins refers to a group of toxic chemical compounds that share certain chemical structures and biological characteristics (see figure 1). Several hundred of these chemicals exist and are members of three closely related families:

- polychlorinated dibenzo-p-dioxins (PCDDs)
- polychlorinated dibenzofurans (PCDFs)
- certain polychlorinated biphenyls (PCBs)

Although hundreds of PCDDs, PCDFs, and PCBs exist, only some are toxic, those with the chlorine atoms in specific positions. Counting around the carbon rings, those with chlorines at positions 2, 3, 7, and 8 are toxic.

Dioxins are highly toxic and can cause cancer, reproductive and developmental problems, damage to the immune system, and can interfere with hormones.

More information about dioxins can be found at:

https://www.epa.gov/dioxin/learn-about-dioxin

MONITORING OF OPERATIONS

Subpart Ec establishes specific monitoring based on the type of control device configuration for HMIWI units. In TMES evaluation of alternative control technologies, TMES determined that good combustion controls was the feasible control technology for NO_x and CO. However, TMES did not propose how good combustion controls were to be deployed or what combustion related parameters were going to be monitored to minimize emissions of NOx and CO. Therefore, the permit will require continuous emission monitoring (CEMS) of CO and NO_x.

Given improvement of measuring multiple pollutants with a single instrument using fourier transform infrared spectroscopy (FTIR) measurement technology and the nature of treating medical waste on a commercial basis, additional monitoring of actual emission are warranted. A commercial medical waste treatment facility, like TMES has proposed, will rely on the actual medical waste generators in properly identify and sort their medical waste. Most likely the medical waste will not be sorted in a consistent or homogeneous basis. Therefore, the synthetic gas quality may not be consistently the same. Thus, the writer is recommending continuous monitoring of the following pollutants:

Criteria Pollutants	**Hazardous Air Pollutants**[2]	**Other Pollutants**
Nitrogen Monoxide (NO)[1]	Acetaldehyde – VOC	Carbon Dioxide (CO_2)
Nitrogen Dioxide (NO_2)[1]	Acrolein – VOC	Methane (CH_4)
Carbon Monoxide (CO)	Benzene – VOC	Ethane (C_2H_6)
Sulfur Dioxide (SO_2)	1,3-butadiene – VOC	Oxygen (O_2)
Propane (C_3H_8) – VOC	Chlorine	Sulfuric Acid
Ethylene – VOC	Ethylbenzene – VOC	Hydrogen sulfide
n-Butane – VOC	Formaldehyde – VOC	Hydrogen
Iso Butane – VOC	Hydrogen Fluoride	
n-Pentane – VOC	Hydrogen Cyanide	
	Hydrogen Chloride	
	n-Hexane – VOC	
	Methylcyclohexane – VOC	
	Methyl Chloride – VOC	
	Naphthalene – VOC	
	Toluene – VOC	
	n-Xylene – VOC	
	p-Xylene – VOC	
	o-Xylene – VOC	

	Acrolein – VOC	

1 - NO and NO_2 shall be summed together as NO_x.
2 - HAPs shall be reported individually and summed together as total HAPs.
3 – VOCs shall be reported as the sum of identified VOCs.

Using the CEMs to demonstrate compliance, the permit will note that the average period will be on a 24-hour block average basis, which is allowed under Subpart Ec.

Metals such as cadmium, lead, mercury can not be measured using FTIR methodologies. FTIR is looking for the unique signature of each compound. Due to the number of different dioxins and furans, the use of CEMs to measure dioxins and furans would not be reasonable.

The formation of dioxins and furans are dependent on chlorine and free oxygen being present in the stream at temperatures of 450 to 1,200 C. Medical waste will contain some amount of plastic material, which contains chlorine. TMES' gasifier requires air to be introduced in the gasifier for completely gasifying the solid medical waste into a synthetic gas. It has been documented that oxygen injected into a gasifier could increase the amount of dioxins and furans generated given that the ideal temperature conditions exist. The permit will require TMES to minimize the amount of air (oxygen) introduced into the gasifier to minimize the formation of dioxins and furans. Thus, monitoring the oxygen level in the gasifier is necessary and is considered to be a reasonable operating parameter to be monitored.

TMES proposed to combust the synthetic gas using a fire tube with an operating temperature between 1,800 to 2,200ºF (982 - 1204ºC), which is within the temperature range that dioxins and furans can form. Another approach in minimizing the formation of dioxins and furans is limiting the time that chlorinate steam with free oxygen is in the dioxin and furans reaction temperature range (e.g., quenches the steam). TMES proposed to vent the exhaust from the fire tube to a boiler, which should (if operated properly) quench the exhaust gasses down to 350 to 400ºF (177 to 204ºC). The writer is recommending monitoring the boiler exhaust exit temperature on a continuous basis.

Operating temperature and pressure of the oxidation zone gasifier would be good indicators that the gasifier is operating properly. The writer is recommending monitoring these parameters on a continuous basis.

TMES ductwork configuration allows a slip stream of the cleaned exhaust to be injected into the cyclone to control exhaust temperature. Thermal decomposition of the sorbent can occur at temperatures greater than 500ºF for sodium bicarbonate. Monitoring the exhaust temperature at this location is recommended.

For gasifier startup events, the permit will limit the number or duration of start up of the gasifier by limiting the usage of natural gas for the gasifier through a heat input limit of 48 MMBtu per year from natural gas. TMES will be required to record the amount of natural gas used for each startup event and maintain a 12-month rolling total in order to demonstrate compliance with the annual heat input limit.

TMES will be required to evaluate all streams exiting the gasifier to determine if that material is hazardous in accordance with the Resource Conservation and Recovery Act.

Other than what is required under Subpart JJJJ, no additional monitoring of the emergency generator is recommended.

RECOMMENDATION TO DIRECTOR

The information provided in the permit application indicates the proposed facility Should meet all the requirements of the applicable rules and regulations when operated in accordance with the permit application. Therefore, the writer recommends granting Thunder Mountain Environmental Services LLC a Rule 13 construction permit for their medical waste to energy facility near Ravenswood, Jackson County, West Virginia.

Edward S Andrews

Digitally signed by: Edward S Andrews
DN: CN = Edward S Andrews email = edward.s.andrews@wv.gov C = US O = WVDEP/Division of Air Quality OU = Permitting/New Source Review Workgroup
Date: 2023.05.19 14:54:09 -04'00'

Edward Andrews, P.E.
Engineer
May 19, 2023

MEMO

To: Ed Andrews Jonathan D. McClung Digitally signed by: Jonathan D. McClung DN: CN = Jonathan D. McClung email = JON.D.MCCLUNG@WV.GOV C = AD O = Department of Environmental Protection OU = Division of Air Quality Date: 2023.02.15 11:34:47 -05'00'
From: Jon McClung
CC: Joe Kessler, Steve Pursley, Rex Compston
Date: February 15, 2023
Re: Air Quality Impact Analysis Review
Thunder Mountain Environmental Services, LLC
Ravenswood, Jackson County, WV
Permit Application: R13-3563
Plant ID: 035-00082

I have completed my review and replication of the air quality impact analysis submitted by Thunder Mountain Environmental Services, LLC (TMES) in support of an air quality permit application (R13-3563) for the proposed construction of a new regulated medical waste (RMW) treatment facility in Ravenswood, within Jackson County, WV. Review and replication of various components of the modeling analysis were performed by Ed Andrews, Joe Kessler, Steve Pursley, and Rex Compston. This dispersion modeling analysis is required to evaluate the impacts from the affected facility to further support the siting analysis required pursuant to 40 Code of Federal Regulations (CFR) Subpart 60.54c(a). TMES has demonstrated that the proposed project will not cause or contribute to any violations of applicable NAAQS.

The protocol for the modeling analysis was submitted by TMES on October 10, 2022, revised on November 10, 2022, and approved by West Virginia Division of Air Quality (DAQ) on December 12, 2022. TMES submitted an air dispersion modeling report and associated electronic modeling files on December 15, 2022. Additional electronic modeling files were submitted by TMES on January 11, 2023 and February 2, 2023.

TMES proposes to construct a new solid medical waste gasification to energy facility. This facility will consist of a single thermal gasification system, a Vista Thermal Gasifier, that will be used for the treatment of medical waste. The thermal gasification system will convert the medical waste into high energy synthetic gas.

Jackson County, WV is in attainment or unclassifiable/attainment status for all criteria pollutants. The following pollutants were evaluated by TMES though dispersion modeling: Lead, NO_x, CO, SO_2, PM_{10}, and $PM_{2.5}$. Also, TMES addressed secondary formation of $PM_{2.5}$ as a result of NO_x and SO_2 emissions as well as formation of ozone from NO_x and VOC emissions. The facility wide maximum project emission rates are in Table 1 (from Page 9/33 of the Ramboll Modeling Report, 12/14/2022).

Table 1. Project Emission Rates

Emission Point	Emission Point Description	PM_{10} (lb/hr)	$PM_{2.5}$ (lb/hr)	CO (lb/hr)	SO_2 (lb/hr)	NO_X (lb/hr)	Lead (lb/hr)	VOC (lb/hr)
EP-001	Thermal Gasifier	0.0870	0.0870	0.286	0.00146	0.0693	5.03E-07	0.880
EP-001	Material Handling	0.0739	0.0261	--	--	--	--	--
		0.161	***0.113***					

Table 2 presents a summary of the air quality standards that were addressed for the TMES project. The pollutants, averaging times, and National Ambient Air Quality Standards (NAAQS) are listed. The NAAQS are incorporated by reference in WV Legislative Rule 45CSR8.

Table 2. Ambient Air Quality Standards (µg/m3)

Pollutant	Averaging Period	NAAQS
Ozone	8-hr	70 ppb
Lead	Rolling 3-month avg.	0.15
CO	1-hour	40,000
	8-hour	10,000
SO_2	1-hr	196
	3-hr	-
	24-hr	-
	Annual	-
NO_2	1-hour	188
	Annual	100
PM_{10}	24-hour	150
	Annual	-
$PM_{2.5}$	24-hour	35
	Annual	12

TMES performed air dispersion modeling and related analyses and added these impacts to representative background concentrations to assess total impacts. Table 3 contains the background concentrations used by TMES (from Page 14/33 of the Ramboll Modeling Report, 12/14/2022).

Table 3. Background Concentrations for TMES Air Quality Impact Analysis

Summary of Background Concentrations for NAAQS Analysis[a]

Pollutant	Averaging Period	Design Value[b]	Units of Measure	AQS Site ID	City
Nitrogen dioxide (NO_2)	1-Hour Annual	26.7 5.23	ppb ppb	21-019-0017	Ashland, KY
Carbon monoxide (CO)	1-Hour 8-Hour	1.00 0.600	ppm ppm	54-039-0020	Charleston, WV
Particulate Matter 2.5 ($PM_{2.5}$)	24-Hour Annual	17.0 7.53	$\mu g/m^3$ $\mu g/m^3$	54-107-1002	Vienna, WV
Particulate Matter 10 (PM_{10})	24-Hour	30.0	$\mu g/m^3$	54-011-0007	Ironton, OH
Sulfur dioxide (SO_2)	1-Hour 3-Hour	19.0 22.0	ppb ppb	54-107-1002	Vienna, WV
Ozone	8-Hour	0.0600	ppm	54-107-1002	Vienna, WV

Notes:
(a) A discussion of the monitor selection for each pollutant can be found in the Modeling Protocol submitted November 10, 2022.
(b) Design Values were provided on EPA's Outdoor Air Quality Data Monitor Values Report.

Modeling Basis

The modeling system used conforms to relevant sections of 40 CFR 51 Appendix W, applicable guidance, the approved protocol, and is summarized below:

- TMES used the regulatory dispersion model and supporting programs: AERMOD (version 21112), AERMET (version 21112), AERMINUTE (version 15272), AERMAP (version 18081), AERSURFACE (version 20060), and BPIPPRM (version 04274). The AERMOD modeling system (AERMOD, AERMET, AERMAP) is the regulatory default modeling system for near-field (<50km) regulatory dispersion modeling.
- AERMET was used to process five years of surface meteorological data from the Mid-Ohio Valley Regional Airport, Parkersburg, WV Airport (ICAO code: KPKB; WBAN Station ID 03804). Upper air data from Pittsburgh, PA airport (ICAO code: KPIT; WBAN Station ID 94823) were used.
- AERSURFACE was used to develop appropriate surface characteristic (albedo, Bowen ratio, surface roughness length) inputs to AERMET.
- A nested receptor grid was developed and AERMAP was used to determine

terrain heights and hill height scales for use by AERMOD to determine maximum modeled concentrations.

- TMES evaluated secondary formation of $PM_{2.5}$ as a result of NO_x and SO_2 emissions as well as formation of ozone from NO_x and VOC emissions.

TMES performed air dispersion modeling using AERMOD and added the modeled impacts to representative background concentrations. Table 4 presents the results of this analysis (from Page 17/33 of the Ramboll Modeling Report, 12/14/2022). The modeled impacts from TMES are very low and the background concentrations account for the majority of the total impacts.

Table 4. Modeling Results for Criteria Pollutants

Summary of AERMOD Results

Pollutant	Averaging Period	AERMOD Concentration (µg/m³)	Background Concentration[a] (ppb)	Background Concentration[a] (µg/m³)	Predicted Concentraiton[b] (µg/m³)	NAAQS (ppb)	NAAQS[c] (µg/m³)	Percent of NAAQS Standard (%)
Nitrogen dioxide (NO_2)	1-Hour	1.91	26.7	50.1	52.1	100	188	28%
	Annual	0.101	5.23	9.83	9.94	53.0	100	10%
Carbon monoxide (CO)	1-Hour	9.48	1,000	1,145	1,154	35,000	40,071	3%
	8-Hour	4.86	600	687	692	9,000	10,304	7%
Particulate Matter 10 (PM_{10})	24-Hour	1.88	--	30.0	31.9	--	150	21%
Sulfur dioxide (SO_2)	1-Hour	0.0461	19.0	49.8	49.8	75.0	196	25%
	3-Hour	0.0404	22.0	57.6	57.7	500	1,309	4%
Lead[d]	3-Month	0.00E+00	--	--	0.00E+00	--	0.150	0%

Notes:

(a) Information on source of background concentrations can be found in **Table 6**. Units converted from ppb to µg/m³ using the following formula: (100 [ppb] + 1000 [ppb/ppm]) * (molecular weight [g/mol] + 1000 [µg/g]) + (82.057338 [atm*cm3/mol-K] * 298.15 [K] + 1 [atm]) * 1000000 [cm3/m3] * 1000 [µg/mg]

(b) Predicted Concentration (µg/m³) = AERMOD Concentration (µg/m³) + Background Concentration (µg/m³)

(c) NAAQS converted from ppb to µg/m³ using the following formula: (100 [ppb] + 1000 [ppb/ppm]) * (molecular weight [g/mol] + 1000 [µg/g]) + (82.057338 [atm*cm³/mol-K] * 298.15 [K] + 1 [atm]) * 1000000 [cm³/m³] * 1000 [µg/mg]

(d) The highest first high 1-month concentration for lead was predicted to be 0 µg/m³. Therefore, the 3-month rolling average was calculated to be 0 µg/m³

TMES performed air dispersion modeling for the direct impacts of $PM_{2.5}$ and also evaluated the secondary formation of $PM_{2.5}$ from NO_x and SO_2 emissions. TMES added the direct impacts, secondary impacts, and background concentrations of $PM_{2.5}$ to compare to the NAAQS. Table 5 contains the results of this analysis (from Page 18/33 of the Ramboll Modeling Report, 12/14/2022). The impacts of $PM_{2.5}$ from TMES are very low and the background concentrations account for the majority of the total impacts.

Table 5. Modeling Results for $PM_{2.5}$

Summary of $PM_{2.5}$ Results

Pollutant	Averaging Period	AERMOD Concentration (µg/m³)	Background Concentration[a] (µg/m³)	Secondarily Formed $PM_{2.5}$[b] (µg/m³)	Predicted Concentraiton[c] (µg/m³)	NAAQS (µg/m³)	Percent of NAAQS Standard (%)
Particulate Matter 2.5 ($PM_{2.5}$)	24-Hour	0.909	17.0	2.23E-05	17.9	35.0	51%
	Annual	0.183	7.53	9.56E-07	7.72	12.0	64%

Notes:

(a) Background concentration from the Vienna, WV monitoring site from 2018, 2020, and 2021

(b) Secondarily Formed $PM_{2.5}$ (µg/m³) = NO_x Secondary Impact (µg/m³) [as provided in **Table 8**] + SO_2 Secondary Impact (µg/m³) [as provided in **Table 8**]

(c) Predicted Concentration (µg/m³) = AERMOD Concentration (µg/m³) + Background Concentration (µg/m³) + Secondarily Formed $PM_{2.5}$ (µg/m³)

TMES the formation of ozone from NO_x and VOC emissions from the proposed project. Table 6 contains the results of this analysis (from Page 19/33 of the Ramboll Modeling Report, 12/14/2022). The impacts from TMES on ozone formation are very low and the background concentrations account for the majority of the total impacts.

Table 6. Ozone Analysis Results

Summary of Ozone Results

Pollutant	Averaging Period	Background Concentration[a] (ppb)	Secondarily Formed Ozone[b] (ppb)	Predicted Concentraiton[c] (ppb)	NAAQS (ppb)	Percent of NAAQS Standard (%)
Ozone	8-Hour	60.0	1.92E-03	60.0	70	86%

Notes:
(a) Background concentration from the Vienna, WV monitoring site from 2018-2020
(b) Secondarily Formed Ozone (ppb) = NO_X Secondary Impact (ppb) [as provided in **Table 10**] + VOC Secondary Impact (ppb) [as provided in **Table 10**]
(c) Predicted Concentration (ppb) = Background Concentration (ppb) + Secondarily Formed Ozone (ppb)

Summary

The air quality impact analysis prepared and submitted by TMES to the DAQ has been reviewed and replicated and conforms to relevant sections of 40 CFR 51 Appendix W, applicable guidance, and the modeling protocol. No modeled violations are predicted for the applicable NAAQS. Accordingly, TMES does not cause or contribute to any violations of the applicable NAAQS. No further modeling is required by TMES.