Pyrolysis and Energy Production Medical Solid
Waste Treatment Facility/
Application & Fees
January 2019
Revision 9 July 28, 2020

Table of Contents

PLEASE READ ENTIRE DOCUMENT AND THE ATTACHMENTS REFERENCED BELOW ARE PART OF THE NARRATIVE.

LIST OF ATTACHMENTS

ATTACHMENT	DESRIPTION
A	Air quality permit, Macerator information, negative pressure, pyrolysis unit specification, plant layout drawings, Industrial Hygiene reports, pyrolysis project specification, various Medrecycler-RI response documents to RIDEM
B	Employee Manual
C	ESH Manual Medrecycler Rev 1
D	Fire Safety and Evacuation Plan
E	Decommissioning documentation, clean-up insurance endorsement, insurance certificate, environmental excess liability insurance and policy declaration.
F	Medrecycler-RI Application signed by Professional Engineer dated June 28, 2019, Revision 8.
G	Various RIDEM corespondent letters, Air quality permit
H	Plat layout drawings, individual equipment drawings, detailed plant drawings

Tab 1 - Application for Pyrolysis and Energy Production
Medical Solid Waste Treatment Facility

RHODE ISLAND DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
OFFICE OF WASTE MANAGEMENT
SOLID WASTE SECTION
235 PROMENADE STREET
PROVIDENCE, RHODE ISLAND 02908-5767

Application for a license or registration to Operate a Pyrolysis and Energy Production Medical Solid Waste Treatment Facility lssued Pursuant to Title 23-Chapter 18.9 of the General Laws of Rhode Island (1979 Reenactment) and the Rules and Regulations for Composting Facilities and Solid Waste Management Facilities, January 1997.

I. TYPE OF APPLICATION (CHECK ONE)

LICENSE FOR:

A. Sanitary Landfill _____
B. Transfer Station/Collection Station _____
C. Resources Recovery Facility/Incinerator _____
D. Petroleum Contaminated Soil Processing Facility _____
E. Construction and Demolition Debris Processing Facility _____
F. Mixed Solid Waste Composting Facility _____
G. Pyrolysis and energy production Medical Waste Treatment Facility X
H. Tire Storage & Recycling Facility _____
I. Other Solid Waste Management Facility _____

REGISTRATION FOR:

A. Leaf and Yard Waste Composting Facility _____
B. Putrescible Waste Composting Facility _____
C. Facilities that Process C & D Debris (less than 50 TPD) _____

2. NAME(S) OF APPLICANT(S) Medrecycler-RI Inc.

3. MAILING ADDRESS: 1600 Division Road, West Warwick, RI, 02893

4. NAME AND ADDRESS OF COMPOSTING OR MEDICAL SOLID WASTE TREATMENT FACILITY: _____

January 29, 2019

Rhode Island Department of Environmental Management
Office of Waste Management
Att: Yan Li
235 Promenade Street
Providence, RI 02908-5767

Dear Yan,

On January 29, 2019 Medrecycler-RI, Inc., seeks a permit to construct and temporarily operate a Pyrolysis and Energy Production System utilizing Medical Waste as the primary source of feed stock.

Thank you,

_____

Nicholas Campenella
Medrecycler-RI Inc.

Tab 2 – Check for ~$_____ (photocopy)

Tab 3 - Expedited Permit Information

1. PROJECT INTRODUCTION

Medrecycler-RI Inc., plans to construct a new medical waste processing facility and produce electrical energy from the production of synthesis gas (syngas). Facility will be located at:

Medrecycler-RI Inc.
1600 Division Road
West Warwick, RI 02893

Contact: Nicholas Campenella

The facility will house a pyrolysis system where organic fractions of the waste will be evaporated and sent to engines that will produce electricity. Other products are produced such as oil and tar and these will be recycled through the system. Off-gas products will be conditioned prior to release via a stack. Emissions from this pyrolysis system are well below the Air Toxic Standards regulated by the Department of Environmental Management for Rhode Island.

Pyrolysis system will be supplied by Technotherm, Inc. located in South Africa with address of:

Technotherm, Inc.
Woodhill Office Park
Block 6 Ground Floor
53 Philip Engelbrecht Street
Mayersdal, South Africa
Website: www.technotherm.co.za
Contact: Richard Bingham

The following are a list of waste to energy projects completed and in progress using Technotherm Technology:

1. Country Meats-Knoostad, South Africa
    a) Waste form: Animal slaughterhouse
2. Ecorevert-Wadeville, South Africa
    a) Waste form: All types of waste, design for plastic
3. Huntington, United Kingdom
    a) Waste form: Biomass (wood)

Medrecycler-RI will be the owner and operator of the waste to energy facility. This will be the first waste to energy project for Medrecycler-RI. Medrecycler-RI relevant project experience is mainly related to alternative energy especially Solar Energy.

Table 1 shows the State Application needed to permit the Pyrolysis System in Rhode Island. The information was taken from the RI-DEM website.

Table 1. List of Required State Application and Registration Documents

Tab	Equipment	Application/Registration	Comments
1	Overall System	Application for Approval of Plans to Construct, Install or Modify Air Pollution Equipment	Specifically related to the Scrubber, Thermal Oxidizer
2	Overall System	Application for Approval of Plans to Construct, Install or Modify Processing Equipment	All Pyrolizer IO's

2. GENERAL PROCESS DESCRIPTION

Overall process takes medical waste (MW), received by a transporting company, and thermally processes it in a pyrolysis system operating at 800°C - 900°C (1,472°F - 2,1652°F). Organic matter from the MW is evaporated forming a syngas that can directly be used as a fuel source for electrical generating engines. Oil and tar are produced where the oil is recycled through the pyrolysis system to make more syngas, and the tar is used to heat a vitrification system where solids from the process are vitrified and made inert. Exhaust from the engines are sent to a drying unit where the MW is dried prior to be introduced into the pyrolysis system. All gasses are sent to a Thermal Oxidizer where they are conditioned for release to atmosphere via a stack at a temperature of 850°C (1,562°F).

3. DETAILED PROCESS DESCRIPTION

Referring to Figure 1 below, a detailed description of the process follows where MW (100) is received, sent to Staging (120) and then to Macerator (200). Macerator (200) operating at negative pressure of -0.024 kPa reduces the MW to less than or equal to 15 mm (.059-inch). MW (100) moves from Macerator (200) to the Dryer (220) and is dried from the exhaust of the Engine (600). Once the MW (100) is dried, it moves to Feed Silo (240) through load lock valves. When the Pyrolysis (300) system is ready to accept feed, load locking valves are actuated such that the feed in put into the Pyrolysis (300) system. Coordinated valve actuation is used to keep oxygen level from air at 0.0% in the Pyrolysis (300) system. As MW (100) is being processed in Pyrolysis (300) system, organic matter is evaporated forming syngas and moves to the Gas Cleanup (400). Gas Cleanup (400) removes particulate matter and performs the bulk of neutralizing acid forming gases. Next, the gas passes to Scrubber (420) where any acid gasses are further removed from the syngas. Syngas then proceeds to the Gasometer (500) which helps regulate the pressure in the Engine (600). Syngas is combusted in the Engine (600) and the exhaust is sent to Dryer (220). Exhaust from the dryer is diverted to the Cyclone (620) and then to Feed Silo (240). Vitrifier (800) exhaust goes to the Pyrolysis (300) system, makes one pass through the outer chamber of the Pyrolyser (300) system in order to provide additional heat, and makes its way to the Dryer (220). Gases from the Dryer (220) exhaust are sent to the Thermal Oxidizer (900) through Cyclone (620). Tar (720) is mixed with Air (820) and heats the Vitrifier sufficiently to make a inert, glass product ready for disposal. Oil (700) is continuously recycled through the Pyrolysis (300) system. Off-gas from the Thermal Oxidizer (900) are sent to the Stack (1000) and are released into the atmosphere.

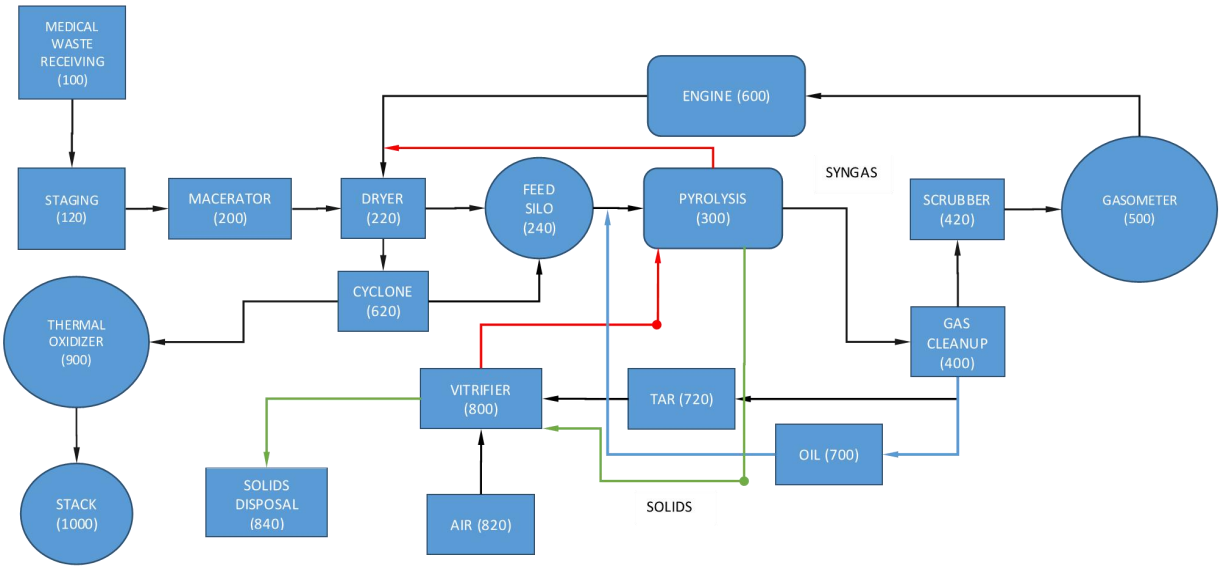


Figure 1. Block flow diagram for detailed process description.

Note: see Attachment "H" document, **H 1131-060-001.pdf**, and Attachment "A" documents, **A Pyrolysis Plant Drawing.pdf** and Drawing **1131 - 001 Plant Layout.pdf**.

4. EMISSIONS ALL DEVICES

Medical waste has significant variation in form and quantity. It seems the best way to describe it as a heterogeneous mixture of solids, semi-solids and liquids. Literature review showed a wide range of medical waste types generated from hospitals, clinics and veterinarian offices to name a few. References to the papers are given at the end of this section. The paper written by Dor and Bartocci[1] showed a reasonable result when examining the variation in medical waste. They state a heterogeneous medical waste composition based on the Bayer Waste Range and is repeated in Table 2. Municipal Solid Waste (MSW) data by Stepien, et.al.,[2] are given for comparison purposes.

Table 2. Range of Heterogeneous Properties of Medical Waste[1].

Medical Waste Composition	Bayer Waste Range (wt, %)	MSW by Stepien, et.al[2]
C	25 to 60	50.50
H2	4 to 10	3.00
O2	0 to 30	21.10
N2	0 to 5	1.90
S	0 to 5	0.46
-Cl	0 to 15	1.20
Oxide	0 to 40	
Metal	1 to 5	
H2O	1 to 20	21.54
HHV (Btu/lb)	4,000 to 12,000	

Composition of the medical waste and the pyrolysis output are shown in Table 3. Pyrolysis emissions are also shown for medical waste by Durcharme[3] and MSW by Technotherm[4].

Table 3. Medical Waste Composition and Pyrolysis Output

Component Medical Waste	Medical Waste Composition (Wt, %)	**Pyrolysis Component**	Pyrolysis Syngas, (Wt, %)	Pyrolysis[3] Syngas, (Wt, %)	Pyrolysis[4] Syngas, (Wt, %)
O2	22.78	**O2**	1.54	2.64[1]	4.21
C	20.50	**CO2**	19.25	18.2	34.77
H2	20.50	**CO**	30.80	27.9	30.81
N2	2.85	**CH4**	2.16	1.8	21.49
CaO	1.59	**H2**	11.55	37.8	3.47
K2O	2.51	**C14H30 (oil)**	3.85		
S	2.85	**C20H42 (tar)**	3.85		
Na2O	5.69	**N2**	2.19		3.47
Cl	8.54	**CaO**	1.23		
MgO	2.39	**K2O**	1.93		
Fe2O3	2.96	**Na2O**	4.38		
H2O	5.69	**HCl**	6.58	0.03	
C2H4	1.14	**H2O**	4.38		
		MgO	1.84		
		Fe2O3	2.28		
		SO2	2.19		
Total	100		100		

***Rounding errors may apply.

Pyrolysis syngas and solids can vary about 30% or greater based on the input feed. An attempt was made to produce a syngas composition where some of the elements and compounds were near the middle and greater than the middle of the feed composition shown in Table 2. Metal-oxides are shown as individual compounds instead of just the term "glass". Although, CaO, MgO and Fe_2O_3 are found in bone and the latter in blood and sharps.

Once a syngas was established within the variations described, the next step was to combust those available compounds through the Engine, Vitrifier and Thermal Oxidizer. Stoichiometric combustion equations are shown below:

2CO	**+**	**O2**	**→**	**2CO2**		
2C14H30	**+**	**43O2**	**→**	**28CO2**	**+**	**30H2O**
2C20H42	**+**	**61O2**	**→**	**40CO2**	**+**	**42H2O**
CH4	**+**	**O2**	**→**	**CO2**	**+**	**H2O**
2H2	**+**	**O2**	**→**		**+**	**2H2O**

Emissions for all devices are shown in Figure 2 (see Attachment 2, end of this TAB) and are shown as an expanded Block Flow Diagram in the following narrative.

The daily throughput for the pyrolysis process system shall be 70 U.S. tons per day and will operate twenty (24) hours a day, seven (7) days a week, for 310 days per year. This equates to 85% availability for processing equipment. All calculations are based on 70 tons/day which equate to only four (4) tractor-trailer loads. All major chambers have the design life of twenty (20) years before replacement.

Throughput calculations are as follows:

<u>Calculation 1</u>: Throughput

- Hourly Throughput: (2,646.703 kg/hour) / (2.204 lb/kg) = 5,833.33 lb/hr
- Annual Throughput
  5,833.33 lb/hr x 24 hr/day x 310 days/year x 1 ton/2000 lb = 21,699.99 tons/year → 21,700 Tons/year
- **Annual Throughput: 21,700 Tons/year**

(lbs/hr x 24 hr/day x 310 day/yr) / 2000 lbs/ton = tons/year (annual output)

Table 5: Hourly, Daily and Annual Emission Outputs (from model results Figure 2)

See Attachment "A", **A 1131 Air Quality Permit Medrecycler-RI-App 2454-2457.pdf**, issued 7 May 2020

Offgas/Solids Component	kg/hour	lbs/hr	lbs/day	US tons/yr
CO2	2,546.81	5,613.18	134,716.31	20,881.03
H2O	5,725.07	12,618.06	302,833.41	46,939.18
N2	22,861.83	50,387.47	1,209,299.24	187,441.38
Ar	293.33	646.51	15,516.18	2,405.01
CAO	3.25×10^{-7}	7.16×10^{-7}	1.72×10^{-5}	2.66×10^{-6}
K2O	5.11×10^{-8}	1.13×10^{-7}	2.70×10^{-6}	4.19×10^{-7}
NA2O	1.16×10^{-7}	2.56×10^{-7}	6.14×10^{-6}	9.51×10^{-7}
HCl	1.74×10^{-6}	3.84×10^{-6}	9.21×10^{-5}	1.43×10^{-5}
H2O	0.0116	0.0256	0.0614	0.0951
MgO	4.87×10^{-8}	1.07×10^{-7}	2.58×10^{-6}	3.99×10^{-7}
FE2O3	6.03×10^{-8}	1.33×10^{-7}	3.19×10^{-6}	4.95×10^{-7}
SO2	5.80×10^{-6}	1.28×10^{-5}	3.07×10^{-4}	4.76×10^{-5}
NO	3.00×10^{-5}	6.61×10^{-5}	2.69×10^{-3}	4.12×10^{-4}
NO2	4.00×10^{-5}	8.82×10^{-5}	3.66×10^{-3}	5.68×10^{-4}
TOTAL	**31,427.06**	**69,265.24**	**1,662,365.77**	**257,666.69**
SOLIDS OUTPUT				
CAO	32.46	71.54	1,717.06	266.14
K2O	51.06	112.53	2,700.67	418.60
NA2O	116.04	255.75	6,137.88	951.37
MgO	48.74	107.41	2,577.91	399.58
FE2O3	60.35	133.00	3,192.02	494.76
NACL	280.22	617.60	14,822.52	2,297.49
NA2SO3	129.54	285.51	6,852.15	1,062.08
TOTAL	**718.39**	**1,583.34**	**38,000.21**	**5,890.03**

Calculations Used:

- kg/hr x 2.204 lbs/kg = lb/hr

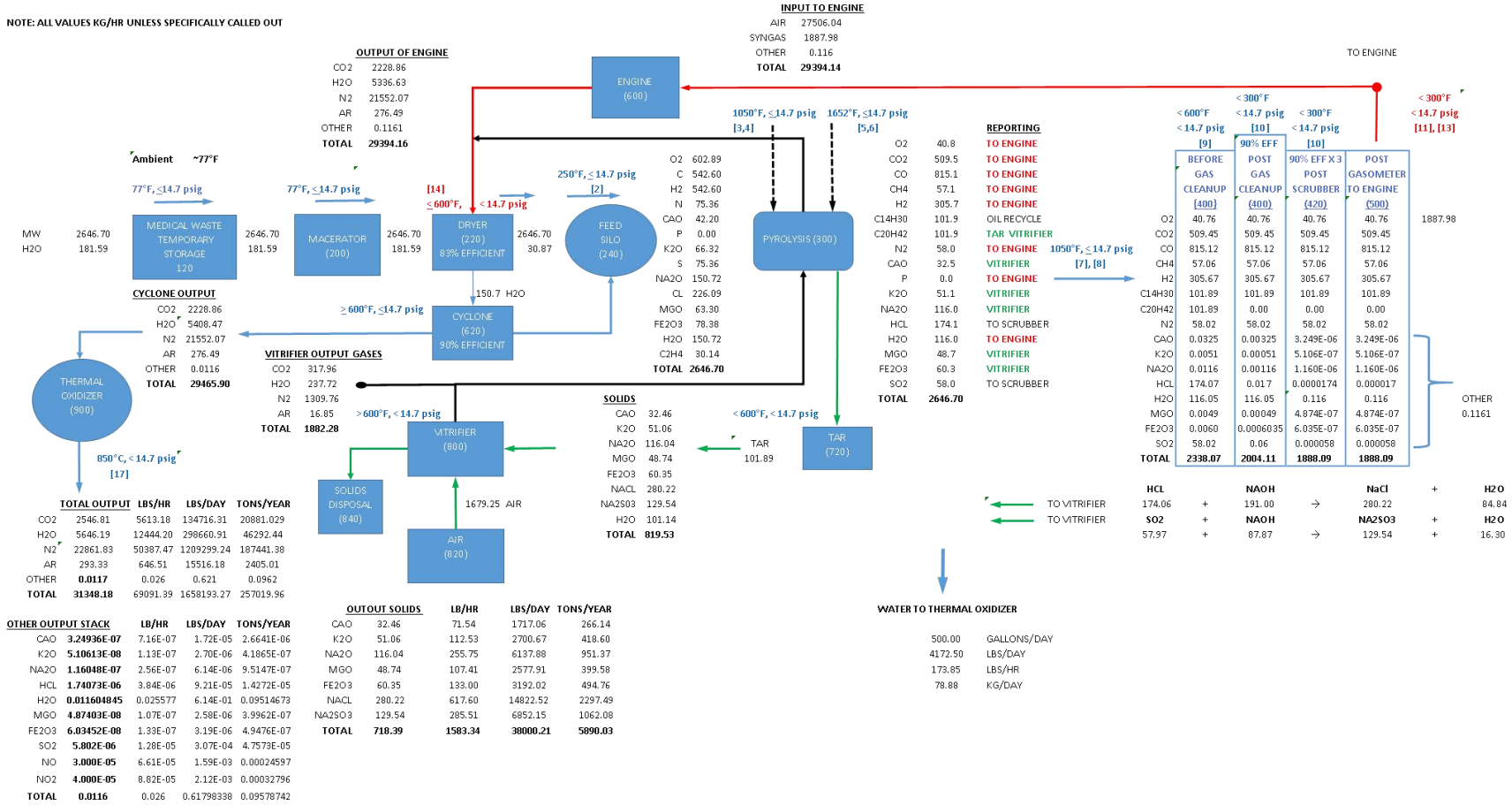


Figure 2. Emissions All Devices and Stack Output.

See Attachment “A” document, **A 1131 Air Quality Permit Medrecycler-RI-App 2454-2457.pdf**, issued 7 May 2020 by RIDEM Office of Air Resources

5. OPERATION OF DEVICES

Table 6 shows quantities and parameters relevant to the proper operation of all devices:

Table 6. Operational Parameters All Devices

Device	Temp, °F	Flow	Press., Psig	Operating Voltage, Volts	Operating Current, Amperes	Other, as stated	Other, as stated
Medical Waste Receiving (100)	Ambient	-	Atm	110-120 V, 60 Hz	15	-	-
Medical Waste Temp Storage (120)	Ambient	-	Atm	110-120 V, 60 Hz	15	Storage Capacity 10 tons	-
Macerator (200)	250-300	5,833 lbs/hr	50-100	480 V, 60Hz	5-20	Capacity 2 tons	-
Dryer (220)	250-300	5,833 lbs/hr	0-3	480 V, 60 Hz	4-40	Capacity 2 tons	-
Feed Silo (240)	250-300	5,833 lbs/hr	0-3	480 V, 60 Hz	15	Capacity 5 tons	-
Pyrolysis (300)	1,472-1,652	5,833 lbs/hr	-0.049-(-0.24)	480 V, 60 Hz	4-40	Capacity 3 tons	Natural Gas 500-1200 SCFH Syngas 500-1200 SCFH
Gas Cleanup (400)	275-325	4100-5100 lbs/hr	0-3	480 V, 60Hz	5-20	-	-
Scrubber (420)	275-325		0-3	480 V, 60Hz	5-20	-	-
Gasometer (500)	275-325		0-3	480 V, 60Hz	5-20	-	-
Engine (600)	300-500		0-3	480 V, 60Hz	5-20	-	-
Cyclone (620)	275-325		0-3	480 V, 60Hz	5-20	-	-
Oil (700)	-	-	-	-	-	-	-
Tar (720)	-	-	-	-	-	-	-
Vitrifier (800)	500-1,000		0-3	480 V, 60Hz	5-20	-	-
Solids (840)	-	-	-	-	-	-	-
Thermal Oxidizer (900)	1,562 MAX	66,000 ACFM MAX	0-3	480 V, 60Hz	5-20	-	-
Stack (1000)	1,562 MAX	66,000 ACFM MAX	0-3	480 V, 60Hz	5-20	-	-

6. SUB-SYSTEM OPERATION PRIME EQUIPMENT DETAIL

Prime Equipment & Systems

The following descriptions supplements the Process Flow Diagrams (PFDs) shown in Figure 1.

Delivery of medical waste

The material will be offloaded from four (4) tractor-trailers per day and tipped onto the receiving conveyor with the use of bin tipping stations as shown in Figure 3. **Medical Waste will not be stored on site.**

Figure 3: Illustration of typical bin tipping station

The waste operator will record the weight of each load prior to tipping. Additionally, a weighbridge operator records the weight of the trucks as they enter and exit the plant.

The material will automatically feed the Macerator required and dictated by the plant control philosophy.

An air extraction system is built into the Macerator with an extraction fan pulling from the topside of the Macerator at a rate of 1.2 m^3/sec. Macerator will be under negative pressure of -0.024 kPa at all times during operations. See Attachment "H" documents, **H 1131-060-055 Shredder Inlet and Outlet Sealing_info.pdf, H 1131 Macerator/Shredder Specification.pdf, H 1131 - Phase Pyrolysis Specification.pdf** and document **A 1131-Pyrolysis unit specification.pdf**.

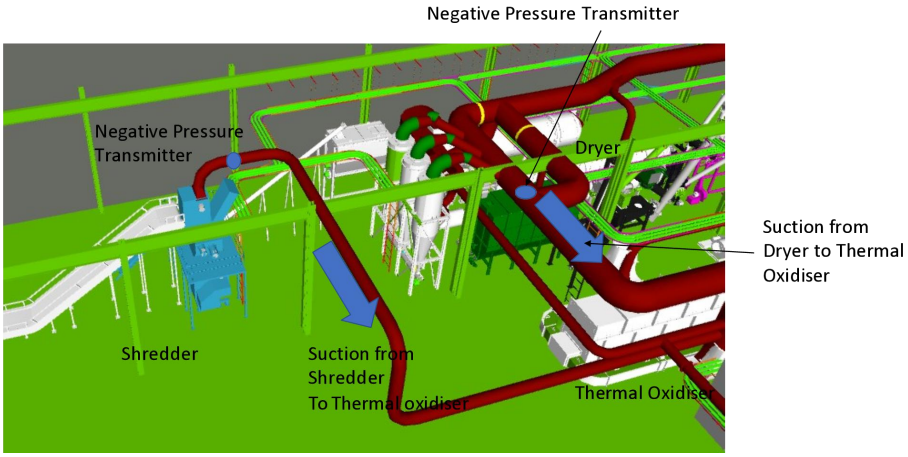


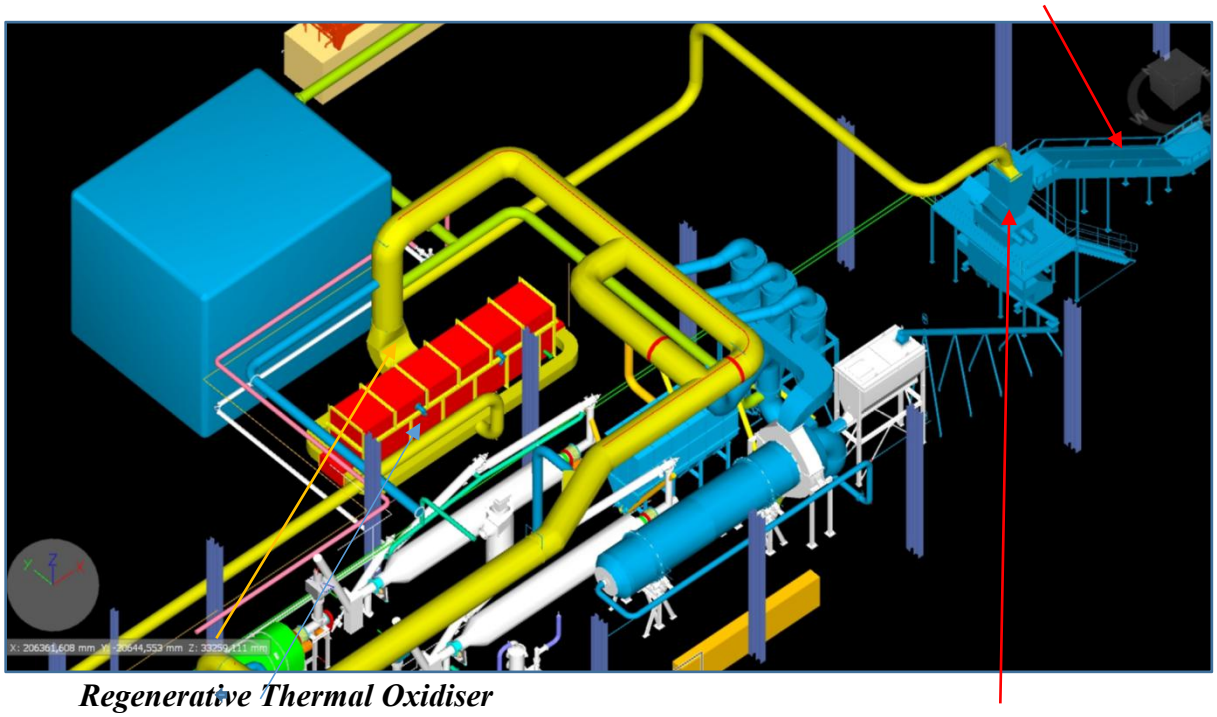
Figure 4. Negative Pressure from Macerator to Thermal Oxidizer.
Note all areas prior to thermal degradation are sealed and under negative pressure

From RIDEM Minor Source Permit document, Medrecycler-RI Inc., Approval Nos. 2454-2457, Section C Paragraph 5:

The owner/operator shall take all necessary precautions to restrict the spreading of biological and infectious diseases by ensuring that the equipment used to process the medical waste prior to the pyrolysis units is a closed system and is maintained under negative pressure at all times.

Further detail, qualifying waste in prepared sealed containers are delivered to the plant and placed on an input conveyor. After placing on the conveyor operator has no further involvement with the waste.

Material input conveyor



Regenerative Thermal Oxidiser

Macerator

Figure 5. Materials input conveyor to Macerator under negative pressure to Thermal Oxidizer.

The shredder / macerator has a single opening that is sealed, allowing the waste to enter as presented through a single entry point under suction that is closed when waste is not presented for an extended period or during shut down mode,

The entire facility is closed to the operating environment and operates under a negative pressure (-0.024 kPa), ensuring no escape of odors or pathogens.

Transfer from the Macerator to the dryer and from the dryer to the thermal pre-pyroliser is also sealed to the environment operating under a negative pressure.

Progression to the high temperature pyrolysis unit (Fig. 4) is again sealed, although at this time all possible contaminants are destroyed.

The main item that is creating a negative pressure is an Induced Draft Fan. This fan is connected to the regenerative thermal oxidizer, from the thermal oxidizer to the Macerator, dryer and all material interfaces.

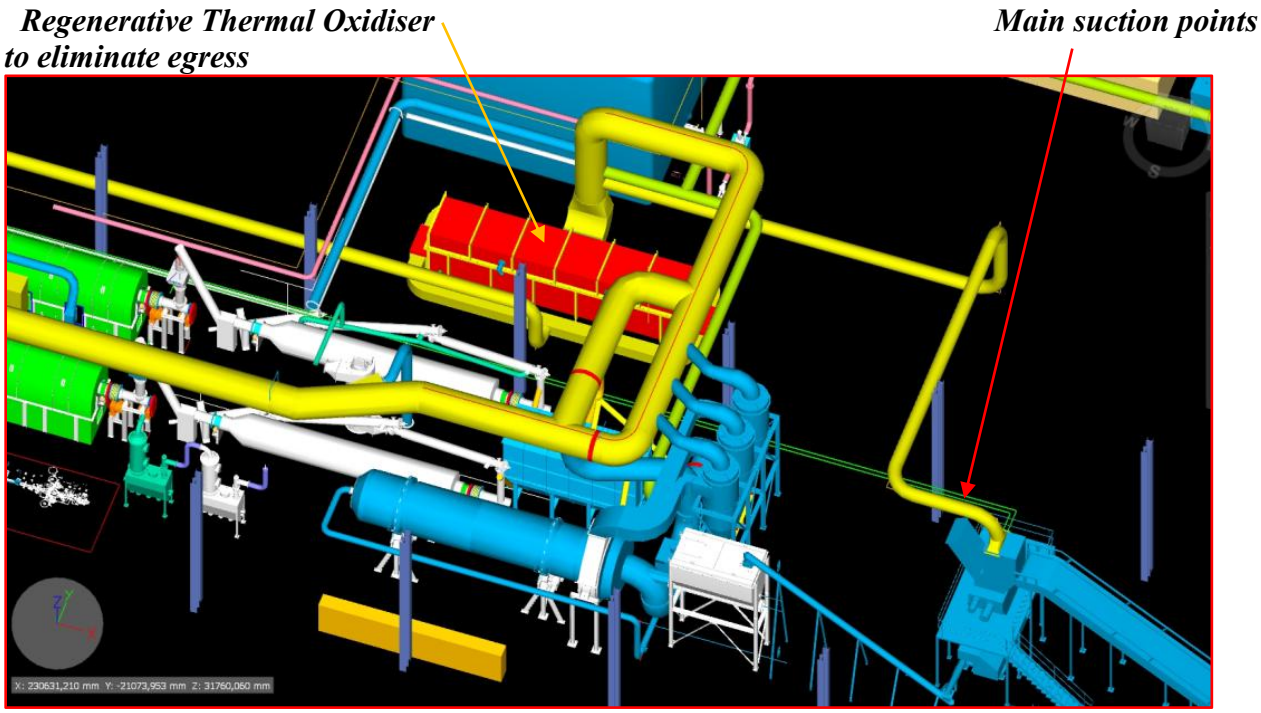


Figure 6. The Regenerative thermal oxidizer is maintained at 850°C.

Interlocks:The plant cannot be energized unless the ID fan is on and the Thermal oxidizer at temperature. There is no possibility of Pathogen escape or odors.

If the Thermal Oxidize goes below a predetermined temperature, the plant goes into shut down mode. In the event of a power failure the main control functions are connected via UPS. At this time a normally closed solenoid valve will have closed the only orifice on the plant which is where the waste is admitted. In the unlikely event of an ID fan failure (never had one in 25 years) the plant will again default to shut down mode. See Attachment “A” at the end of this Application for reference documents:

1. H 1131-060-055 Shredder Inlet and Outlet Sealing_info.pdf
2. A 1131 Air Quality Permit medrececycler-RI-App 2454-2457.pdf
3. A 1131 Layout Negative Pressure Monitoring.pdf
4. A 1131 Macerator Negative Pressure.pdf
5. A 1131-020-001 Medical waste macerator (shredder) Rev A.pdf
6. A DEM response on negative pressure and macerator.pdf

From Industrial Hygiene Company: Environmental Health & Engineering, Inc., also Attachment “A” documents.

<u>Biological Testing Efficacy</u>:

1. A IH Recs for DEM Response Update (EH&E 23129).pdf. Document dated December 19, 2019

Macerator Negative Pressure:

1. H 1131-060-055 Shredder Inlet and Outlet Sealing_info.pdf
2. A IH RIDEM Response letter-may 2020.pdf. Document dated May 2020

Macerator material (feed stock) is conveyed to the thermal dryer feed hopper. Figure 7 shows a typical Macerator system.

Figure 7. Picture of a typical Macerator/Shredder system.

Thermal Dryer

The drying of the feed stock is carried out in a direct heated, parallel flow, rotary twin drum type dryer using a combination of engine exhaust and, if necessary during start-up or unusual operating conditions, syngas and, as a last resort, natural gas / LPG. See Attachment “H” document, **H 1131 - Dryer Specification.pdf.**

Feed stock is transported from the dryer feed hopper into the dryer by means of a screw conveyor. Upon entering the dryer inner retort, the moist feed stock comes into direct contact with the parallel stream of hot

flue gases.

Lifters and progression plates ensure intimate contact between the feed stock and flue gas therefore facilitating efficient drying, sterilization and movement of feed stock along the retort. Once both feed stock and flue gases reach the closed end of the dryer they are discharged from the inner concentric retort into the outer retort and return to the entry end of the dryer, discharging 10% moisture level feed stock into an expansion chamber. Coarse dry feed stock falls to the bottom of the chamber forming a heap on the belt conveyor located beneath.

The flue gas exhaust, contaminated with light particulate feed stock material, is also discharged from the expansion chamber and ducted to a bank of cyclones where separation occurs. Fine particulate falls to the bottom of each cyclone and is discharged via rotary valves into a common screw conveyor. The screw conveyor discharges the fine product onto the belt conveyor joining the dryer exit material and fine product. This conveyor transfers the combined dry feed stock streams onto a conveyor feeding an intermediate storage hopper that feeds both Pyrolyzers.

The cooled flue gas stream from the cyclones is directed to the Thermal Oxidizer.

Figure 8 and Figure 9 shows photos of a typical dryer in operation.

Figure 8. Photo of a typical dryer in operation from first floor level.

Figure 9. Photo of a typical dryer in operation from ground floor level.

Pyrolyser & Vitrification Furnace

Overview

The Pyrolyser train is fed dried feed stock from a thermal dryer as described in the previous section. The Pyrolysis train consists of two identical Pyrolyzers. Per unit, the source of indirect heat is primarily hot exhaust flue gas from a vitrification furnace located beneath the pyrolysis retort. These hot flue gasses exit the Pyrolysis Retorts and then progress to the medium grade heat applications (Thermal Dryer and during start up Syngas Cooler and Tar Condenser). Supplemental heating of the pyrolysis retort is being provided by firing a portion of the cleaned syngas. Natural gas / LPG is available for initial start-up or any start-up where insufficient syngas is available. After passing through the dryers the gas is progressed to the Thermal Oxidizer.

Detailed Description

Feed stock is transferred from the dryer to a live bottom screw hopper, which feed an inlet hopper complete with horizontal material feed screw. Material is fed from a gas-tight, storage hopper into the horizontal, conically shaped, rotary drum Pyrolyzer Retort by a rotary screw. See Attachment “H” document, **H 1131 Phase Pyrolysis Specification**, Attachment “A” document, **A 1131 Pyrolysis unit specification.pdf**.

As the material passes through the pyrolysis retort, it undergoes thermal degradation releasing volatile organic syngas compounds that are discharged from the retort. The crude syngas off-takes are collected into a common manifold that transfers the syngas to the syngas cleaning system.

The heavier particles, mainly comprising of ash and fixed carbon, collect in a specially designed high temperature de-acceleration chamber where the particles are collected and returned to the vitrification furnace.

The Pyrolyzers must be designed and arranged such that no propensity for harmonic vibrations shall exist under any load condition and shall be complete with all ancillary equipment for safe, reliable and efficient operation, and be of proven design capable of the required continuous, intermittent and transient operation and be suitable for its intended location. The design and materials of construction shall take fully into account the location.

Ash and carbonaceous residue produced by the Pyrolyzers drops off the dust from the aforementioned de-acceleration chamber screw conveyors, together with the main residue collected from the base of the Pyrolyzer into a Vitrifier, a refractory lined furnace fired by recovered tars (described below in the syngas cleaning equipment). The heat liberated by burning the tars and oils is sufficient to heat the ash from the Pyrolysis units above their eutectic temperature with excess, preheated air to burn off the tars. The char is completely combusted into CO_2 and H_2O.

Figure 10, Figure 11 and Figure 12 show photos of Pyrolyzers in operation.

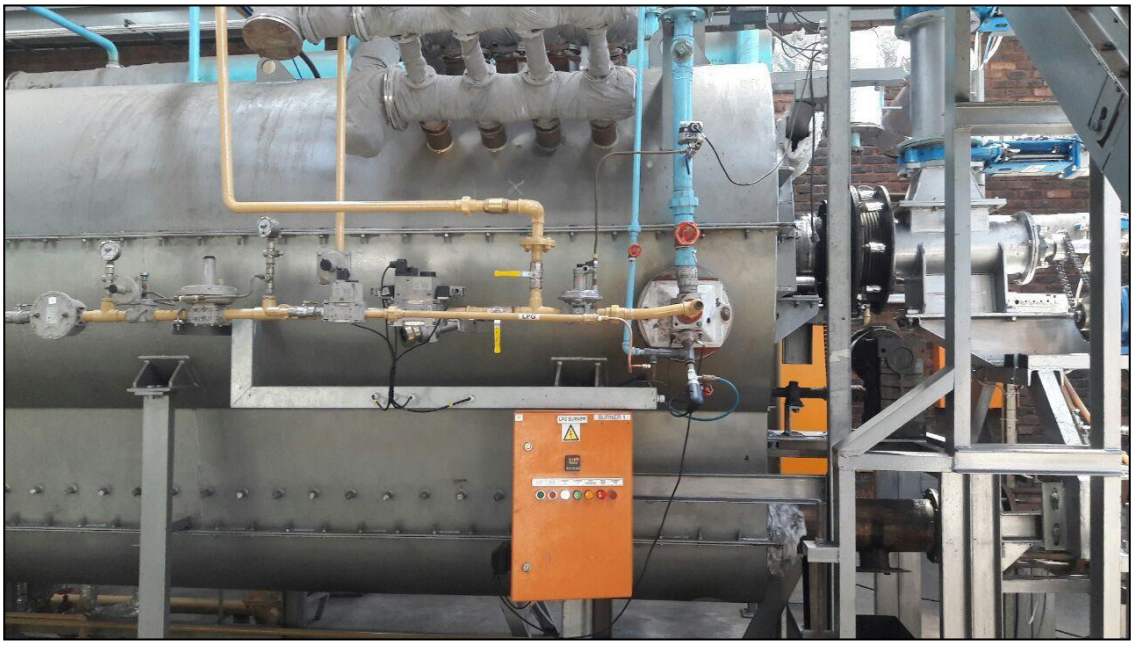


Figure 10. Photo A of typical high temperature pyrolysis unit.

Figure 11. Photo B of typical high temperature pyrolysis unit.

Figure 12. Photo of typical low temperature pyrolysis unit.

Syngas Cleanup

Particulate Matter (PM) Cleanup

Raw syngas is removed from the Pyrolysis Retorts, as described above, and passes through a de-acceleration chamber and then hot cyclones. The cyclones are arranged for parallel flow to ensure maximum PM removal efficiency during start-up and shutdown as the flow varies. PM drops to specially designed hot screw conveyors and from there is directed to the vitrification furnaces described above. See Attachment "H" document, **H 1131 - Gas Clean-up System**.

Syngas Coolers

The partially cleaned, still hot, flue gas flows next through stainless steel tubular syngas coolers. The cooler is in essence a Heat Exchanger which indirectly transfers heat from syngas to the combustion air heaters.

Tar Condensers

The syngas from the coolers described above flows to a stainless-steel shell & tube Heat Exchanger/cooler that is cooled by an air blower system. Tars are condensed out and drop into heated troughs, the heat source of which is engine exhaust. Hot condensed tar is pumped to the vitrification furnaces described above. The common installed spare set of coolers uses engine exhaust flue gas to heat the heat exchangers and thereby cause the tars to drop into the heated trough below.

Oil Condensers

The syngas from the tar condensers described above flows to a shell & tube Heat Exchangers/cooler that are cooled by water cooling system. Condensed oils, which also contain condensed water, are collected and is pumped to the vitrification furnace described previously. The common installed spare set of coolers uses engine exhaust flue gas to heat the heat exchangers and thereby cause the oils to drop into the heated trough below.

Venturi Scrubbers

From the oil condensers the syngas flows through a high pressure drop Venturi Scrubber to remove any remaining PM.

Figure 13 and 14 show photos of a typical gas cleanup system in operation.

Figure 13. Photo A of a typical gas cleanup system in operation

Figure 14. Photo B of a typical gas clean up system in operation

Gas Bladder (Syngas Storage Tank)

The syngas storage tank provides surge capacity of cleaned syngas to level out flow and composition variations. It shall be a bladder contained within a demarcated area. The bladder will operate with an internal pressure of 30 to 40 millibar gauge.

Figure 15 shows a typical gas bladder in operation.

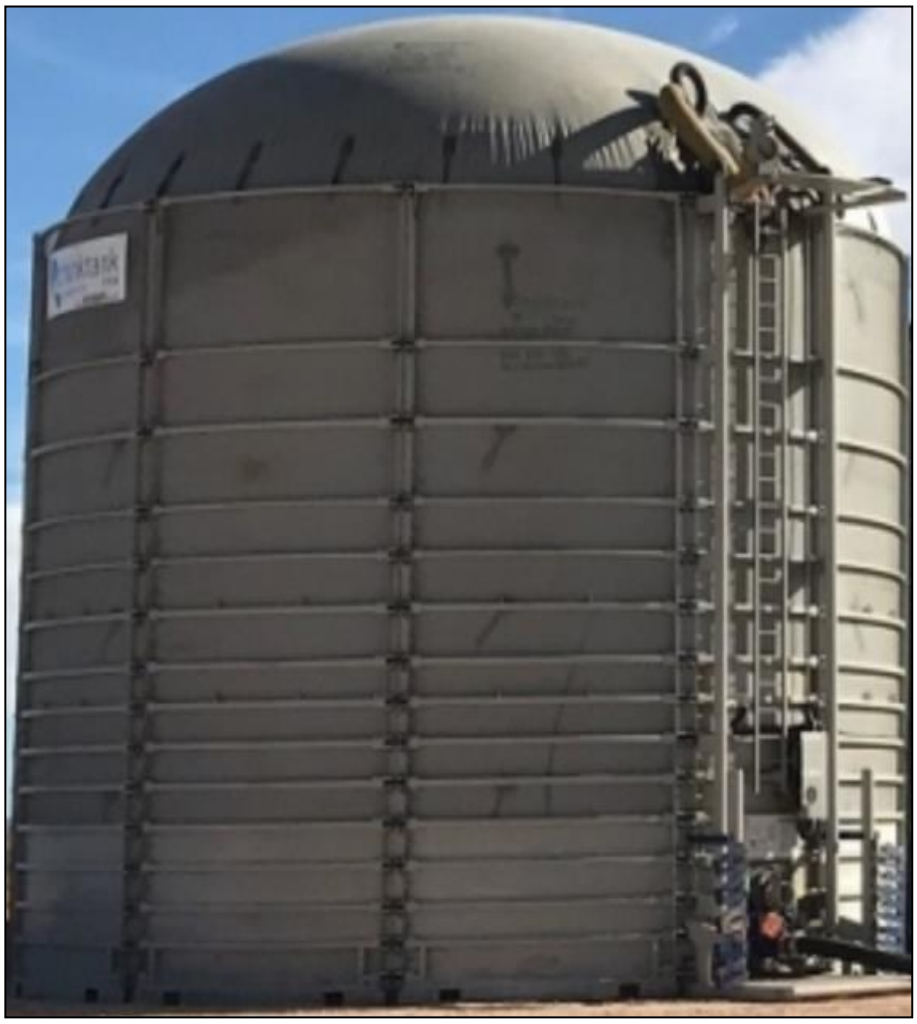


Figure 15. Picture of typical gas bladder

Stack and Flare

The stack and flare comprises of the following:

- Induced Draft Fan
- Flare Stack (combined with plant stack) and
- Plant Stack (5 m above nearest building x 720 mm dia.)

See Attachment “H”, documents, **H 1131 Stack cut sheet.pdf**, **H-1131 Stack cut sheet**, **H 1131 Stack pilot burner.pdf** and **H 1131 -Stack GA, H 1311 - 065-001 Rev 0**.

The hot gasses progress through the stack in to the atmosphere after passing through the Thermal Oxidizer (discussed in next section).

Thermal Oxidizer

After passing through a scrubber the flue gasses enter a Thermal Oxidizer comprising of a rectangular box shaped furnace. The internal dimensions are determined by the total volume that needs to be raised to 850 °C and maintained for 2 seconds. See Attachment “H” document H 1131 Regenerative Thermal Oxidizer Specification.

Figure 16 shows a typical Thermal Oxidizer in operation. Please refer to the technical specification file for more details if required.

Figure 16: Photo of a typical Thermal Oxidizer in operation

Syngas Engines

Each syngas engine shall be a fully packaged unit complete with all associated components and auxiliaries. These engines are of robust design and have been proven on low and medium calorific value gas fuels.

The engine package will be complete to allow the engine to start, synchronize, operate continuously at base or part load and shut down.

The syngas engines shall be assembled in containers as indicated on the plant layout. The containerised engines shall conform to a sound pressure level of 80 dBA (2005 Noise Regulations 1st Action Level) as measured one meter from the enclosure at two meter above floor level.

Notwithstanding the syngas clean up equipment and systems described in the Syngas Clean up Section above, the syngas engine exhaust systems shall be designed and installed such that they meet emissions standards as of the Commencement Date.

The Engine cooling will be by means of external radiators, they shall be designed and constructed with sufficient margin and spare surface area for the maximum heat rejection duty under all operational conditions.

The radiators shall incorporate features to minimize corrosion and erosion on the air and watersides and suitable provisions for cleaning and core replacement.

The radiators and all of their component parts shall be of proven design and arranged so as to minimize maintenance work.

Figure 17 and Figure 18 illustrates the containerized engines in production.

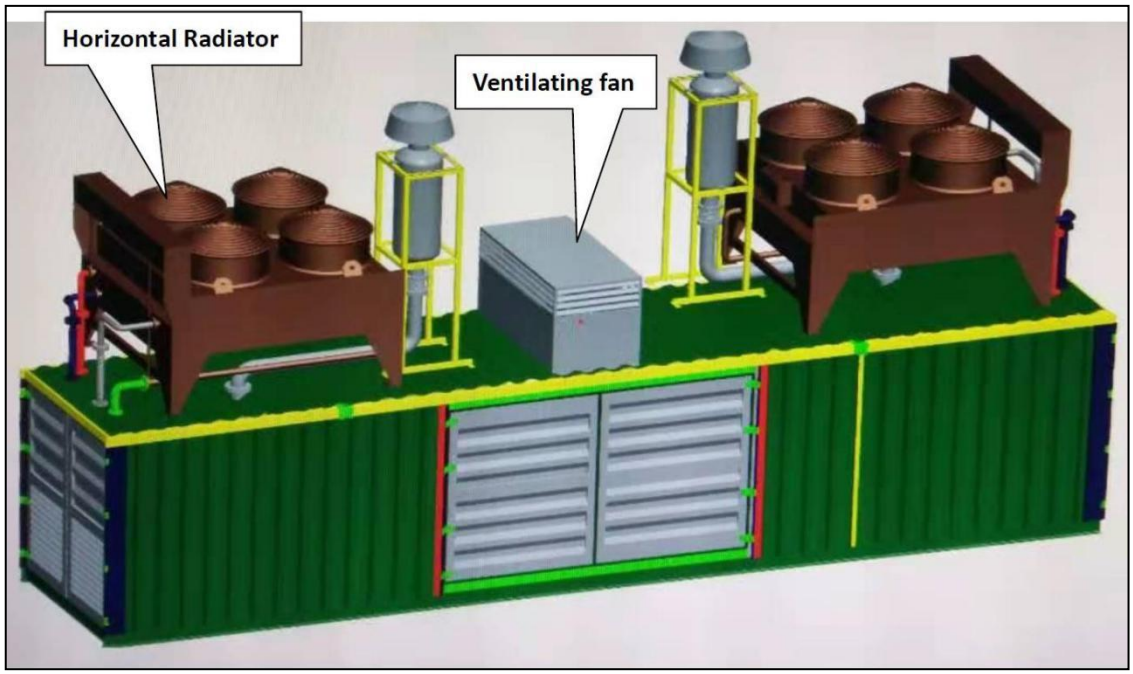


Figure 17. Illustration A of containerized engines in production

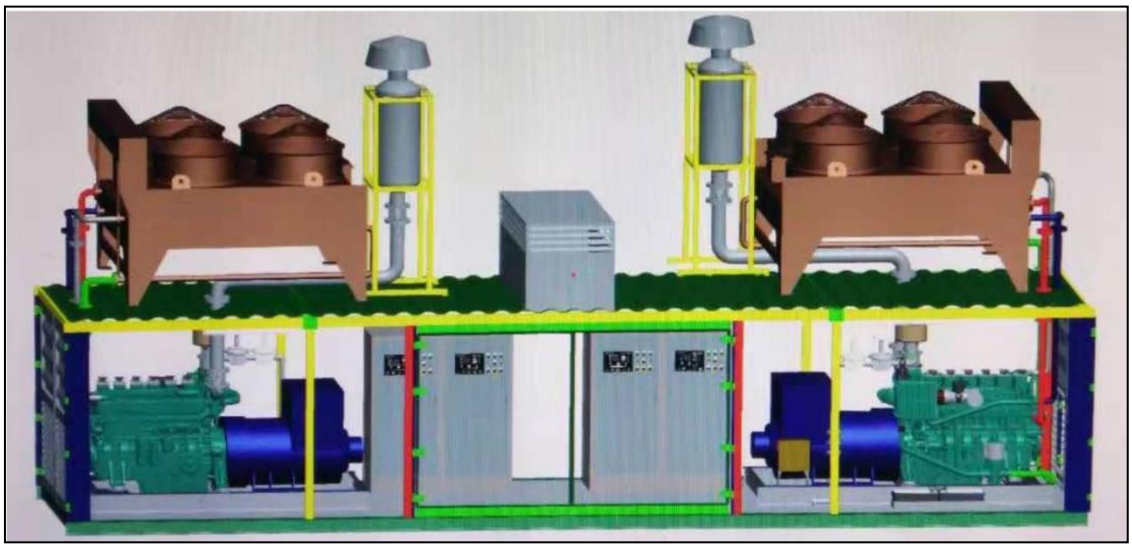


Figure 18. Illustration B of containerized engines in production

7. GENERAL PROCESS CONTROL PHILOSOPHY

General

The closed system plant is designed to convert Medical Waste (MW) into synthetic gas and an inert residue. This is done by taking a controlled amount (weight) of the MW and loading it into the Pyrolizer retort via a series of valves and a hydraulic piston feed arrangement under negative pressure of -0.024 kPa. This ensures no release of fumes, gasses, particles and odors into the environment where employees are working nor into the environment surrounding the facility, thereby protecting the local population. See Attachment "H" documents, **H 1131 - Phase Pyrolysis Specification.pdf**, **H 1131 - Macerator Shredder Specification.pdf** and Attachment "A" document, **A IH RIDEM Response letter-may 2020.pdf, dated May 2020**.

> *From RIDEM Minor Source Permit document, Medrecycler-RI Inc., Approval Nos. 2454-2457, Section C Paragraph 5:*
>
> *The owner/operator shall take all necessary precautions to restrict the spreading of biological and infectious diseases by ensuring that the equipment used to process the medical waste prior to the pyrolysis units is a closed system and is maintained under negative pressure at all times.*

See Attachment "A" document, **A Air Quality Permit Medrecycler-RI - App 2454-2457** for complete permit. Also, See Attachment "H" document **H 1131-060-055 Shredder Inlet and Outlet Sealing_info.pdf.**

The Pyrolizer section of the plant consists of the product feed arrangement under negative pressure the hydraulically operated loading piston, a rotating retort within a heated chamber, a residue collection system and a residue removal screw conveyor (Fig. 19). A cyclone and "drop-out box" are installed after the residue collection system to remove the majority of the produced product fines that are carried in the syngas stream, before they can get to the plant condensers.

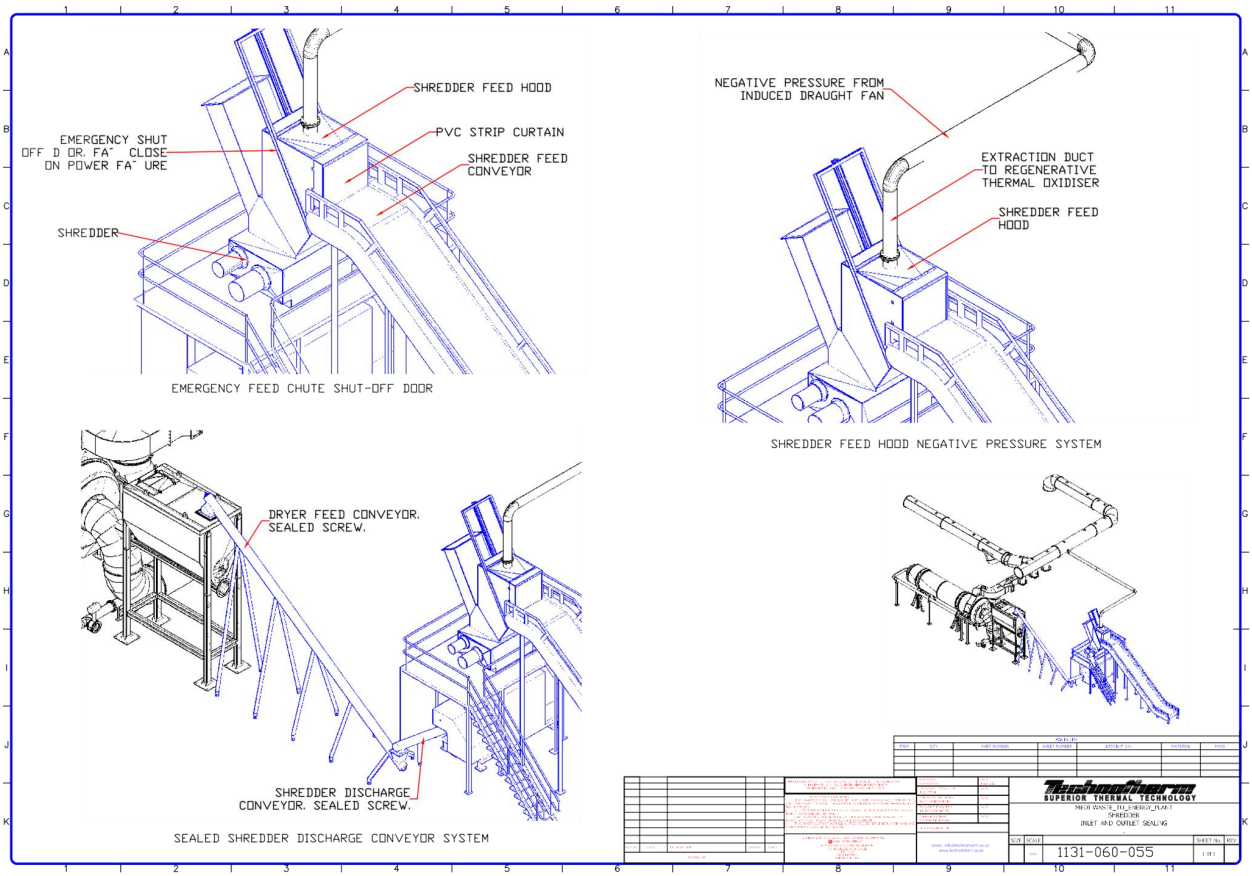


Figure 19. Macerator/Shredder detail (see Attachment "H", document H 1131-060-055 Shredder Inlet and Outlet Sealing_info.pdf, and H 1131 Shredder feed and Discharge)

Referring to Figure 19:

- Emergency shut-off door:
  - This door is operated with compressed air
  - Fails closed in the event of an emergency power outage
  - Sufficient compressed air in receiver tank to allow sufficient operation after power failure
  - Actuator set to allow fail close operation
- Negative pressure system:
  - Keep shredder under constant negative pressure during normal operation
  - Suction is maintained by main ID fan
  - Plant shuts down in the event of ID fan failure (very unlikely event)
  - Extraction duct connected to shredder at two positions
  - Lower position maintains constant negative pressure during normal operation
  - Top position only used in emergency conditions and has own battery-powered extraction fan
  - Top position added as an additional layer of protection
- Discharge conveyor system:
  - Utilizes sealed screw conveyors and feed hoppers up to Pyrolyser chamber
  - Inclined screw conveyors capable of transporting solid and liquid waste

- Aerosol waste contained within sealed process
- Forms a single integrated process for mechanical and thermal destruction of waste

A separate burner heating system is used to bring the Pyrolizer to operating temperature, after which the produced syngas is used as the heating source during processing.

An engine is also coupled to the system in order to demonstrate the syngas operating an engine should this be required.

PYROLIZER SECTION

Product Feed System

The product to be processed is delivered to the Pyrolizer on a timed basis, adjustable on the plant HMI. The equipment involved in the loading sequence consists of a conveyor, a load cell mounted tilting receiving hopper, which is tipped by a pneumatic cylinder, two pneumatic gate valves and a hydraulically driven loading piston.

The loading sequence description is as follows:
The plant feed conveyor **(CV01)** driven by motor **(00FD03)** via a VSD, delivers the product into a tilting receiving hopper that is mounted on load cells. When the required weight is reached the load cell unit transmits a signal to stop **(CV01)** and pneumatic gate valve **(40XV02)** opens. When **(40XV02)** open position sensor **(40LSO02)** is active, the pneumatic cylinder **(40XV01)** on the receiving hopper extends and tips the product into the loading tube **(40LSO01)** active, it then returns to its retracted position**(40LSC01)** active. Pneumatic gate valve **(40XV02)** then closes. After a pre-set time triggered when the closed position sensor **(40LSC02)** is activated, pneumatic gate valve **(40XV03)** opens allowing the product to drop into the piston loading tube. As soon as open position sensor **(40LSO03)** is triggered the hydraulic piston **(CV02)** moves forward to push the product through the piston tube and into the Pyrolizer retort, before returning to its default park position. After a pre-set time delay which is triggered by open position sensor **(40LSO03)** pneumatic gate valve **(40XV03)** closes.

When the closed position sensor **(40LSC03)** indicates active the loading sequence can continue again. When the tilting receiving hopper returns to retracted loading position **(40LSC01)** active, the feed conveyor **CV01** starts and reloads the tilting receiving hopper so that it is ready for the next loading sequence. The **(40XV01), (40XV02), (40XV03)** pneumatic cylinder and pneumatic gate valve position sensors have to activate or de-activate when the cylinder or the valves function. Should this not happen, then the loading process sequence stops and the plant alarm is triggered.

Hydraulic feed piston

After it receives a signal from pneumatic gate valve **(40XV03)** open position sensor **(40SLO03)** the hydraulic feed piston, **(CV02)** moves forward until it strikes the forward limit switch **(31HLS02)** then returns until it strikes the reverse limit switch **(31HLS01)**, which is the default park position, where is waits until the action is repeated on the next sequence.

On the shutdown command from the PLC when the shutdown button on the HMI is pressed, the hydraulic piston sequence changes. Forward limit switch **(31HLS02)** stop command is ignored and the piston moves past it for a pre-set time triggered by the forward limit switch **(31HLS02)** before it returns to the reverse position. The forward movement is then repeated, again ignoring the **(31HLS02)** limit switch stop command and progresses for a second timed sequence triggered by **(31HLS02)** before it returns to the reverse position. The forward movement is then repeated a third time until the piston strikes the fully extended limit switch **(31HLS03)** before returning to the reverse default park position and the loading sequence is discontinued. This hydraulic piston sequence only happens after the product loading sequence has completed one cycle after **(CV01)** stops.

The reverse **(31HLS01)** and forward **(31HLS02)** limit switches have to activate or de-activate during the

hydraulic loading sequence. Should this not happen, then the loading process sequence stops and the plant alarm is triggered.

Pyrolizer Retort and Heating Chamber Description

The Pyrolizer retort **(CV03)** motor **(00FD02),** which is driven via a VSD, rotates in the default feed direction from start-up. The rotation speed is adjustable on the HMI.

An Natural gas burner **(BR001)** with its own temperature control instrument is used to heat the Pyrolizer heating chamber to temperature, after which it will operate in a standby function when the process syngas is available. The low fire/pilot burner is always functional to ensure that a flame is always present should the process syngas be used below ignition temperatures.

Heating temperature control is via an input signal from thermocouple **(TT02)** to the temperature instrument, which is situated in the gas burner control panel.

The process syngas heating temperature control is via an input from thermocouple **(TT01)**. This set point is set and adjustable on the HMI. When the syngas heating method is selected the pneumatic butterfly valves **(41XV10)** and **(41XV11)** open and close at the temperature set point to allow the syngas to enter the Pyrolizer heating chamber. The syngas set point temperature should be set 30 degrees Celsius above the LPG gas burner **(BR001)** set temperature to prevent the operation of both heating systems at the same time. For safety reasons pneumatic butterfly valves **(41XV10)** and **(41XV11)** cannot be opened unless the pilot burner is functioning.

A third thermocouple **(TSH01)**, which is hard wired to an independent instrument, is installed for over temperature safety. Should this situation occur, the LPG burner high fire is switched off and if the syngas heating method is in use **(41XV10)** and **(41XV11)** are closed The product feed sequence is stopped and the Pyrolizer retort reverts to its timed forward/reverse sequence.

A rotation sensor **(RS002)** is fitted to indicate if the Pyrolizer retort stops rotation. If this should occur, the product loading system is stopped and the plant alarm is triggered.

Residue Return Screw Conveyor

The residue return screw **(CV04)** is driven by motor **(00FD01)** via a VSD and rotates in the default feed direction from start-up. A rotation sensor **(RS001)** is fitted to indicate if the screw rotation stops. Should this situation occur the Pyrolizer retort **(00FD02)** defaults to its timed forward/reverse function, the product feed is stopped and the alarm is triggered to alert the operator.

To minimize screw wear, during start up and shut down or idling when no product is fed to the unit, the screw will pulse rotate on and off at a timed sequence set on the HMI.

There are two methods of collecting the product residue. These are described below:
A switch over button that changes residue collection method 1 sequence over to residue collection method 2 and vice verse is available on the HMI.

Residue Collection Method 1

The residue/gas separator receives the converted product from the Pyrolizer retort, where it is passed through to the residue return screw. The sequence is as follows:
Pneumatic knife gate valve **(40XV05)** opens, open position sensor **(40LSO05)** active. A pneumatic swing gate in the top of the separator **(40XV04)** receives a signal from the open position sensor **(40LSO05)** and opens, **(40LSO04)** active, for a pre-set time before closing and deposits the residue into the tube above gate valve **(40XV06)**. 3 seconds after **(40XV04)** pneumatic swing gate valve position sensor **(40LSC04)** indicates closed **(40XV05)** closes and its closed position sensor signals for **(40XV06)** to open and deposit the residue into the residue screw conveyor **(CV04)**. When **(40XV06)** open position sensor **(40LSO06)**

indicates that it has been open for 3 seconds it closes, **(40LSC06)** active, after which the sequence starts again.

40XV04), (40XV05), (40XV06) positions sensors delay open and closed times are pre-set in the PLC. The **(40XV04), (40XV05), (40XV06)** pneumatic swing gate and gate valve position sensors have to activate or de-activate during the sequence. Should this sequence be interrupted the Pyrolizer retort **(00FD02)** defaults to its timed forward/reverse function, the product feed is stopped and the alarm is triggered to alert the operator.
The product feed sequence to the Pyrolizer cannot operate if the residue collection sequence for method 1 is not functioning. These interlock only apply to method 1

Residue Collection Method 2

When residue collection method 2 is functional the pneumatic swing gate **(40XV04)** and pneumatic gate valve **(40XV05)** remain functional and pneumatic gate valve **(40XV06)** is removed from the system.
A residue collection box is installed below gate valve **(40XV05)** to collect the residue. This is filled with residue by a PLC pre-set timed sequence function of the pneumatic swing gate **(40XV04)** and pneumatic gate valve **(40XV05)**. The sequence is as follows:
Pneumatic knife gate valve **(40XV05)** opens, open position sensor **(40LSO05)** active. Pneumatic swing gate **(40XV04)** receives a signal from the open position sensor **(40LSO05)** and opens, **(40LSO04)** active, 3 seconds after **(40XV04)** pneumatic swing gate valve position sensor **(40LSC04)** indicates closed **(40LSC04)** active, **(40XV05)** closes **(40LSC05)** active. This sequence is repeated after 20 seconds.
When the residue collection box is to be emptied a switch on the HMI is required to stop the sequence with both the pneumatic swing gate valve **(40XV04)** and pneumatic gate valve **(40XV05)** in their closed positions; **(40LSC04)** and **(40LSC05)** active. When this switch is active the Pyroliser retort **(00FD02)** defaults to its timed forward/reverse function and the product feed is stopped. When the residue collection box is cleaned and resealed the operation is returned to normal by the operator.
The product feed sequence to the Pyrolizer cannot operate if the residue collection sequence for method 2 is not functioning. These interlock only apply to method 2.

GAS CLEANING SECTION

Tar, Oil and Aerosol Condenser Description

The syngas, which is hot and laden with vaporized tar and oil as well as a small amount of particulates, has to pass through a cleaning system before it can be used. This is done by passing the syngas through a set of condensers to settle out these products. There are three condensers in the process: One tar condenser, one oil condenser and one aerosol condenser.

Air delivered by the combustion air blower **(00CB01)** is used to cool the syngas temperature in the tar condenser. The air passed over the syngas heat transfer tubes in the condenser and exits to the Pyrolizer exhaust system. Temperature transmitter thermocouple **(TT03),** which is situated at the gas entry to the tar condenser, indicates the syngas entry temperature to the tar condenser on the **HMI**. A second temperature transmitter thermocouple **(TT04),** situated at the gas entry of the oil condenser, indicates the gas entry temperature to the oil condenser. A third temperature transmitter thermocouple **(TT05),** situated at the gas entry to the aerosol condenser, indicates the gas entry temperature of the aerosol condenser.

During plant start-up the blower air is fed into and through the Pyrolizer retort, where it is heated. This is done to preheat the equipment and pipework up to the tar condenser so that no condensation of the syngas occurs before it enters the tar condenser.

Pressure switch, (**00PS1)** contact active, indicates that blower **(00CB01)** is running and that air is available. Should the blower malfunction, the pressure switch **(00PS1),** will indicate contact inactive and the alarm is triggered to alert the operator.

The aerosol condenser is situated immediately after the oil condenser. This and the oil condenser, are

water cooled. This closed circuit system has two functions; it cools both the aerosol and oil condensers and the water in the wet gas scrubber positioned behind them.

Wet Gas Scrubber Description

The scrubber system is used to wash any remaining particles out of the syngas prior to it entering the Gasometer. There are four pumps on the system **(WP01)**, **(WP02A)**, **(WP02B)** and **(WP03)**.

The function of pump **(WP01)** is to circulate cooled water through a coil in the scrubber cooling tank, the aerosol condenser and the oil condenser to cool the gas passing through them, as well as the scrubber cleaning water. A radiator, which is cooled with fan **(RFA01)**, is installed in the water circuit to cool the water. This is fitted with an air flow switch **(AFS01)** to indicate if there is a fault with the fan and an alarm will be triggered to alert the operator.

The function of pumps **(WP02A)** and **(WP02B)** is used to pump the cooled water from the leveling tank back to the spray nozzles in the scrubber and to its venturi section.

The function of pump **(WP03)** is used to pump the water from the scrubber tank to the filter in the cooling section, where any particulates are captured.

All flow circuits are fitted with flow switches **(WFS01)** on pump **(WP01)** circuit, **(WFS02)** on pump **(WP02A)** and **(WP02B)** feed circuit to the scrubber spray circuit, **(WFS02A)** on the venturi spray circuit and **(WFS03)** on pump **(WP03)** circuit. These indicate that the system is operational and functioning correctly. If water flow is interrupted, these flow switches will trigger an alarm to alert the operator.

GAS COLLECTION SYSTEM

Gasometer Description

The gas blower **(00GB01)** situated before the Gasometer, is connected via a VSD.

A bypass pipe with a 4-20mA controlled pneumatic butterfly valve **(41PIC01)** fitted in the line, is looped around gas blower **(00GB01)**. This valve is controlled by the pressure transmitter **(001PT)**, which is situated on the residue collection box. The pressure range is set up in the PLC program with a high/low setting control. The operating range is typically around 2-5 mbar and the command from the pressure transmitter when the pressure drops to the lower pre-set level, is to drive **(41PIC01)** towards the open position, the reverse happens when the pressure approaches the high setting. This function causes circulation of the syngas around the gas blower, thereby controlling the gas pressure within the set range. Gas blower **(00GB01)** starts at 25% of its normal speed when the equipment start temperature is reached. When product is fed to the Pyrolizer this speed must be increased on the **HMI** to 60%, which is the minimum speed used when putting syngas into the Gasometer. When the syngas is ready to be put into the Gasometer, the Gasometer entry pneumatic butterfly valves **(41XV01)** and **(41XV02)** are opened by the operator on the **HMI**. Before the pneumatic butterfly valves **(41XV01)** and **(41XV02)** are opened, the syngas is bypassed to the plant flare via pneumatic butterfly valves **(41XV06)** and **(41XV07).**
There is an interlock between **(41XV01)** and **(41XV02)** which are fail closed and **(41XV06)** and **(41XV07)** which are fail open.

The oxygen analyzer **(43OA1)** reads the oxygen of the syngas content on a permanent basis, before it enters the Gasometer. This is to ensure that no oxygen can enter the Gasometer and create poor gas quality. A safety default is employed to prevent the Gasometer inlet pneumatic butterfly valves **(41XV01)** and **(41XV02)** from opening if the oxygen content is above 3%. These valves will also close if, during normal operation, the oxygen level increases above 3% and pneumatic butterfly valves **(41XV06)** and **(41XV07)** will open. The hand valve in the sampling line must be open whenever the plant is started and remain open during the entire time that the equipment is in operation.

The syngas is drawn by a pump within the oxygen analyzer, through a gas filter to flow meter **(43FM1)**

which is equipped with a low level alarm to alert the operator if there is a flow restriction.
Pressure transmitter **(002PT)**, is situated on the exit piping of the gasometer and is used to indicate pressure to show that gasometer is elevated. Indication is shown on the **HMI**, no control function is necessary.

Three limit switches **(LSH01)**, **(LSL02)** and **(LSHH01)** are fitted to the gasometer for control and safety purposes. **(LSH01)** is a high limit switch that will open pneumatic butterfly valve **(41XV05)** and bypass the gas to the flare should an over production of gas raise the Gasometer to its upper level. Pneumatic butterfly valve **(41XV05)** will close after a pre-set timed period. A safety limit switch **(LSHH01)** is situated immediately after **(41PIC01)** and will close pneumatic butterfly valves **(41XV01)** and **(41XV02)** to shut off the gas supply to the Gasometer. Simultaneously pneumatic butterfly valves **(41XV06)** and **(41XV07)** will open to allow the produced gas to pass to the flare. **(41XV01)** and **(41XV02)** will only open again when the Gasometer has dropped below limit switch **(LSH01)**.

The syngas from the Gasometer feeds to 2 items of equipment. These are the Pyrolizer heating chamber, and the engine. Should the Gasometer level switch **(LSL02)** contact become active, all of the pneumatic valves that feed syngas to the downstream equipment will close to shut off the gas supply to their respective items. These pneumatic butterfly valves are **(41XV03)** and **(41XV04)** which feeds the Pyrolizer combustion chamber, and **(41XV09)**, which feeds the engine.

The Gasometer floating lid is sealed by a water seal and the water level is maintained by a cistern type water level float. A water level switch **(WLS03)** will trigger an alarm should the water level drop below the safety level.

Equipment Start Command

When the equipment start temperature, which is set on the **HMI** all of the equipment on the plant that did not start at start-up becomes operational and can started from the **HMI**.

Process Feed Start

Providing that the equipment start temperature has been reached, all of the plant equipment has been started and the Pyrolizer retort and the residue return screw rotation sensors are active, the loading sequence can be initiated. The start order will be:

1 Start the residue collection sequence, method 1 or method 2
2 Start hydraulic motor **(00FD20)**.
3 Press the auto start button on the HMI

The product will then enter the load cell hopper and trigger the operation of **(40XV01),** (**40XV02), (40XV03)**. This sequence can only be activated when the equipment start temperature has been reached and all of the plant equipment is operating and Macerator is at negative pressure -0.024 kPa.

Pipe line Valve and Equipment Functions and Commands

When processing starts, there are a number of valves and other equipment that will be operated via the PLC during operation.

- **(40XV07)**. This pneumatic butterfly valve is the emergency relief valve and will open if **(001PT)** indicates a pressure exceeding 25mbar, adjustable on the **HMI**.
- **(40XV10)** and **(40XV11)**. These pneumatic butterfly valves will open and close according to the Pyrolizer temperature set point. Open below set point, closed above set point.
- **(41PIC01)**. This 4-20mA pneumatic butterfly valve is controlled by **(001PT)** and will function within the pressure range of 2 to 7mbar.
- **(001PT)**. This 4-20mA pressure transmitter controls pneumatic butterfly valve **(41PIC01)** within a pre-set pressure range and opens pneumatic butterfly valve **(40XV07)** in the event of an over pressure situation. The loading sequence stops. This valve can only be closed by the operator.

When closed the loading sequence can be restarted. If an over-pressure situation reoccurs the operator must investigate and if necessary stop production.

- **(00PS01).** This pressure switch indicates that the combustion blower is operating.
- **(00CB01)**. This combustion blower is started at plant start-up and runs continuously until the plant is shut down and the Pyrolizer temperature drops to below 250C.
- **(TSH22)** which is hard wired to an independent instrument is installed for over temperature safety. Should this situation occur, the LPG burner high fire is switched off and if the syngas heating method is in use, then pneumatic butterfly valves **(40XV03)** and **(40XV04)** close.

All motors can be started in manual mode, and rotation switches can be ignored.

Plant Start-up from Cold

When the plant is started in automatic mode the sequence is as follows:

(00FD01) starts **(RS001)** active.
(00FD02) starts **(RS002)** active.
(00CB01) starts **(00PS01)** active.
If **(RS001)** or **(RS002)** are not active an alarm is activated and indicated on the HMI.
Providing the above is okay the burner **(BR001)** can be started.
When the plant reaches the equipment start temperature, the functions of the balance of the equipment can be initiated.

Interlocks at Automatic Cold Start

- Discharge screw rotation motor **(00FD01)** and burner **(BR001)**. No heating can take place unless the screw is rotating. Rotation sensor **(RS001)** active.
- Pyrolizer retort rotation motor **(00FD02)** and burner **(BR001)**. No heating can take place unless the retort is rotating. Rotation sensor **(RS002)** active.

Process Interlocks

- Unless the equipment start temperature is active none of the process sequences can be started.
- If either or both of the rotation sensors **(RS001)** and **(RS002)** are not active the product feed sequence is stopped.
- If the residue valve sequence is interrupted the product feed sequence is stopped and the Pyrolizer retort reverts into a timed forward and reverse sequence.
- If the residue return screw stops the product feed sequence is stopped and the Pyrolizer retort reverts into a timed forward and reverse sequence.
- If the equipment start temperature signal is lost due to a drop in temperature the product feed sequence is stopped and the Pyrolizer retort reverts into a timed forward and reverse sequence.

Shutdown Procedure

When a planned shutdown procedure is initiated the following sequence must be initiated.

- The product loading conveyor delivers 1 load of product to the load cell hopper and is not re-filled.
- The loading sequence of the valves **(40XV01), (40XV02), (40XV03)** completes one cycle and remain inactive.
- After 1 normal operating function between limit switches **(31HLS01)** and **(31HLS02)** the hydraulic piston ignores **(31HLS02)** and 2 timed forward sequences take place, followed by a full forward movement to **(31HLS03)** then returns to **(31HLS01)** position.
- After 60 minutes, adjustable on the HMI, the Pyrolizer retort **(00FD02)** reverts to its timed forward/reverse sequence and the residue valves (method 1 **(40XV04), (40XV05), (40XV06)** or method 2 **(40XV04), (40XV05),**) sequence stops after completing 1 cycle.

- The residue screw **(00FD01)** reverts to its timed pulse function.
- The gas burner **(BR001)** is switched off.
- When the plant temperature drops to 250 Celsius **(00FD01)** and **(00FD02)** stop.

HMI Views and Controls

- Plant bitmap
- Temperature indication, also to be set on screen.
- All alarms
- Start button for the residue valve sequences method 1 or method 2
- Start button for the hydraulic motor
- Start button for the Product loading sequence and hydraulic piston loading sequence
- Valve position alarms if sequence position fails
- Valve positions, also a screen for manual control
- Pulse time for discharge screw
- Pyrolizer retort rotation, manual direction control buttons on the screen
- Air pressure switch condition and alarm
- Pilot flame condition and alarm
- Air blower manual start button
- Pressure transmitter 001PT reading display
- Pressure transmitter 001PT range setting control (if possible)
- All motor manual start and stop buttons

8. MONITORING DEVICES

Monitoring points for all devices are shown in Figure 19.

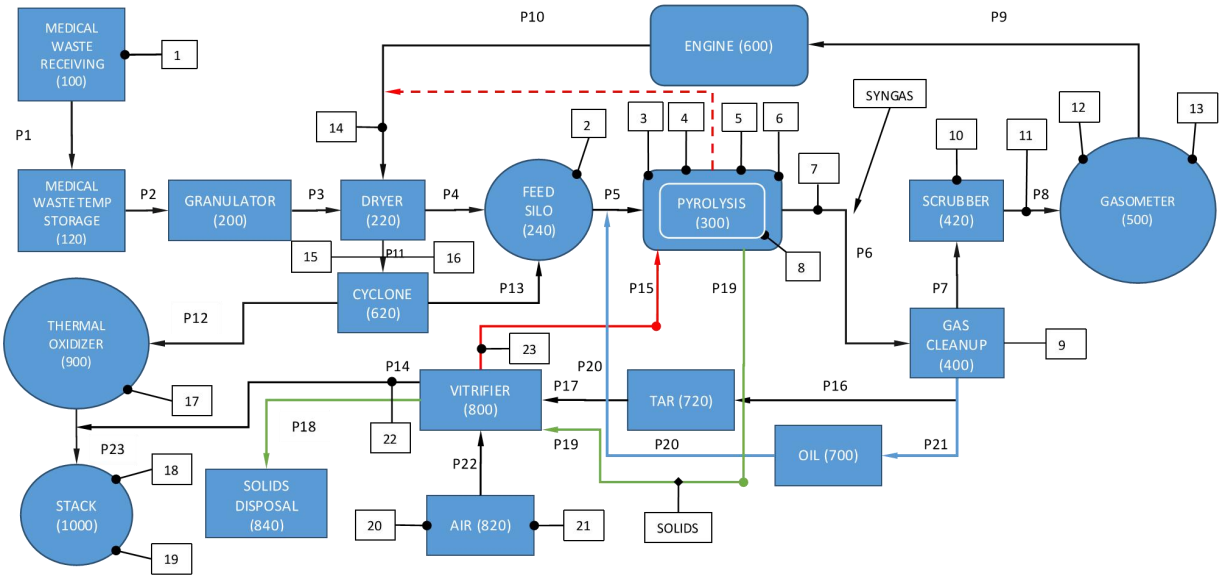


Figure 20. Monitoring points for devices.

Table 7 defines the measuring points and controls for specific system devices. All control units will be connected to a Data Acquisition System (DAS), where all points will be monitored by the operators. There will also be display units on the specific devices and relevant piping, so that operators working in the operational area can see the system control data output.

In Figure 19, there are measuring point numbers in squares and pipe runs labeled PX and PXX, such as P2 and P14. These will be used to help define measuring points in Table 7.

As shown in Table 7, Device (Parameter) means the Device indicated in Figure 19 and (Parameters) indicates the range of measurement for that particular temperature, pressure and flow transmitter. Next is the Control Unit designator that would appear on the DAS screen and Device display, followed by Control Unit output and Operational Parameter.

Table 7. Monitoring Points and Control of Specific System Devices

Monitoring Point	Device (Parameter)	Control Unit	Pipe Run	Control Unit Output	Control Unit Operational Parameter
1	MWR (100): Weigh Scale (0-2 tons)	WS-1	On Device	4-20 mA	115 V, 60 Hz
2	FS (240): Weigh Scale (0-2 tons)	WS-2	On Device	4-20 mA	115 V, 60 Hz
3	PR (300): Temperature Transmitter- Inlet (75-2000°F)	TT I-1	On Device	4-20 mA	115 V, 60 Hz
4	PR (300): Temperature Transmitter-Inlet (75-2000°F)	TT I-2	On Device	4-20 mA	115 V, 60 Hz
5	PR (300): Temperature Transmitter-outlet (75-2000°F)	TT I-3	On Device	4-20 mA	115 V, 60 Hz
6	PR (300): Temperature Transmitter-outlet (75-2000°F)	TT I-4	On Device	4-20 mA	115 V, 60 Hz
7	PR (300): Pressure Transmitter (0-3 Psig)	PI I-5	P7	4-20 mA	115 V, 60 Hz
8	PR (300): Temperature Transmitter-inner (75-2000°F)	TT I-6	On Device	4-20 mA	115 V, 60 Hz
9	GC (400) (75-600°F)	TT I-7	On Device	4-20 mA	115 V, 60 Hz
10	S (420): pH meter (0-14)	pH I-8	On Device	4-20 mA	115 V, 60 Hz
11	G (500): Alarm Transmitter (>600°F)	AT I-9	P8	4-20 mA	115 V, 60 Hz
12	G (500): Pressure Transmitter (1-100 Psig)	PI I-10	On Device	4-20 mA	115 V, 60 Hz
13	G (500): Temperature Transmitter (75-600°F)	TT I-11	On Device	4-20 mA	115 V, 60 Hz
14	D (220): Temperature Transmitter (75-600°F)	TT I-12	P10	4-20 mA	115 V, 60 Hz
15	C (620): Temperature Transmitter (75-600°F)	TT I-13	P11	4-20 mA	115 V, 60 Hz
16	C (620: Temperature Transmitter (75-600°F)	TT I-14	P11	4-20 mA	115 V, 60 Hz
17	TO (900):Temperature Transmitter (75-2000°F)	TT I-15	On Device	4-20 mA	115 V, 60 Hz
18	S (1000): Pressure Transmitter (-1 to +1 Psig)	PT I-16	On Device	4-20 mA	115 V, 60 Hz
19	S (1000): Temperature Transmitter (75-2000°F)	TT I-17	On Device	4-20 mA	115 V, 60 Hz
20	A (820): Flow Transmitter (25-300 scfm)	FT I-18	On Device	4-20 mA	115 V, 60 Hz
21	A (820): Pressure Transmitter (-1 to +1 Psig)	PT I-19	On Device	4-20 mA	115 V, 60 Hz
22	V (800): Temperature Transmitter (75-2000°F)	TT I-20	P14	4-20 mA	115 V, 60 Hz
23	V (800): Temperature Transmitter (75-2000°F	TT I-21	P23	4-20 mA	115 V, 60 Hz

9. POTENTIAL TO EMIT FOR PROJECT AND STATIONARY SOURCES

The sections describes what “potential to emit” is for the proposed project and for stationary sources

The “Potential to emit” for Project is the quantity of air contaminants that the facility could release into the air while operating at the maximum design capacity, operating 100% of the time with the highest polluting materials.

The “Potential to emit” from Sources is the quantity of air contaminants from stationary sources, such as the Pyrolysis Reactor (300), could release into the air while operating at the maximum design capacity, operating 100% of the time with the highest polluting materials.

The data given in Section 4 shows the maximum throughput of medical waste that the Pyrolysis system can processes per hour. The system is design to take a maximum of 70 tons per day. As stated previously, one unit will be installed and utilized to process 35 tons per day and then a second unit will be installed to bring the daily throughput of 70 tons per day. The annual throughput is based on 310 days per year, so the maximum design capacity, operating at 100% must take into account 365 days per year. This would yield maximum throughput at 70 tons per day, 24 hours per day, 7 days per week, 365 days per year.

Assumption are:

1. Total system is the same as shown in Section 4, Figure 1 and 2.
2. Maximum design capacity for throughput is 70 Tons per day, starting at 35 tons per day, but always using 70 tons per day in the calculations.
3. Temperature for control units are the same as shown in Figure 2.
4. Pressure for all devices are the same as shown in Figure 2.
5. The materials emitting the highest amount of air contaminants are used or processed. This has been discussed above with emphasis here that we need to make a product gas with the gasses involved.
6. Used the following formula:

   PTE = (maximum hourly emission rate of pollutant) x (8760 hours) divided by 2000 lbs/ton

Table 8 shows the “Potential to Emit” emissions output for the Pyrolysis system.

Table 8: Potential to Emit for Emissions

Offgas/Solids Component	US tons/yr PTE
CO2	24,585.73
H2O	55,267.10
N2	220,697.11
AR	2,831.70
CAO	3.13×10^{-6}
K2O	4.93×10^{-7}
NA2O	$1.12 \times ^{-6}$
HCL	1.68×10^{-5}
H2O	0.112
MGO	4.71×10^{-7}
FE2O3	5.83×10^{-7}
SO2	5.60×10^{-5}
NO	2.89×10^{-4}
NO2	3.86×10^{-4}
TOTAL	**303,381.75**
SOLIDS OUTPUT	
CAO	313.36
K2O	492.87
NA2O	1,120.16
MGO	470.47
FE2O3	582.54
NACL	2,705.11
NA2SO3	1,250.52
TOTAL	**6,935.04**

Fugitive emissions from the Pyrolysis system into the facility is very low to non-existent. Reasons for this assessment of exposure are the following:

1. Medical waste will be in sealed plastic bags and contained in sealed cardboard boxes.

2. The boxes of medical waste will be transferred to a temporary holding area after passing a Geiger counter, weighed and then transferred sealed to the Macerator. Boxes will not be opened.

3. Boxes of waste enter the Macerator under negative pressure (-0.024 kPa) without being exposed to the air in the facility. When the box is reduced, it will be sealed inside the Macerator under negative pressure (0.024 kPa).

4. Pyrolysis system is a closed system.

5. Therefore we have a closed transfer and a closed system under negative pressure (-0.024 kPa).

Even though the Pyrolysis system is a closed system and close transfer can achieved, it would be prudent to perform a Qualitative Exposure Assessment (QEA). The purpose of the QEA is to:

1. Identify the hazard

2. Anticipate/Estimate Severity of Exposure

3. Develop Exposure Monitoring Priorities

    a) Quantity Exposure

    b) Confirm Severity Estimations

        i. Operational Industrial Hygiene (IH) Inspection during operation

Table 9 shows the QEA for the potential hazards in the caused by emissions from the pyrolysis system.

Hazardous Emission	Probability of Exposure	Frequency of Exposure	Possible Routes of Exposure	Controls
CO	NIL	NIL	Ventilation	CO monitors, Plant HEPA ventilation not part of office ventilation.
HCl	NIL	NIL	Ventilation	Monitor pH in Scrubbers
SiO_2	NIL	NIL	Ventilation	Monitor pH in Scrubbers
Steam	NIL	NIL	Ventilation, Floor	Negative Pressure
Tar/Oil	NIL	NIL	Floor	Berm around Gas Cleanup

NIL = close system, guaranteed by Technotherm, Inc.

10. DEMONSTRATION OF PROPOSED NEW SOURCE

This section describes what a "New Source" is and what it means to not qualify as a "Major Stationary Source".

Demonstration of Proposed New Source is not a "Major Stationary Source"

The Pyrolysis system is a New Source but is not a "Major Stationary Source". This is due to the emission data in Table 5 and PTE in Table 8.

11. IDENTIFICATION OF THE APPLICABLE STATE AMD FEDERAL REGULATIONS

Table 10 describes all State and Federal air pollution control regulations that apply to this project.

Table 10. Applicable State and Federal Air Quality Control Regulations

Regulation RI-DEM	Regulation Title	Comment
1	Visible Emissions	Pollution equipment prevent visible emission
7	Emission of Air Contaminates Detrimental to Persons or Property	See Table 5 and 8
9	Air Pollution Control Permits	See permits and Table 5 and 8
14	Record Keeping and Reporting	See Facilities TAB 4
16	Operation of Air Pollution Control Systems	See Table 5 and 8 and permit
17	Odors	Pyrolysis and Pollution equipment prevent orders
22	Air Toxics	See Table 5 and 8 and permit

12. STATIONARY SOURCE COMPLIANCE WITH APPLICABLE STATE OR FEDERAL REGULATION STARTS OPERATION

At the start of steady state operation, Source Testing will be done by an independent company that will report stack emissions to verify compliance to relevant RI-DEM regulation.

13. *BEST AVAILABLE TECHNOLOGY (BACT) ANALYSIS*

"Potential to Emit" in Table 8 does not trigger a BACT Analysis. Although, Research was conducted using the RACT/BACT/LAER clearinghouse data base and no results were given for processing medical waste using a Pyrolysis system. Furthermore, Pyrolysis is not an innovative technology because people have turned wood into charcoal since ancient times.

14. AIR QUALITY IMPACT STUDY (AQIS)

Emissions are below Air Toxics and therefore an AQIS is not necessary.

Reference Page

For more detail regarding the Pyrolysis System, please see Attachment "A" through "H" at the end of the document.

[1] Environmentally Friendly Medical Waste Recycling Using Plasma-Gasification-Melting (PGM) and Wet Scrubbing Technology

https://www.envitechinc.com/hs-fs/hub/62003/file-26219347-pdf/docs/it310_60_med_waste_gasifier_final.pdf

[2] Simulation analysis of wastes gasification technologies

https://www.researchgate.net/publication/315119438_Simulation_analysis_of_wastes_gasification_technologies

[3] Technical and economic analysis of Plasma-assisted Waste-to-Energy processes

http://www.seas.columbia.edu/earth/wtert/sofos/ducharme_thesis.pdf

[4] MSW syngas data given by Technotherm, South Africa

Tab 4 - Facility Operating Plan

Medrecycler-RI, Inc. Division Road PYROLISIS AND
ENERGY PRODUCTION, MEDICAL WASTE
TREATMENT FACILITY OPERATING PLAN

Prepared in accordance
with
the State of Rhode Island and Providence
Plantations
Department of Environmental
Management
Rules and Regulations Governing the Generation, Transportation, Storage,
Treatment, Management and Disposal of Regulated Medical Waste in
Rhode Island (Regulation DEM-DAH-MW-01-92, March 1992), as Amended
July 2010 and Solid Waste Regulations Number 1, as Amended October,
2005 and Solid Waste Regulations Number 3, as Amended January, 1997.

January 2019
Revision 9 July 28, 2020

1. OPERATING HOURS

The Division Road facility processes regulated medical waste and ships byproducts up to 24 hours, 7 days per week, 310 days per year. There are fluctuating shifts due to volume and seasonal market demands.

2. OPERATING AND DESIGN CAPACITIES

The Division Road facility plans to accept 70 tons of waste per day starting with 35 tons per day for the first unit. Once the second unit is constructed, 70 tons per day will be the maximum feed rate (midnight-to-midnight).

Syngas from the Pyrolysis system will be used to produce electricity by the utilization of engines designed to accept syngas.

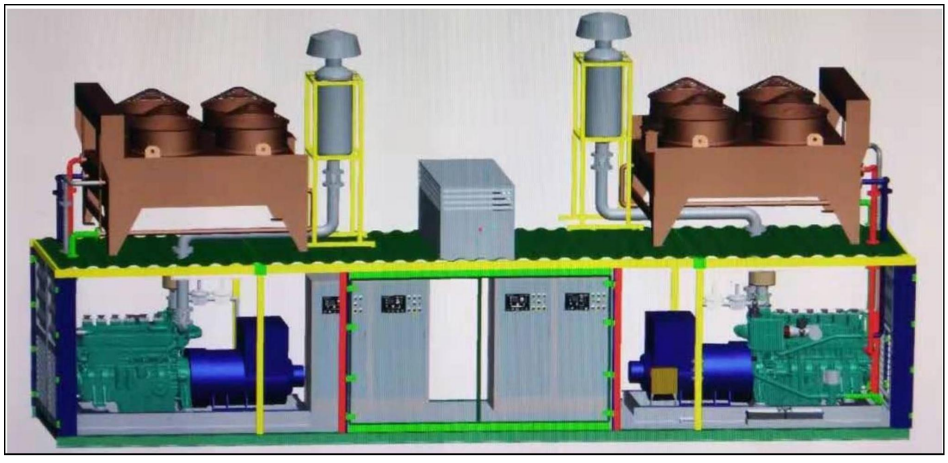


Figure 21. Electrical generator engines.

3. TYPES OF REFUSE TO BE ACCEPTED/ AND/ OR RECYCLED

The type of waste accepted is consistent with the Rules and Regulations Governing the Generation, Transportation, Storage, Treatment, Management, and Disposal of Medical Waste in Rhode Island. In accordance with these regulations the following types of waste are included in regulated medical waste:

Cultures and stocks
Pathological/Anatomical waste
Human waste, blood and blood products
Sharps
Animal waste
Chemical Waste
Incinerate Only Wastes
Unused sharps
Spill/cleanup material Mixtures
Legend drug waste/Non-RCRA pharmaceutical waste
Sharps and reusable sharps

Non-hazardous solid waste mixed with regulated medical waste is considered regulated medical waste as stated in section 2.03 of RIDEM medical waste regulations.

4. ***WASTE TRANSFER:***

Medrecycler-RI, Inc considers the following wastes unacceptable to the Pyrolysis and energy production process and will reject said wastes:

Etiologic agents
Radioactive waste
RCRA empty Chemotherapeutic/Cytotoxic wastes
Isolation wastes
Prions or OD Infected Waste or by-products
Hazardous waste

RI-DEM Office of Waste Management will be notified orally or via voice/E-mail immediately of all unacceptable loads of the above wastes and they shall be returned to the originating facility. Medrecycler-RI, Inc will then submit a written report of the incident within forty-eight (48) hours.

5. UNACCEPTABLE WASTE:

The following are wastes that are not accepted by the Industrial Lane facility:

Etiologic agents
Radioactive waste
RCRA empty Chemotherapeutic/Cytotoxic wastes
Isolation wastes
Prions or OD Infected Waste or by-products
Hazardous waste
Anthrax.

See Attachment “A” document, **A 1131 Air Quality Permit Medrecycler-RI - App 2454-2457.pdf**, Section C, Paragraph 4 where it states unacceptable wastes as:

"**The facility shall not process any of the following waste streams in either pyrolysis unit:**

a. **Radioactive waste;**
b. **Etiologic agents;**
c. **RCRA empty Chemotherapeutic/Cytotoxic waste;**
d. **Isolation wastes; or**
e. **Prions or OD infected waste or by-products."**

As part of Medrecycler-RI, Inc's Medical Waste Contingency Plan, RI-DEM Office of Waste Management, will be notified orally or via voice/E-mail within 24 hours of all incidents related to fires, medical waste spills or acceptance of radioactive waste or RCRA Hazardous Waste. A complete written report will be submitted within forty-eight (48) hours detailing the incident in question.

RADIATION CONTROL

Radioactive material is any material, solid, liquid, or gas which emits ionizing radiation spontaneously at greater than 3x (three times) the facility's background radiation.

The facility's radiation monitors are located at the medical waste receiving entrance. Should radioactive material be detected the container is labeled as radioactive and temporarily placed in a controlled area away from the employees. In most cases, the material will decay to an acceptable background limit and may be processed as regulated medical waste. If the waste does not decay to acceptable levels within the allotted time frame, the waste will be returned to the generator by a licensed hauler. The radiation monitors will be calibrated annually. The RIDOH and RI-DEM will also be notified of the arrival of any radioactive material as defined above. Medrecycler-RI, Inc personnel will follow the guidance issued by the RIDOH & the RDEM. For further reference, see Medrecycler-RI, Inc's Unacceptable Waste Policy.

6. CONTAINER WEIGHT

As the containers are unloaded into the facility, a Medrecycler-RI, Inc employee weighs the container prior to processing. However, some loads of waste are pre-weighed. Generators are notified of containers which exceed the expected weight limit of 50 lbs or when the manifest weight is different from the actual weight. Containers are rated for the manufacturer's suggested weight limit of 50 lbs. Generator notifications of overweight containers are maintained at the customer service center.

7. *WASTE STORAGE*

No medical waste is stored at the Medrecycler-RI, Inc Division Road RI facility. Four (4) to Six (6) tractor trailers will come in each day for processing. If certain medical waste is rejected, Medrecycler-RI, Inc will send it back to the Generator or arrange to have waste directed to another permitted off-site treatment and destruction disposal facilities. Medrecycler-RI, Inc will then submit to RIDEM, a written report within forty-eight (48) hours.

Generators of the regulated medical waste shall keep a record at the facility that includes all information pertaining to the Facility's operation. These records must be maintained for at least three years from the date of the last entry in the log.

8. *CONTAINERS*

Regulated medical waste, with the exception of sharps waste, is placed in DOT specification red bags. The red bags are placed into the fiberboard box or reusable container. The boxes/containers will be fed into the pyrolysis system.

Rhode Island regulations require all regulated medical waste containers be labeled clearly as containing medical waste. The labels used to demarcate regulated medical waste must include the words "Medical Waste" or clearly display the biohazard symbol that is known universally. The red plastic bags that are used as an inner liner to medical waste packaging do not need to display a "Medical Waste" label.

Containers of waste that are improperly packaged, marked, or labeled are addressed by the operations staff by completing an Exception Report. The Exception Report is designed to notify generators via written correspondence which details the deficiencies and directs and informs the generator as to the proper packaging requirements in accordance with Regulation DEM-OWM-MW-1-2009),as Amended July 2010 and the Federal Hazardous Materials Transportation Regulations. Reports will be maintained at the facility.

9. MANIFESTING DOCUMENT

A medical waste tracking form will accompany all incoming waste and will be used to track wastes processed by the pyrolysis system.

10. DRIVER TRAINING

Medrecycler-RI, Inc transports none of the incoming waste via its own fleet of vehicles. Permitted medical waste haulers transport all of the waste.

11. SPILL CONTROL

The processing facility has procedures for responding to leaking boxes or damaged containers. These procedures are outlined in Medrecycler-RI Spill Clean-Up Policy. See Attachment "A" document, **A Industrial Hygienist Document Review (EH&E 23129).pdf**, also Attachment "C" document, **C ESH Manual Medreycler-RI Rev 1.pdf** for spill clean-up procedures

In the event that a medical waste container is leaking or otherwise contaminated with medical waste, the spill response should be followed according to the Medrecycler's Spill Clean-up Policy. As a best management practice for managing medical waste spills, the spilled or contaminated material should only be remediated by those trained to handle medical waste, using appropriate personal protective equipment. A container that is discovered to be leaking or contaminated with other medical waste shall be broken down and placed into a new red bag and/or regulated medical waste container. Any material that is used

to clean up a spill shall be placed into a new medical waste container and treated as regulated medical waste, with respect to handling, treatment and storage of the medical waste.

12.0 REJECTED LOADS (SLAG OR OTHER) OF PROCESSED WASTE

RI-DEM Office of Waste Management will be notified orally or via voice/E-mail immediately of all loads returned to the ~~facility from~~ the destination facility. Medrecycler-RI, Inc will then submit a written report of the incident within forty-eight (48) hours.

13. PERSONNEL AND DUTIES

A standard shift will be staffed with employees with positions similar to those outlined below, however, dependant upon the waste stream, plant conditions, and other factors, the number of employees and positions may change accordingly:

One (1)- Shift Supervisor

Responsible for on-floor production operations, safety, and quality control with specific emphasis on identifying and subsequent handling, control and disposition of all wastes. Also conducts audits on the floor of quality control records.

One (1)- Maintenance Technician

Responsible for executing the company's standard preventative maintenance plan during scheduled down times and executing emergency repairs as required.

Three (3) – Unloader's / loaders

Responsible for unloading trucks, checking tracking documents and reloading trailers.

One or two (1-2)- waste dumpers/Operators

Responsible for 100% quality control and record keeping for company standards, operating and monitoring of the Pyrolysis and energy production process. The operators are also responsible for filling any containers needed with processed medical waste bi-products, which have completed the approved treatment cycle.

Two or Three (2-3) – Shipping Station Attendant

Responsible for filling containers, quality control, drying, proper labeling and removal of old generator labels if any.

Currently, the office personnel consist of:

- One (1) – Operations Manager – responsible for facility operations including transportation, production, maintenance and financial stability.
  One (1) – Safety Manager and One (1) Compliance Manager – responsible for all safety, regulatory and quality issues for the processing facility and related transportation functions. These personnel visit the site on a periodic basis and are always available to plant management via phone or email.
  Three (3) – Production Supervisors – responsible for all activities associated with the proper and efficient processing of regulated medical waste.
  One or two (1 or 2)- Administrative Assistant- responsible for the accurate input of all incoming and processed materials.
- Sales personnel as required to support new client and to secure incoming wastes.

14. PLANT OPERATIONS EMPLOYEE TRAINING

As part of the annual safety training employees are trained, at a minimum in the following areas:

- Blood borne pathogens
- Hazard communication
- Accident/injury reporting
- Personal protective equipment (PPE)
- Noise and hearing protection
- Back safety – proper lifting
- Medical waste spill control
- Unacceptable wastes
- Quality assurance/quality control
- Contingency plan including: emergency phone numbers to relevant emergency response teams, state and federal agencies.
- Right-to-access medical and exposure records
- Forklift safety-(If needed)
- Electrical safety and lock out/tag out awareness
- Work station training and cross training
- Fire safety including:evacuation plans, and designation of a muster area
- Disaster preparedness
- Confined Spaces awareness/ entry
- Hazardous chemical exposure, handling, transportation, spills and warning signs
- Portable (power operated) tools and equipment
- Hazard communication should include a U.S. Occupational Safety and Health Administration (OSHA) Job and Safety and Health Protection Poster.
- Machine Guarding
- RI-DEM Regulations
- Emergency response team training
- Emergency first aid
- Respirator training
- Facility Operating Permit & Procedures

15. FACILITY MANAGEMENT

Medrecycler-RI, Inc will notify RI-DEM in writing of any changes in plant management, which would be limited to the Facility Manager and the Safety or Environment Manager. The facilities management will carry a communication device to ensure continual contact with the processing facility.

16. HELP LINE

Medrecycler-RI, Inc has put into place a HELP LINE for employees. The HELP LINE is for employees to call to ask questions, report operating violations, safety infractions, etc. This is part of the ongoing quality assurance program. It is a confidential reporting method monitored by Medrecycler-RI, Inc's Senior Management.

17. DUST CONTROL PROGRAM

The facility is paved. The facility will use the guidance offered in 1.7.10, of the Solid Waste Regulations, if required.

18. ODOR CONTROL PROGRAM

There may occasionally be unusual odors associated with the Medrecycler-RI, Inc process. Facility management makes every effort to minimize odors through deodorizers, filtration and storage constraints. Medrecycler-RI, Inc will conduct daily walk around inspections to ensure that all trailers are locked and that there is no offensive odor at the property boundaries from the trailers. If a trailer is determined to be emitting an offensive odor, that trailer will be sent off-site to an alternate approved medical waste treatment and destruction facility or processed immediately.

19. SLAG CONTROL PROGRAM

Once the waste is processed, treated, and destroyed, there may be small amounts of slag on the floor. The slag is inert and will be swept up and disposed of like all vitrified products. All treated waste products are loaded into appropriate for transport to disposal. Any fragments of treated material that might escape the facility during handling are cleaned up.

20. SUBSTITUTE DISPOSAL AND/OR TRANSFER ARRANGEMENTS

The facility maintains an adequate supply of spare parts to prevent extensive downtime for the operation. However, if a condition existed where the processing facility could not operate, then all the inbound waste will be diverted to alternate processing facilities in accordance with Solid Waste Regulation # 3, Section 3.2.06.

21. COMMUNICATIONS EQUIPMENT AVAILABLE

The facility is equipped with standard telephone service, an inter-office facility paging system, and emergency hand held radios.

22. *PROVISIONS FOR LIMITED ACCESS*

Access to the facility is through the from door and loading dock.

The Shift Supervisor is the only person after hours that can allow non-Medrecycler-RI employees access to the processing facility.

23. ***WEIGHING FACILITIES***

Waste is scanned and weighed prior to processing. The scanning records the time and weight of each container into Medrecycler-RI, Inc's "TBD" System.

24. ***AESTHETIC CONSIDERATIONS***

The facility is a 48,000 square foot existing warehouse.

25. RESIDUE DISPOSAL ARRANGEMENTS {FOR RESOURCE RECOVERY FACILITIES}

Not Applicable.

26. FINAL DISPOSAL ARRANGEMENTS (FOR TRANSFER AND COLLECTION STATIONS)

Medrecycler-RI, Inc sends the treated waste products to facilities permitted to accept such waste.

27. VECTOR CONTROL PROGRAM

There is a pest control program at the processing facility.

28. FIRE CONTROL AND PREVENTION PROVISIONS

The building is equipped with sprinklers for fire safety. All employees are trained in fire safety provisions in accordance with Medrecycler-RI, Inc's Fire Prevention Plan. Fire extinguishers are located throughout the processing facility. Processing facility doors are equipped with panic hardware for fire safety. Please see Attachment "D" document, **D Fire Safety and Evacuation Plan.pdf**.

29. ON SITE TRAFFIC PATTERNS

There is only one driveway entrance into the processing facility. A sign is posted in the front of the facility to adequately direct drivers to the appropriate unloading area, assist in traffic control, and to regulate speed within the facility, as required in Rule 1.7.06. The front part of the building is used for car traffic, employee parking, and visitor parking. The rear of the building is used for delivery of product, truck turning, trailer parking and, if necessary, additional employee parking.

Increasing the capacity of the facility will slightly increase the traffic entering and exiting the facility. At the maximum traffic there will be approximately 10 extra truck/trailers entering and exiting the building per day.

30. SPECIAL WASTE HANDLING AND PROCESSING PROCEDURES

Tracking form discrepancies are handled in accordance with Section 15.04 of the Rules and Regulations Governing the Generation, Transportation, Storage, Treatment, Management and Disposal of Regulated Medical Waste in Rhode Island.

Record keeping is handled in accordance with Section 15.05 of the Rules and Regulations Governing the Generation, Transportation, Storage, Treatment, Management and Disposal of Regulated Medical Waste in Rhode Island

31. PROCESS DESCRIPTION

The Medrecycler-RI, Inc process can be described in the following sections 2 TAB 3: Receiving of Waste, Process Area Description and Procedures, Reusable Container Sanitizing Process, Employee Training and Proper Protective Equipment, Applicable Regulations for the Process, and Process Validation.

32. *RECEIVING OF WASTE*

All waste received whether processed or transferred is reconciled with the medical waste tracking documents. As part of the quality assurance program, all waste loads from the generator to the processing facility are tracked. This is done for all generators in all states regardless of whether or not the state has specific tracking requirements. All generators will have access to their tracking documents by electronic filing handled through Medrecycler-RI, Inc's contracted document retention contractor once the waste has been processed.

33. PROCESS AREA DESCRIPTION

The following is a list of the major pieces of equipment installed in the facility.

- Two (2) Pyrolysis systems
- Four (4) Electrical Producing Engines
- One (1) Granulator
- One (1) Dryer
- One (1) Feed Silo
- One (1) Vitrifier
- One (1) Thermal Oxidizer
- One Gas Cleanup Device
- Three (3) Offgas Scrubbers
- One (1) Gasometer

Once the waste is received into the facility, it will be scanned into the facility's computer system, weighed and scanned for radiation. Waste will then be placed in the hopper whole and unopened, or placed in the ready to process storage trailers awaiting processing.

Overall process takes medical waste (MW), received by a transporting company, and thermally processes it in a pyrolysis system operating at 822°C - 900°C (1472°F - 1652°F). Organic matter from the MW is evaporated forming a syngas that can directly be used as a fuel source for electrical generating engines. Oil and tar are produced where the oil is recycled through the pyrolysis system to make more syngas, and the tar is used to heat a vitrification system where solids from the process are vitrified and made inert. Exhaust from the engines are sent to a drying unit where the MW if dried prior to be introduced into the pyrolysis system. All gasses are sent to a Thermal Oxidizer where they are conditioned for release to atmosphere via a stack at a temperature of 850°C (1,562°F).

33. *CAPACITY*

The facility is designed to accept to 70 tons of waste per day, (midnight to midnight).

34. *DATA ACQUISITION*

The run data for each system are maintained for a period of three years consistent with other

regulatory documents.

36. FINAL DISPOSTION OF WASTE

Final disposition of the medical waste are: syngas to combustion emission, slag (a glassy inert product), approximately 500 gallons of clean water recycled through the Pyrolysis System and a carbon based char that will be recycled in Hot Mix Asphalt.

37. REUSABLE CONTAINER

All exceptable waste forms will be processed in unopened boxes and none will be reusable.

38. EMPLOYEE MEDICAL SURVEILLANCE

Each employee, prior to starting a work assignment, receives a pre-employment physical, which includes a health assessment, inoculations and drug testing. Each employee is then subject to medical surveillance monitoring. Medical surveillance is reviewed regularly to insure compliance with CDC guidelines and OSHA requirements.

39. *EMPLOYEE PERSONAL PROTECTIVE EQUIPMENT {PPE}*

Employees at the processing facility change into company provided uniforms and safety shoes. See Attachment "C" document, **C ESH Manual Medrecycler Rev 1.pdf**.

40. APPLICABLE REGULATIONS FOR THE PROCESS

The Medrecycler-RI, Inc processing facility has no air emissions as regulated by NESHAP.

There are two water flows within the facility. The water is sent to the Division Road water department. The Medrecycler-RI, Inc facility is permitted for this process.

41. PROCESS VALIDATION

Time/Temperature charts

Each Medrecycler-RI, Inc Pyrolysis and energy generator records the operational condition of all parts of the system continuously during operation and stores it in a data acquisition database. . These monitoring devices are checked and calibrated according to the manufacturers specification to insure their accuracy. The can be reviewed at any time during operation to insure the proper operation of the system.

Biological Validation

Biologics cannot survive the process of Pyrolyzation. The hopper and shredders will have to be sterilized and checked periodically for any contamination. See Attachment "A" at the end of this Application for reference documents:

1. H 1131-060-055 Shredder Inlet and Outlet Sealing_info.pdf
2. A 1131 Air Quality Permit medrececycler-RI-App 2454-2457.pdf
3. A 1131 Layout Negative Pressure Monitoring.pdf
4. A 1131 Macerator Negative Pressure.pdf
5. A 1131-020-001 Medical waste macerator (shredder) Rev A.pdf
6. A DEM response on negative pressure and macerator.pdf

From Industrial Hygiene Company: Environmental Health & Engineering, Inc., also Attachment "A"

documents.

Biological Testing Efficacy:

2. A IH Recs for DEM Response Update (EH&E 23129).pdf. Document dated December 19, 2019

Macerator Negative Pressure:

3. A IH RIDEM Response letter-may 2020.pdf. Document dated May 2020

42. PROCESS CONTROLS

Each Medrecycler-RI, Inc Pyrolysis and energy generator records the operational condition of all parts of the system continuously during operation and stores it in a data acquisition database. . These monitoring devices are checked and calibrated according to the manufacturers specification to insure their accuracy. They can be reviewed at any time during operation to insure the proper operation of the system.

43. BULKY WASTE HANDLING PROCEDURES

The waste received into the processing facility is very predictable in size and density. All waste is in bags or over packed in reusable containers or boxes. In accordance with Solid Waste Regulations# 1, Section 1.7.04 (d) & (e), the facility relies on source segregation for identifying, removing, storing, recycling and disposing PCB capacitors and chlorinated fluorocarbons such as Freon. The facility shall not knowingly accept any PCB capacitors or chlorinated fluorocarbons such as Freon.

44. ROUTINE HOUSE CLEANING SCHEDULES

Standard housekeeping procedures are applied to the cleaning and sanitizing in the processing, loading and unloading areas. Each employee is responsible for housekeeping and grounds keeping.

There are no RCRA or RIDEM Hazardous Waste on site that require SARA Title III, Section 304 reporting. There are Materials Safety Data Sheets (MSDS) for all chemicals at the facility. Chemicals used are for cleaning and sanitizing the work area and for maintenance procedures

45. SECURITY

The property is under a full security system. All exit doors are provided with electrical relays that monitor the status of each door (i.e. signals when door is open). When the plant is closed, this system is activated. The back trailer parking area has only one entrance, which is equipped with a locking gate.

46. POPULATION AND SERVICE AREA

Medrecycler-RI, Inc In services the Jonston area market. This market includes areas such as _____. Within an area encompassing these cities, there are approximately _____ hospitals with_____ beds that conservatively generate 81.5 million pounds of medical waste annually.

47. Methods & Equipment for Recycling Operations

N/a

48. ***REPORTING TO RIDEM***

Medrecycler-RI, Inc will maintain all operating records, including but not limited to date, time, quantities and operational data of equipment

Additionally, RIDEM's Office of Waste Management will be notified orally or via voice/E-mail within 24 hours of all incidents related to fires, medical waste spills or acceptance of radioactive waste or RCRA or RI-DEM Hazardous Waste. A complete written report will be submitted within forty-eight (48) hours detailing the incident in question as well as Medrecycler-RI, In response to the incident.

49. ***DECOMMISIONING, SITE CLEAN-UP, INSURANCE DOCUMENTATION, EXCESS LIABILITY PAPERWORK***

For decommissioning, site clean-up, insurance and excess liability documentation see Attachment “E”.

Tab 5– Facility Floor Plan

SEE ATTACHMENT “H” FOR FACILITY FLOOR PLAN
AND SUB-SYSTEM EQUIPMENT DRAWINGS

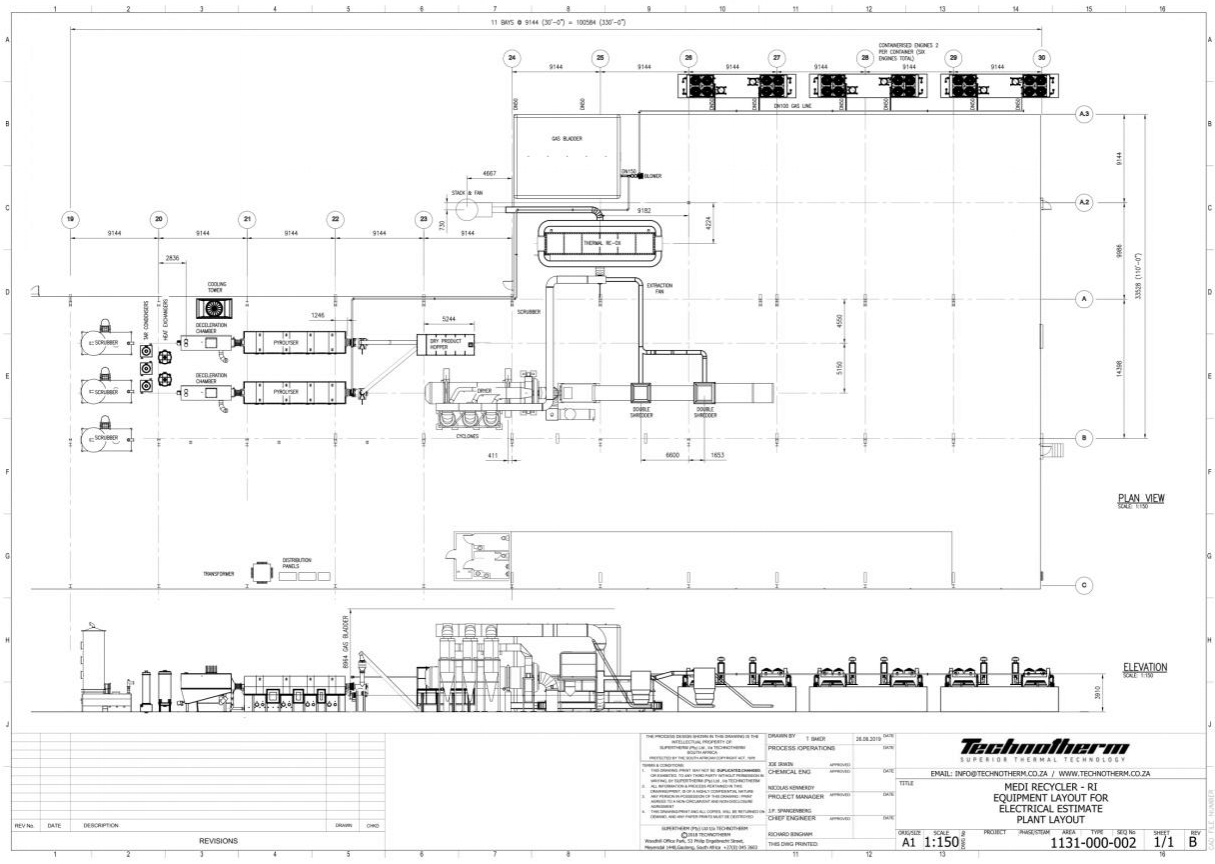


Figure 22. Facility floor plan

LIST OF ATTACHMENTS

ATTACHMENT	DESRIPTION
A	Air quality permit, Macerator information, negative pressure, pyrolysis unit specification, plant layout drawings, Industrial Hygiene reports, pyrolysis project specification, various Medrecycler-RI response documents to RIDEM
B	Employee Manual
C	ESH Manual Medrecycler Rev 1
D	Fire Safety and Evacuation Plan
E	Decommissioning documentation, clean-up insurance endorsement, insurance certificate, environmental excess liability insurance and policy declaration.
F	Medrecycler-RI Application signed by Professional Engineer dated June 28, 2019, Revision 8.
G	Various RIDEM corespondent letters, Air quality permit
H	Plat layout drawings, individual equipment drawings, detailed plant drawings