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CHATTANOOGA-HAMILTON COUNTY AIR POLLUTION CONTROL BUREAU

Statement of Basis
Part 70 Permit No. 47-065-4240

3/19/24

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Emission Unit No.	Description
001	Three 310-Ton Capacity Sand Storage Silos
002	Sand Delivery System
003	Resin-Coated Sand Production Lines #1, #2, and #3
004	150-Ton Capacity Sand Storage Silo

Purpose

Porter Warner Industries, LLC, has applied for the renewal of their Part 70 (Title V) permit. This company name is registered as an active entity with the Tennessee Secretary of State. A Part 70 permit renewal application was received from Porter Warner on July 21, 2023. This statement of basis includes discussions of the operation of the permitted equipment, the air pollutant emissions, and the applicable regulations. It has been adapted from the Bureau annual inspection report for Porter Warner dated March 13, 2023.

Process Description

Porter Warner produces resin-coated sand, known as shell sand that is subsequently used by iron and steel foundries for forming cores. This sand is also infrequently used by the foundries to form molds, but other sand mixtures are normally used for this purpose. Molten iron or steel is poured into the sand molds, which form the external surface of metal castings. Cores are molded sand shapes that are used to fashion internal voids in the castings.

Sand (silica, silicon dioxide, SiO_2) is normally received at the plant in railcars, but it can also be brought in by truck. The sand is transferred from the railcars to a bucket elevator by way of a belt conveyor. The bucket elevator then loads any of three storage silos **(Emission Unit 001)** that are each dedicated to hold sand of a specific size classification. Sand that is delivered by truck is pneumatically conveyed directly to the appropriate silo. The capacity of each of the three silos

is 310 tons. The bucket elevator and three silos are each equipped with a sock filter that is used to control particulate matter (PM) emissions of sand that occur during loading. A portion of the air that is displaced from loading a silo is considered to be exhausted through the sock filter for the bucket elevator.

Sand from the three 310-ton capacity silos is unloaded onto a belt conveyor by way of separate screw conveyors. Only one of the three silos can be unloaded at a time. This belt conveyor deposits the sand into an enclosed bucket elevator that carries it to a compartmentalized hopper. The belt conveyor for railcar unloading and the belt conveyor for unloading the three silos are adjacent to each other and are collectively referred to as the sand delivery system **(Emission Unit 002)**. Uncontrolled fugitive PM emissions of sand result from four transfer points of this system. These points are as follows: where sand is unloaded onto the first belt conveyor from railcars, where sand is discharged from the first belt conveyor to the bucket elevator for the three silos, where sand is deposited onto the second belt conveyor from the three screw conveyors that serve the three silos, and where sand is discharged from the second belt conveyor to the bucket elevator for the compartmentalized hopper. No PM emissions result from the filling of the compartmentalized hopper and a weigh hopper that follows it because these two vessels are sealed and are vented back to the enclosed bucket elevator.

From the compartmentalized hopper, sand of the required size classification is weighed and pneumatically conveyed to any of three resin-coated sand production lines **(Emission Unit 003)**. These batch lines are designated as Lines #1, #2, and #3. Lines #1 and #2 are nearly identical, and they each have a production capacity of 7,500 lb/hr. The production capacity of Line #3 is 12,000 lb/hr. Lines #1 and #2 each consist of the following pieces of equipment, in order: a surge hopper, a weigh hopper, a heater, a "muller," an initial screen, a cooler, an enclosed bucket elevator, a storage bin, a final screen, and a bagging station. Line #3 consists of the same pieces of equipment in the same order, except that the final screen precedes the bucket elevator. Occasionally, either zircon sand (zirconium silicate, $ZrO_2 \cdot SiO_2$) or carbon sand (spherical grained carbon) may be used in place of silica sand. If needed, they are dispensed to any of the three production lines from bulk bags.

The sand is directly heated to a temperature of about 295°F in the heaters, which are fueled exclusively by natural gas. The heaters for Lines #1 and #2 each have a rated capacity of about 1.0 MMBtu/hr, and the rated capacity of the heater for Line #3 is about 2.0 MMBtu/hr. Emissions that result from fuel combustion in each of these three heaters are classified as an insignificant activity in accordance with §4-56(c)(12)(xiii).

The thermosetting resin that is used to coat the sand is novolac, which is a polymer of phenol (C_6H_5OH) and formaldehyde (methanal, CH_2O). The novolac resin, in the form of flakes, is mixed in with each batch of heated sand in the mullers. The resin melts and adheres to the sand grains. The coated sand in the mullers is then partially cooled by being quenched with water into which hexamethylenetetramine [HMTA, hexamine, $(CH_2)_6N_4$] has been dissolved. The hexamine serves to cure the resin. A small quantity of calcium stearate [$(CH_3[CH_2]_{16}COO)_2Ca$] powder,

which functions as a lubricant for the coated sand, is added to the sand in the mullers at the end of each batch.

Novolac resin, which is made by using excess phenol, contains some unpolymerized phenol monomer and a lesser amount of unpolymerized formaldehyde monomer. A portion of the hexamine may decompose in the mullers by reacting with water to form formaldehyde and ammonia (NH_3) in accordance with the following reaction: $(CH_2)_6N_4 + 6H_2O \rightarrow 6CH_2O + 4NH_3$. Steam is vented from the mullers during the water quenching step, and uncontrolled volatile organic compound (VOC) emissions of phenol and uncontrolled PM emissions of sand are entrained in this steam. Any VOC emissions of formaldehyde and any ammonia emissions that may be entrained in this steam are uncontrolled and negligible. Both phenol and formaldehyde are hazardous air pollutants.

A solution known as Ecosorb® is injected as a fine spray through three atomization nozzles that are located inside the exhaust stack for each muller while steam is being vented. It is injected upwards in the exhaust stacks for Lines #1 and #2, and it is injected horizontally in the stack for Line #3. It serves to partially neutralize the VOC emissions of phenol that result from the mullers. Ecosorb® contains non-toxic, naturally occurring essential oils, which are derived from plants, and its safety data sheet indicates that it has a slight citrus or floral odor. The effectiveness of Ecosorb® in controlling VOC emissions of phenol from a particular source is dependent on many factors, such as reaction time, degree of atomization, humidity, and temperature. While Ecosorb® controls VOC emissions of phenol from the mullers to some extent, no control efficiency has been determined for this specific use of it to date.

PM emissions of sand that result from the heater, initial screen, cooler, and bagging station of each of the three production lines, from the final screen of each of Lines #1 and #2, and from the storage bin of Line #3 are all controlled by a single main baghouse. Filterable PM emissions that result from burning natural gas in the heaters of the three production lines are controlled by this baghouse, and other emissions that result from fuel combustion in the heaters are uncontrolled. PM emissions of calcium stearate are also emitted from the coolers and are controlled by the baghouse. The coolers function by sparging cold air through the sand. Calcium stearate is not emitted from the exhaust stacks for the mullers because a drying fan damper is closed off before the calcium stearate is added.

PM emissions of sand from the surge hoppers of Lines #1 and #2 are controlled by a single baghouse, and PM emissions of sand from the surge hopper of Line #3 are controlled by another baghouse. No PM emissions result from the filling of the weigh hoppers of the three lines or from the filling of the storage bins of Lines #1 and #2 because these vessels are sealed and are vented to the equipment that precedes them. No PM emissions result from the final screen of Line #3 as it is followed by an enclosed bucket elevator.

The resin-coated sand product is packaged in the bagging station of each of the three production lines into bulk bags that have an average capacity of 1.5 tons. Rather than being bagged, some of the coated sand product can be transferred by way of a belt conveyor from the bucket

elevator of Line #3 to a 150-ton capacity silo **(Emission Unit 004)**. PM emissions of sand that result from filling this silo are controlled by a baghouse. Either railcars or trucks can be loaded with product from the silo by way of another belt conveyor. No PM emissions result from either of the two belt conveyors because the points where sand is deposited onto them and discharged from them are enclosed.

Evaluation

Emission Unit 001 Three 310-Ton Capacity Sand Storage Silos

Each of the three 310-ton capacity sand storage silos can be loaded from a railcar at a maximum rate of about 50,000 lb/hr and from a truck at a maximum rate of approximately 22,500 lb/hr. Only one of the silos can be loaded at any one time from a railcar, and only one of them can be loaded at a time from a truck, although loading from trucks is not normally done. The three resin-coated sand production lines combined use sand at a maximum rate of 27,000 lb/hr, and they are each operated for no more than 6,000 hr/yr. The annual production of resin-coated sand from the three lines combined during calendar year 2022 was 19,429 tons. The resin-coated sand product consists of 97% sand and 3% resin, on average. 186.87 tons of sand was received by truck in 2022. Each of the four sock filters has an estimated PM control efficiency of 99%.

The estimated PM emissions from the three silos and bucket elevator combined are given in the table at the end of this section. These emissions were calculated by using an AP-42 (1993) uncontrolled emission factor of 0.029 lb/ton. The potential emissions are based on loading sand at the maximum rates and on supplying the maximum amount of sand (regardless of whether from railcars or trucks) that could be required by the three resin-coated sand production lines.

The PM emissions from the three 310-ton capacity sand storage silos and bucket elevator combined are limited by Rule 10.7 to 0.25 gr/scf. This limitation is equivalent to 0.011 lb/hr for the calculated exhaust flow rate of 5.05 scfm when a silo is being loaded from a railcar by way of the bucket elevator, and it is equivalent to 0.64 lb/hr for the stated exhaust flow rate of 300 scfm when a silo is being pneumatically loaded from a truck. The exhaust flow rate for loading from a railcar is considered to be equivalent to the amount of air that is displaced from a silo by sand that has a specific gravity of 2.65, according to a safety data sheet. The Rule 10.7 limitation is more stringent than the Rule 10.3 (Schedule 2) PM emission limit of 26.4 lb/hr for loading from a railcar and 16.1 lb/hr for loading from a truck.

Emission Unit 002 Sand Delivery System

One of the belt conveyors of the sand delivery system is used to unload railcars at a rate of about 50,000 lb/hr. The three larger silos can each be unloaded by way of the other belt conveyor at a maximum rate of about 80,000 lb/hr, and only one of them can be unloaded at a time. The three resin-coated sand production lines combined use sand at a maximum rate of 27,000 lb/hr, and they are each operated for no more than 6,000 hr/yr. The annual production of resin-coated

sand from the three lines combined during calendar year 2022 was 19,429 tons. The resin-coated sand product consists of 97% sand and 3% resin, on average. 186.87 tons of sand was received by truck in 2022.

The estimated PM emissions from the sand delivery system are given in the table at the end of this section. These emissions were calculated by using an AP-42 (1993) emission factor of 0.029 lb/ton for each of the four transfer points of this system. The potential emissions are based on unloading sand at the maximum rates and on supplying the maximum amount of sand that could be required by the three resin-coated sand production lines.

The PM emissions from the sand delivery system are limited by Rule 10.3 (Schedule 2) to 26.4 lb/hr for the belt conveyor for railcar unloading and 31.2 lb/hr for the belt conveyor for unloading the three 310-ton capacity silos. The Rule 10.7 PM emission limit of 0.25 gr/scf for each of the four transfer points of the sand delivery system is not applicable because the emissions are fugitive in nature.

Emission Unit 003 Resin-Coated Sand Production Lines #1, #2, and #3

Each of Resin-Coated Sand Production Lines #1 and #2 operates at a rate of about 4.0 minutes/batch, and Resin-Coated Sand Production Line #3 operates at a rate of about 3.75 minutes/batch. Lines #1 and #2 each have a production capacity of 500 lb/batch and 7,500 lb/hr, and the production capacity of Line #3 is 750 lb/batch and 12,000 lb/hr. Each of the three lines is operated for no more than 6,000 hr/yr. The annual hours of operation during calendar year 2022 were 1,274.80 hours for Line #1, 1,368.95 hours for Line #2, and 2,189.40 hours for Line #3. The annual production of resin-coated sand from the three lines combined during 2022 was 19,429 tons. Apportioning this quantity among the production lines by prorating by actual hours of operation and weighting by production capacities results in 4,029.43 tons for Line #1, 4,327.03 tons for Line #2, and 11,072.54 tons for Line #3. In addition, 3,995.71 tons of resin-coated sand were loaded into the 150-ton capacity sand storage silo during 2022.

Novolac resin is applied to the sand at average and maximum rates that are equivalent to 3.0% and 4.0% of the production rate, respectively. The hexamine usage rate is equal to 15% of the usage rate for resin. According to safety data sheets, the novolac resin that is used has average and maximum unpolymerized phenol concentrations of 4.0% and 5.5%, respectively. However, the resin can have an unpolymerized phenol concentration of no more than 4.4% if it is applied at the maximum rate of 4.0% of the production rate. In addition, the resin can be applied at a rate of no more than 3.2% of the production rate if it has the maximum unpolymerized phenol concentration of 5.5%. The resulting average and maximum unpolymerized phenol concentrations of any batch of sand when resin is initially applied to it are 0.120% (0.030 × 4.0%, 1,200 ppm) and 0.176% (0.040 × 4.4% or 0.032 × 5.5%, 1,760 ppm), respectively. The average and maximum concentrations of unpolymerized formaldehyde that are in the resin are 0.2% and 0.3%, respectively.

Samples of resin-coated sand product were collected on March 2, 1995, and were analyzed to determine the concentration of unpolymerized phenol in them. These samples were produced by using novolac resin that had the average unpolymerized phenol concentration of 4.0% and that was applied to the sand at varying rates. The sample analysis results indicate that the amount of unpolymerized phenol that is in a given quantity of coated sand is nearly linearly proportional to the amount of unpolymerized phenol that was in the resin that was applied to that sand. Analyses of the samples that were produced by applying resin at the average rate, which is equivalent to 3.0% of the production rate, resulted in an unpolymerized phenol concentration of 800 ppm in the coated sand product. Using the method of least squares to extrapolate the sample analysis results to coated sand that is produced by using sand that has the maximum unpolymerized phenol concentration of 1,760 ppm upon resin application results in an unpolymerized phenol concentration of 1,304.8 ppm in the product. All of the unpolymerized phenol that is supplied from the resin and that does not remain in the product is considered to be emitted as the efficiency of the Ecosorb® exhaust injection systems in controlling VOC emissions of phenol has not be estimated at this time. No formaldehyde emissions were detected by sampling of the muller for Line #1 that was conducted on May 28, 1998, using Sensidyne/Gastec detector tubes.

The main baghouse for the resin-coated sand production process, the baghouse for the surge hoppers of Lines #1 and #2, and the baghouse for the surge hopper of Line #3 each have an estimated PM control efficiency of 99.9%. Approximately 1,000 pounds of PM were collected by the main baghouse per month before Line #3 began operating and before the surge hoppers of Lines #1 and #2 were vented to a separate baghouse. Based on the typical production rate at that time of 1,500 tons/month and on not counting the filterable PM emissions that result from natural gas combustion in the heaters, the resulting process PM emission factor is 0.666 lb/ton before control by the baghouse. The emission sources of each of Lines #1 and #2 that are encompassed by this emission factor are the surge hopper, the heater, and the cooler.

AP-42 (1993) uncontrolled emission factors for screens and for bulk loading are 0.16 lb/ton and 0.056 lb/ton, respectively. Because the initial screens, final screens, and bagging stations of Lines #1 and #2 are now also vented to the main baghouse, the revised process PM emission factor for each of these two production lines, including their surge hoppers, is approximately 1.042 lb/ton before control by a baghouse. Corresponding process PM emission factors, before control by a baghouse, for Line #3, including its surge hopper, are approximately 0.988 lb/ton when the product is bagged and 0.826 lb/ton when the product is transferred from the bucket elevator to the 150-ton capacity silo. The PM emissions that result from each of the three mullers have not been estimated, but are considered to be less than 0.10 lb/hr.

The estimated process PM emissions and VOC emissions of phenol from the three resin-coated sand production lines are given in the table at the end of this section. The potential emissions are based on simultaneous operation of all three production lines for 6,000 hr/yr at their capacities while using resin that contains the maximum unpolymerized phenol concentration and that is applied to the sand at the maximum rate. The potential emissions are also based on bagging all of the product from Line #3. The emissions that result from natural gas combustion in the heater of each of the three production lines are classified as an insignificant activity.

The resin-coated sand production process was modified in 1996 by the addition of Line #3. Therefore, the VOC emissions from this process are subject to BACT (Rule 25.3). Control of the VOC emissions of phenol from each of the three resin-coated sand production lines by an Ecosorb® exhaust injection system has been determined to be BACT. Appropriate BACT limitations for these emissions have been previously determined to be 3.5 lb/hr for each of Lines #1 and #2 and 5.7 lb/hr for Line #3. An appropriate BACT limitation for the unpolymerized phenol concentration of sand when novolac resin is initially applied to it has been previously determined to be 0.176%. In addition, an appropriate BACT limitation for the operating hours for each production line has been previously determined to be 6,000 hr/yr.

The PM emissions from the resin-coated sand production process are subject to Rule 27.3. Control of the PM emissions from various emission sources of this process by a baghouse has been determined to be reasonable and proper, in accordance with Rule 27.3. An appropriate reasonable and proper limitation for the PM emissions from the two surge hoppers of Lines #1 and #2 combined has been previously determined to be 0.005 lb/hr. An appropriate reasonable and proper limitation for the PM emissions from the surge hopper of Line #3 has also been previously determined to be 0.005 lb/hr. An appropriate reasonable and proper limitation for the PM emissions from the main production process baghouse has been previously determined to be 0.04 lb/hr. In addition, an appropriate reasonable and proper limitation for the PM emissions from the muller of each of the three production lines has been previously determined to be 0.10 lb/hr.

Each of the reasonable and proper PM emission limitations is more stringent than the Rule 10.7 PM emission limit of 0.25 gr/scf. The Rule 10.7 limit for the surge hoppers of Lines #1 and #2 cannot be converted into units of lb/hr because the exhaust flow rate of the baghouse for these surge hoppers is not available at this time. The Rule 10.7 limit for the Line #3 surge hopper is equivalent to 0.75 lb/hr for the stated exhaust flow rate of 350 scfm for the baghouse of this surge hopper. The Rule 10.7 limit for the main production process baghouse is equivalent to 16.69 lb/hr for the stated exhaust flow rate of 7,789 scfm for this baghouse. Each of the Rule 10.7 limits for the mullers of Lines #1 and #2 are equivalent to 1.61 lb/hr for the previously stated exhaust flow rate of 750 scfm for each of these mullers, although the actual exhaust flow rate for the Line #1 muller is now somewhat higher than that for the Line #2 muller. The Rule 10.7 limit for the muller of Line #3 is equivalent to 2.57 lb/hr for the stated exhaust flow rate of 1,200 scfm for this muller. The sum of the reasonable and proper PM emission limitations for the emission sources of the production process is equal to 0.35 lb/hr and is more stringent than the Rule 10.3 (Schedule 2) PM emission limit of 18.0 lb/hr for the combined sources of the production process.

Emission Unit 004 150-Ton Capacity Sand Storage Silo

The 150-ton capacity sand storage silo can be loaded at a rate of 12,000 lb/hr, which is the maximum production rate for Resin-Coated Sand Production Line #3. This line is operated for no more than 6,000 hr/yr. The baghouse has an estimated PM control efficiency of 99.9%. 3,995.71 tons of resin-coated sand were loaded into the silo during 2022.

The estimated PM emissions from the silo are given in the table at the end of this section. These emissions were calculated by using an AP-42 (1993) uncontrolled emission factor of 0.029 lb/ton. The potential emissions are based on loading, at the maximum rate, the maximum amount of resin-coated sand that could be produced by Line #3. The plant-wide potential emissions in this table are based on bagging all of the Line #3 production and therefore do not include any emissions from the silo.

Porter Warner is located within the former PM non-attainment area. The 150-ton capacity sand storage silo was installed in 1990. As of 2002, the silo went for two years without being used, and it was no longer considered to be an existing source at that time, in accordance with §4-8(c)(1). Although the PM emissions from the silo could be considered (as of 2002) to be subject to Rule 27.3 (reasonable and proper emission limitations), these emissions continue (since 1990) to be subject to BACT [§4-8(e)(2)] because BACT is more stringent. Control of these emissions by a baghouse has been determined to be BACT. An appropriate BACT limitation for the PM emissions from the silo has been previously determined to be 0.002 lb/hr. This limitation is more stringent than both the Rule 10.3 (Schedule 2) PM emission limit of 10.9 lb/hr and the Rule 10.7 PM emission limit of 0.25 gr/scf, which is equivalent to 0.54 lb/hr for the stated exhaust flow rate of 250 scfm for the baghouse of the silo.

Plant-Wide Emissions

Pollutant and Source	Actual Emissions *tons/yr*	Potential Emissions *lb/hr*	Potential Emissions *tons/yr*	Allowable Emissions *lb/hr*
Particulate Matter				
Silos Loading from Railcar (001)	0.0027	0.0073	0.012	0.011*
Silos Loading from Truck (001)	0.000026	0.0033		0.64*
Railcar Unloading (002)	0.541	1.450	2.349	26.4
Silos Unloading (002)	0.547	2.320	2.349	31.2
Resin Line #1 Muller (003)	0.064	0.100	0.300	0.10
Resin Line #2 Muller (003)	0.068	0.100	0.300	0.10
Resin Line #3 Muller (003)	0.109	0.100	0.300	0.10
Resin Process Baghouses (003)	0.0089	0.014	0.041	0.05
150-Ton Capacity Silo (004)	0.000058	0.00017	0.00052	0.002
Total Particulate Matter	**1.341**	**4.094**	**5.651**	**58.6**
Phenol (Volatile Organic Compound)				
Resin Line #1 (003)	1.612	3.414	10.242	3.5
Resin Line #2 (003)	1.731	3.414	10.242	3.5
Resin Line #3 (003)	4.429	5.462	16.387	5.7
Total Phenol	**7.772**	**12.290**	**36.871**	**12.7**

*0.25 gr/scf

Summary

The three 310-ton capacity sand storage silos (Emission Unit 001) are subject to and in compliance with §4-41, Rule 3 (visible emissions), Rule 10 (PM emissions), and Rule 26.11 (RACT visible emissions from material handling sources) of the Chattanooga Air Pollution Control Ordinance (the Ordinance).

The sand delivery system (Emission Unit 002) is subject to and in compliance with §4-41, Rule 10 (PM emissions), Rule 11 (visible emissions from material handling in open air), and Rule 26.11 (RACT visible emissions from material handling sources) of the Ordinance.

Resin-Coated Sand Production Lines #1, #2, and #3 (Emission Unit 003) are subject to and in compliance with §4-41, Rule 12 (odor), Rule 25.3 (BACT VOC emissions), and Rule 27.3 (reasonable and proper PM and visible emissions) of the Ordinance.

The 150-ton capacity sand storage silo (Emission Unit 004) is subject to and in compliance with §4-8(e)(2) (BACT PM and visible emissions) of the Ordinance.

None of the emission sources at this facility are subject to §4-68(d) ("Compliance Assurance Monitoring," Title 40 *Code of Federal Regulations* Part 64) of the Ordinance.