pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

MEMO

FROM William Weaver WRW 11/6/23 and Thomas J. Hanlon *TJH 11/1/23*
Air Quality Program Manager East Permit Section Chief

DATE December 1, 2022

RE RACT 3 Review Memo
Boyertown Foundry Company
Title V Operating Permit No. 06-05063
Boyertown Borough, Berks County

Introduction/Facility Description

On November 11, 2022, Boyertown Foundry Company submitted a RACT 3 proposal regarding sources at their Boyertown facility. The facility is a major source for VOC that has been in operation prior to August 3, 2018, and therefore, in in accordance with 25 Pa. Code Section 129.111, the facility is subject to the Department's RACT 3 requirements cited in 25 Pa. Code Sections 129.111 thru 129.115.

Per the RACT 3 application, *"Boyertown's facility continues to operate a gray iron foundry with a potential melting capacity of 16 tons per hour. The foundry incorporates a single cupola melting furnace and two (2) green sand molding lines to produce gray iron castings. The facility produces the majority of its own cores primarily utilizing the Isocure process, with limited shell sand and oil sand production also used as required."*

Also, *"Boyertown's facility is a major stationary source (MSS) and has clearly outlined its potential to emit (PTE) volatile organic compounds and all other priority pollutants and HAPs in its Title V Permit Renewal Application submitted to the DEP in November 2002, and subsequent dates. Based on these documents it is clear that the Boyertown facility does not trigger major status in the emission or potential emission of nitrogen oxides, NOX. The facility has not been modified or changed since the RACT 2 Application was submitted, and we are therefore utilizing the RACT 2 case-by-case proposal for the RACT III submission."*

As previously noted in DEP's review memo for the facility's RACT 2 proposal, the facility PTE for NOx was previously calculated at 11.3 tpy, as delineated in the following table. This PTE is less than the NOx major source level and therefore the facility is not subject to RACT 3 for NOx.

Source ID	Source Name	NG MMCF	Metal Handled	NOx PTE tpy	Notes
031	Boilers >2.5 MMBTU	23.6		1.2	Per AP-42 Section 1.4 Natural Gas Combustion
032	Boilers <2.5 MMBTU	51.0		2.5	Per AP-42 Section 1.4 Natural Gas Combustion
033	Make-Up Air Units	24.9		1.2	Per AP-42 Section 1.4 Natural Gas Combustion
034	Space Heaters	24.9		1.2	Per AP-42 Section 1.4 Natural Gas Combustion
101	Iron Cupola		92,160	4.6	Per FIRE 3-04-003-01 and T5 operating hour limit (D 101 004)
112	Hydroslinger Sand Sys		59,904	0.3	Per FIRE 3-04-003-20 and cupola T5 operating hour limit (D 101 004), with resultant thruput divided between Sources 112 and 115.

Source ID	Source Name	NG MMCF	Metal Handled	NOx PTE tpy	Notes
115	KW Line		32,256	0.2	Per FIRE 3-04-003-20 and cupola T5 operating hour limit (D 101 004), with resultant thruput divided between Sources 112 and 115

In fact, per the company's 11/22/22 and 12/1/22 email responses to a DEP technical deficiency email regarding the RACT 3 proposal, the total heat input of these sources is actually less than presented in the table below, and therefore the NOx PTE of the facility is also less than presented in the table above.

The remaining sources at the facility do not have NOx emissions:

The facility PTE for VOC is presented in the RACT 3 proposal as 93.77 tpy, as delineated in the following table. This is identical to the VOC PTE presented in the facility's RACT 2 proposal, as no sources have been added at the facility.

Source ID	Source Name	VOC PTE tpy	Notes
031	Boilers >2.5 MMBTU	0.06	Per AP-42 Section 1.4 Natural Gas Combustion
032	Boilers <2.5 MMBTU	0.14	Per AP-42 Section 1.4 Natural Gas Combustion
033	Make-Up Air Units	0.07	Per AP-42 Section 1.4 Natural Gas Combustion
034	Space Heaters	0.07	Per AP-42 Section 1.4 Natural Gas Combustion
101	Iron Cupola	0.83	Per FIRE 3-04-003-01 and T5 operating hour limit (D 101 004)
110	Core Making Area	20.65	Per T5 E SG01 005, limits of: a. Binder in the mix - 1.7 percent, by weight, or less (annual average) b. Catalyst - 2.26 pounds per ton of sand or less (annual average) c. Sand - 13,333 tons during any consecutive 12-month period (T5 E SG01 003 permit limit is 20.8 tpy VOC)
112	Hydroslinger Sand Sys	31.00	Per T5 D 112 002 permit limit. Note: The combined PTE for Sources 112 and 115, calculated per FIRE 3-04-003-20 (0.14 lb VOC/ton metal) and 3-04-003-31 (1.2 lb VOC/ton metal) would be greater than the current combined T5 permit caps.
115	KW Line	35.00	Per T5 D 115 003 permit limit. Note: The combined PTE for Sources 112 and 115, calculated per FIRE 3-04-003-20 (0.14 lb VOC/ton metal) and 3-04-003-31 (1.2 lb VOC/ton metal) would be greater than the current combined T5 permit caps.
116	Cold Cleaner	3.26	subject to 129.63; PTE based on 6,522 lb/yr cold cleaner used
PB	Paint Booth	2.69	Subject to 129.52d (recordkeeping only); (T5 D 117 002 permit limit is 1 tpy VOC)

As further explanation of the VOC PTE calculation for Source 110, the facility's RACT 2 proposal explained that, "*The emission factor is based on Ashland Chemical emission tests on our binder/resin (OCMA Weight Loss method recognized by the EPA). This value is 0.0911 lb/VOC per pound of binder (test results previously provided to DEP in 3/2005). This EF is multiplied times the weight of binder used in a month/year*."

Also, per the company's 11/22/22 email response to a DEP technical deficiency email regarding the RACT 3 proposal, "*The Coating Booth was removed from the TV permit, and most of the equipment has also been removed. Source 117 has ceased to exist, and no VOC releases are possible*."

Based on the above PTEs, the RACT 3 proposal for this facility addresses a case-by-case RACT analysis for the following VOC sources:

110	Core Making Area
112	Hydroslinger Line
115	Kunkle Wagner Line

RACT 3:

Exempt or Presumptive RACT 3 Sources

The facility's RACT 3 application lists the following as presumptive RACT 3 sources, per 25 Pa. Code Section 129.112(c)(4), as boilers or other combustion sources with an individual rated gross heat input less than 20 million Btu/hour.

ID	Source
031	Two Natural Gas/Oil Boilers >2.5 mmbtu
032	Six Natural Gas/Oil Boilers <2.5 mmbtu
033	Four Natural Gas Make-Up Air Units
034	Fifty-One Natural Gas Space Heaters

However, per the company's 11/22/22 email response to a DEP technical deficiency email regarding the RACT 3 proposal, all of the individual sources are less than 10 MMBtu, as noted in italics below, and as such they each have a VOC PTE less than 1 tpy. Therefore all these units are exempt from RACT 3, rather than being presumptive RACT 3 sources.

a. Source 031 (Boilers >2.5 MMBTU) consists of two (2) 2.5 mmbtuh natural gas fired boilers designated as Pangborn 1 and Pangborn 2 by BFC.
b. Source 032 (Boilers <2.5MMBTU) consists of four (4) natural gas fired small boilers designated as:
  i. 1.7 mmbtuh Foundry Shower Room
  ii. 1.8 mmbtuh Maintenance Area
  iii. 2.0 mmbtuh Pattern Shop Area
  iv. 0.125 mmbtuh Assembly Shower Room
  (note: The Isocure B & P and Isocure Shalco units have been removed)
c. Source 033 (Make-Up Air Units) consists of four (4) natural gas fired Make-Up Air Units designated as:
  i. Applied Air Unit rated at 2.074 mmbtuh in the Isocure Area
  ii. #1 Aerovent Unit rated at 9.0 mmbtuh in the Hydroline Area
  iii. #2 Aerovent Unit rated at 9.0 mmbtuh in the Hydroline Area
  iv. Rapid Engineering Unit rated at 2.0 mmbtuh in the Hydroline Area
d. Source 034 (Space Heaters) currently consists of 51 small natural gas fired space heaters with a maximum firing rate of <12.0 mcf per hour. The TV permits requires BFC to maintain an inventory of the units in this source updated NLT February 1st of each year.

The company further clarified the capacity of the space heaters in a 12/1/22 email to DEP, as follows: "*The 12 MCF of gas use for all of Source 034 is well above the actual use rate. In 2014, Boyertown converted all oil fired units to natural gas firing, and after careful evaluation we conservatively estimated approximately 20% of the facility natural gas use went to Source 034 (Space Heaters) during heating months. In 2022 the highest month's NG use was 4,332 MCF with 744 hours of operation (January). The 034 Source use was therefore 866.4 MCF for the month. The hourly rate was 1.16 MCF. We also calculated use based on BTUs, and get the same result. Based on these actual use rates we can be certain that all of the small natural gas fired units combined are less than 12 MCF/hr, and that in 2022, for example, our highest monthly use was only 5.82 MCF/hr for all natural gas use for all sources in the facility.*"

Source 101 Iron Cupola has the following restriction in D 101 002: "*The permittee shall limit the emissions of VOC from this source to less than 1.0 tons during any consecutive 12-month period.*" Therefore it is exempt from RACT 3.

Cold Cleaner Source 116 is subject to 129.63, and therefore is not covered by RACT 3.

Case-by-Case RACT 3 Evaluation

The case-by-case RACT 3 sources at this facility include:

ID	Source	Includes
110	Core Making Area	Core Making includes the two production isocure core machines and specialty core areas
112	Hydroslinger Line	Hydroslinger Line Molding Operations including shakeout and pouring/ casting operations.
115	Kunkle Wagner Line	Kunkle Wagner Line Molding Operations and combined Sand Handling System. This source includes the shakeout and pouring/ casting operations for the Kunkle Wagner Line.

Per 25 Pa. Code Section 129.114, Alternative RACT proposal and petition for alternative compliance schedule, in Section (i), "*An owner or operator subject to subsection (a), (b) or (c) and § 129.99 that has not modified or changed a source that commenced operation on or before October 24, 2016, and has not installed and commenced operation of a new source after October 24, 2016, may, in place of the alternative RACT requirement or RACT emission limitation required under subsection (d), submit an analysis, certified by the responsible official, in writing or electronically to the Department or appropriate approved local air pollution control agency on or before December 31, 2022, that demonstrates that compliance with the alternative RACT requirement or RACT emission limitation approved by the Department or appropriate approved local air pollution Control agency under § 129.99(e) (relating to alternative RACT proposal and petition for alternative compliance schedule) assures compliance with the provisions in subsections (a)—(c) and (e)—(h), except for sources subject to § 129.112(c)(11) or (i)—(k).*"

Boyertown Foundry asserts that it qualifies under 129.114(i)(1)(i), which provides that "*The owner or operator of a subject source or facility that evaluates and determines that there is no new pollutant specific air cleaning device, air pollution control technology or technique available at the time of submittal of the analysis and that each technically feasible air cleaning device, air pollution control technology or technique evaluated for the alternative RACT requirement or RACT emission limitation approved by the Department or appropriate approved local air pollution control agency under § 129.99(e) had a cost effectiveness: (i) equal to or greater than $7,500 per ton of NOx emissions reduced or $12,000 per ton of VOC emissions reduced shall include the following information in the analysis:*" [required information is listed as (A)-(E)]

DEP concurs that this option applies, per the following table snipped from DEP's 9/25/19 RACT 2 review memo for the facility, which shows that add-on control cost effectiveness #s for the affected shakeout and pouring operations were all >$12,000 per ton.

Source	VOC PTE	$/ton	Submission Date
KW Shakeout	31.34	13,772	9/9/19
KW Pour	3.66	63,552	9/9/19
HS Shakeout	27.76	24,475	9/20/19
HS Pour	3.24	118,559	9/9/19

DEP's 9/25/19 RACT 2 review memo also concurred with the overall magnitude of the facility's add-on control estimate of $43,005 for the Coremaking Operation (Source 110).

As a review, DEP's 9/25/19 RACT 2 review memo assessed the technical feasibility of the available control options for the Shakeout and Pouring/Casting (Sources 112 and 115) as follows:

[begin quote from RACT 2 memo]

SHAKEOUT AND POURING/CASTING (SOURCES 112 AND 115):

Control Option	Applicant's Evaluation of Technical Feasibility	Technically Feasible?	DEP concurs?
Recuperative Thermal Oxidation	The recuperative oxidizer would be an acceptable technology and with the capability for about 70 percent heat recovery it would significantly reduce fuel consumption from a non-recuperative unit.	Yes, but RTO is better	Yes
Regenerative Thermal Oxidization	These units can achieve high removal efficiencies (97-99 percent) at relatively low temperatures (1400-1500°F) because of the thorough mixing in the ceramic packing sections. These systems are more maintenance intensive than recuperative types because of the mechanical system which performs the alternating of cells. As a result of the increased heat recovery, it was determined that regenerative thermal oxidation would be the best option for the thermal oxidation technologies at this particular facility.	Yes	Yes
Catalytic Oxidation	The catalytic oxidizers were eliminated from consideration due to the unknown composition of the VOC stream to the oxidizer and the sensitivity of both precious and non-precious catalysts to poisoning and fouling.	No	Yes
Flares	None	Not evaluated	DEP deems this approach to be not technically feasible due to the low concentration of VOC in the exhaust stream of the foundry operations.
Combustion Units	None	Not evaluated	DEP deems this approach to be not technically feasible due to the low concentration of VOC in the exhaust stream of the foundry operations.
Adsorption	While carbon adsorption seems to offer many potential advantages, there is also the same concern of sensitivity to the composition of the VOC as with catalytic oxidation. Since carbon adsorption has not been used for VOC control in an iron foundry, there is concern both for the adsorption efficiency and for being able to desorb the organics from the carbon after collection. Since there was no information available for review and design, this technology was not considered in the final analysis.	No	Yes
Condensers	None	Not evaluated	DEP deems this approach to be not technically feasible due to the low concentration of VOC in the exhaust stream of the foundry operations.

Control Option	Applicant's Evaluation of Technical Feasibility	Technically Feasible?	DEP concurs?
Combined Adsorption and Thermal Incineration	The combination systems were not considered due to the relatively low flows of the operations. There would be no significant operating or cost advantage to adding an additional unproven technology.	No	Yes
Sonoperoxone Treatment Systems (SP)**	SP is currently an unproven technology. Several foundries are presently operating SPP reactors in order to determine the practicality of this technology and to establish the actual emission reductions, if any, which can be achieved. Since our original 2003 proposal, SP technology has achieved successful results in few, if any, foundry applications which are used at Boyertown. Boyertown will continue to monitor this technology as it applies to the iron and steel foundry industry, but at this time it is clearly an unproven VOC control for foundries.	No	Yes
Low VOC Materials	Low VOC binders for both cores and the green sand, which would lower the VOC emissions, are under development and are undergoing evaluation and testing by the vendors. Boyertown is continually working with the vendors to determine whether these binders can be developed into an operationally acceptable system before attempting to use them in this facility. We also note that in spite of numerous indications from vendors of potential major breakthroughs for the past several years, there have been no significant new developments that are applicable to foundry operations such as those operating at Boyertown.	No	No

**Per the company's latest RACT 2 application revision, "*The SP technology uses the combination of coal in the mold sand mix and hydrogen peroxide, ozone, and sonication to oxidize VOC from pouring, cooling, and shakeout. In this system, the dust from the baghouse is blown into a Sono-Peroxone Plasma (SPP) reactor where it is contacted with city water, ozone, and hydrogen peroxide. It is theorized that the coal in the mold sand is actually activated in the pouring operation. This then allows the VOC from the pouring, cooling, and shakeout areas to be adsorbed onto the activated carbon particles. These VOC are then oxidized in the SPP reactor.*"

Having concluded that an RTO is the top level technically feasible control option for the shakeout and casting/cooling operations, and that the other incineration options would be less favorable from a cost standpoint, the latest application revision then notes that:

"The use of a regenerative thermal oxidizer to control the VOC emissions from the shakeout and casting/ cooling operations from both lines would require the installation of an independent baghouse to remove particulate from the input gas stream (the emissions from all but the Hydro Slinger pouring/ casting operation, which is uncontrolled, are presently routed to one of three large permitted baghouses which also control releases which do not contain VOC). Therefore, the cost analysis for the shakeout and pouring/ casting operations must include the total annualized costs from the operation of the oxidizer and a new dedicated baghouse. There is no practical way to utilize the installed baghouses to filter the particulate from only the VOC containing gases. A pulse-jet baghouse was selected because Boyertown currently utilizes

this type of baghouse in controlling other emissions at the foundry, and the overall efficiency of a well-designed pulse-jet unit is excellent."

The latest application revision goes on to first evaluate that: "*The Kunkle Wagner Line shakeout operation has a lower collection volume due to its smaller flask size and the fact that the molding line is fully mechanized. The individual exhaust points which comprise the "Shakeout Operation" and the "Pouring Operation" are already hooded and vented to the Amerex Model RP-12-705-D4 bag filter collector. It is, of course, impractical to consider add-on controls to the entire existing collector therefore the new pulse-jet collector will be evaluated only for the exhaust volume currently exhausted from the individual operations, for the shakeout operation-12,550 cfm, for the Pouring Operation - 5,000 cfm. The existing Amerex RP-12-705-D4 collector would continue to provide particulate control for the non-shakeout portions of the Kunkle Wagner Sand System."*

In like manner, the case-by-case RACT analysis for the Hydroslinger Line shakeout concluded that a new 26,500 cfm baghouse would be needed as a prefilter to an RTO; also, a new 10,000 cfm baghouse would be needed to prefilter a separate RTO for the HS Line Pouring Operation. RTO efficiency was assumed to be 95%.

The applicant points out in its 4/9/18 technical deficiency response letter, that "*There is one baghouse (C12) exhausting the Hydroslinger Molding Line (112) with a capacity of 84,500 cfm. The Kunkle Wagner Molding Line (115) has two existing fabric filters, a 61,000 cfm Amerex and a 15,900 cfm Seneca. It is not practical for either of the existing collectors to be used as a prefilter for the RTOs being evaluated as primary VOC controls for numerous reasons. The Amerex collector (61,000 cfm) is obviously far too large, and the cost of the RTO as well as the huge gas consumption make this non-feasible. The smaller Seneca collector is a possible substitution for the 12,500 cfm proposed new fabric filter, however, evaluation of this older design collector has shown that in order to handle the additional differential pressure imposed by the RTO it would be necessary to strengthen the housing. Further evaluation has shown that this is not practical due to the construction and age of the unit. Additionally, a new fan, motor, and major modification to the ductwork would be required. Another important factor in requiring four (4) individual systems is the fact that the foundry now operates on a flexible schedule which may require only the operation of one molding line at a time, and in many cases the foundry may only melt on alternating days. Therefore, the shakeout and pouring operations may not operate simultaneously.*"

With regard to the amount of VOC controlled by each of the baghouse/RTO scenarios, BF proposes to allocate the 31 and 35 tpy VOC caps for the HS and KW operations respectively, into two portions each, based on a ratio of the EPA FIRE factors for shakeout and pouring. The relevant EPA FIRE factors are for pouring and shakeout, respectively, are 3-04-003-20 (0.14 lb VOC/ton metal) and 3-04-003-31 (1.2 lb VOC/ton metal). The shakeout contribution to the total of these two factors is 89.55%. Therefore, for instance, for the economic calculations for the KW Shakeout, Boyertown Foundry has estimated that 89.55% of the 35 tpy Title V permit cap is 31.34 tons, and this emission figure was then used in the RACT 2 control cost evaluation. The remainder of the KW 35 tpy cap was allocated to the KW Pouring control scenario. DEP concurs that this approach is reasonable.

[end quote from RACT 2 memo]

DEP's 9/25/19 RACT 2 review memo also assessed the technical feasibility of the available control options for the Core making (Source 110) as follows:

[begin quote from RACT 2 memo]

CORE MAKING:

With regard to core making, the facility's latest application revision asserts:

The core making area (Source 110) consists of the two isocure core making units and the handling and storage facilities use to store the cores prior to their use in the molds. As discussed above, the wet acid scrubber provides control of the *catalyst released in the core machines. The unspeciated VOC release from the "gas-off" and curing of the cores for up to 168 hours after production takes place in the core making area and the large storage and core racks used to hold the cores before they are transported to the two molding areas. There is no hooding or enclosures of the existing core making areas.*

The cores, after production, are manually stored in racks or on the floor in two areas. The combined areas are approximately 150 feet wide by 300 feet long and 30 feet high. The VOC release in this area is low (approximately168 hours), and the emissions are unspeciated (they are the result of a complex catalytic reaction). This area is currently part of the large open bay and in order to capture and exhaust the VOCs it will be necessary to enclose this large area and exhaust it to a control device. With the high cost per CFM of the control devices available the enclosure will have to be as tight as possible and be limited to minimum openings to facilitate the loading and unloading of the cores. A conservative estimate of the exhaust volume required would be 50,000 cfm-and we have used this value in our cost analysis.

The PTE from the core making operation is 20.65 tons per year (OCMA tests of the actual core resin system in use which have been provided to the PA DEP previously). The destruction efficiency of the regenerative thermal oxidizer was taken as 95 percent-a common engineering factor in the industry. Although many of these types of units achieve efficiencies in the 98 percent range, the unknown nature of the VOC caused a more conservative estimate of 95 percent to be used.

Our analysis has concluded that regenerative thermal oxidation is the only technology which would be applicable for VOC control. When these systems were installed Boyertown was unable to obtain any guarantees of capture/ destruction efficiency of the unspeciated VOC releases from this core operation, and recent inquiries have confirmed that this is still the case. At Boyertown the hoods and some of the ductwork are already in place at the core machines, but new enclosures for the core racks and conveyors will be necessary prior to the installation of regenerative thermal oxidizer. This work will require substantial modification of the existing structure as noted in our conservative cost estimate. There is no significant particulate matter associated with the exhaust for this source, therefore a fabric filter will not be necessary.

DEP concurs with the selection of RTO as technology needing further evaluation for RACT 2 for the core making operations. Having evaluated the applicant's cost calculations for the RTO, DEP concurs with the overall magnitude of the estimated cost of $43,005 per ton, to control the PTE of 20.65 tpy of VOC. DE[P] further concurs that this option is not cost-effective for RACT 2.

[end quote from RACT 2 memo]

RACT 3 129.114(i)(1)(i) ANALYSIS:

With the preceding RACT 2 case-by-case analyses as background, we now turn to the re-evaluation required under 129.114(i)(1)(i)(A)-(E). This requires the applicant to include the following information in the abbreviated RACT 3 case-by-case analysis: [requirements in **bold**; discussion following each requirement in regular font]

(A) a statement that explains how the owner or operator determined that there is no new pollutant specific air cleaning device, air pollution control technology or technique available.

Boyertown Foundry provided the following statement with their RACT 3 submittal: "*In preparation for our submission of this RACT III proposal, and in accordance with the provisions of §129.114, Boyertown has conducted in-dept[h] research to determine if any new VOC air cleaning devices, air pollution control technology or technique has been developed since the preparation and submission of our RACT 2 Proposal. The results of our evaluation were as follows: a) Boyertown Foundry continually reviews new manufacturing techniques, products, equipment, and alternative chemical resins and binders in its on-going efforts to reduce VOC emissions from not only the case-by-case sources included in this Proposal, but all VOC releases from the facility. In addition to these efforts Boyertown contacted the following foundry industry trade associations that include environmental issues in their areas of concern:*

- *American Foundry Society (AFS)*
- *Steel Foundry Society of America (SFSA)*

• Non Ferrous Foundry Society (NFFS)
None of the trade associations were aware of new technology or products having been developed during the time in question. We also contacted our environmental consultants, Joseph A. Guimond & Associates, and requested that they review the state of-the-art control technology and methods for these sources. They also reported that they were not aware of any new technology or techniques for these sources. b) The list of the technically feasible control technology and techniques considered for each of the four (4) case-by-case emission sources therefore remains unchanged from the Proposal submitted in Boyertown's RACT 2 Proposal approved in September 2019."

(B) a list of the technically feasible air cleaning devices, air pollution control technologies or techniques previously identified and evaluated under § 129.92(b)(1)—(3) included in the written RACT proposal submitted under § 129.99(d) and approved by the Department or appropriate approved local air pollution control agency under § 129.99(e).

Boyertown Foundry's RACT 3 submittal included a list of the air cleaning devices, air pollution control technologies or techniques previously identified and evaluated under RACT 2.

(C) a summary of the economic feasibility analysis performed for each technically feasible air cleaning device, air pollution control technology or technique listed in clause (b) and the cost effectiveness of each technically feasible air cleaning device, air pollution control technology or technique as submitted previously under § 129.99(d) or as calculated consistent with the "EPA Air Pollution Control Cost Manual" (sixth edition), EPA/452/b-02-001, January 2002, as amended.

Boyertown Foundry's RACT 3 submittal included a summary of the economic feasibility analyses conducted under RACT 2.

(D) a statement that an evaluation of each economic feasibility analysis summarized in clause (c) demonstrates that the cost effectiveness remains equal to or greater than $7,500 per ton of NOx emissions reduced or $12,000 per ton of VOC emissions reduced.

Boyertown Foundry's RACT 3 submittal included the statement that "*The evaluation of all four case-by-case economic feasibilities remains above $12,000 per ton of VOC as stated in the DEP's 9/25/2019 RACT 2 Review Memo*."

(E) additional information requested by the Department or appropriate approved local air pollution control agency that may be necessary for the evaluation of the analysis.

DEP did not require any additional information regarding the case-by-case aspect of the Boyertown Foundry's RACT 3 analysis.

DEP ASSESSMENT:

DEP concurs that the technically feasible add-on-controls for Sources 110, 112 and 115 remain cost-ineffective for RACT 3. It should be noted that the RACT 2 cost figures (RTO) for these sources were stated in terms of 2016 dollars. The Chemical Engineering Plant Cost Index (CEPCI) from 2016 – 2021 (most current year available) is 1.3199. Applying this factor to these figures to convert them to current dollars would only increase the cost-ineffectiveness of the controls as follows:

Source	ID	RACT 3 $/ton (2022 $)
Core Making	110	56,763
HS Shakeout	112	32,305
HS Pour	112	156,487

Source	ID	RACT 3 $/ton (2022 $)
KW Shakeout	115	18,178
KW Pour	115	83,883

The facility's RACT 2 proposal stated, with regard to the pouring and casting sources, that "*The primary castings produced at the BFC are boiler castings. These casings, when assembled, contain the high pressure water and steam in a fossil fuel boiler necessary to allow the boiler to produce the heat and steam which it is designed for. The boiler castings are carefully designed by the boiler manufacturer's and designers to optimize the heat transfer from the intense heat generated in the combustion of the fossil fuel as well as the transfer of the captured heat to the intended end use. This requires a "thin walled" casting cross section, but one which can withstand the harsh conditions of the combustion chamber combined with the high internal pressures inside the boiler tubes (casting). All boiler castings produced by BFC must be tested and certified under the strict ASME pressure vessel codes*." Furthermore, the coremaking operation is already controlled by the coremaking scrubber.

The Department has reviewed the source information, control technologies or measures, and cost analysis performed by the company. The Department also performed an independent analysis which included, the Department's continuous review of permit applications since the applicability date of RACT II, internet searches, BACT/RACT/LAER Clearinghouse search, contact with the American Foundry Association, and knowledge gained from the Department permitting staff participating in technical presentations by several vendors and manufacturers of pollution control technology. Based on review of these materials, along with training and the expertise of the reviewing staff, the Department concludes that there are no new or updated air pollution control technologies available for the affected sources at this facility, and determines that good management practices, including an OM&M plan and appropriate recordkeeping, plus the use of the existing coremaking scrubber, as embodied in the existing approved case-by-case RACT 2 requirements in the facility's Title V permit, assure compliance with requirements for RACT 3 in § 129.111 - § 129.115, for the affected sources, as follows:

T5 E SG05 – RACT 2 case-by-case

I. 112 Hydroslinger Line and 115 Kunkle Wagner Line

(a) The permittee shall limit the throughput of Sources 112 and 115 combined to not greater than 7,680 tons of metal per month.

(b) The permittee shall maintain and adhere to an operation and maintenance plan for the above sources, which shall address good operation and maintenance practices for the minimization VOC emissions.

(c) The permittee shall maintain records of any maintenance or modifications performed on above sources

(d) The permittee shall calculate and record the actual fuel and/or process thruput amounts, and actual monthly and 12-month rolling VOC emissions from the above sources.

(e) The permittee shall maintain written documentation of the items in (b)-(c) above for five years. The records shall be made available to the Department upon written request pursuant to 25 Pa. Code §129.100(d) and (i).

II. 110 Core Making Area

(a) The permittee shall limit binder/resin usage at Source 110 to 35,552 pounds per month, and shall also limit catalyst usage at Source 110 to 2,222 pounds per month.

(b) The permittee shall utilize the coremaking scrubber for controlling VOC emissions. The scrubber shall be in operation at all times that the associated coremaking process is in operation.

(c) The permittee shall continuously monitor and display the pressure drop across the scrubber packed bed, the scrubber liquid flow to the packed bed, and the pH of the scrubber liquid.

(d) The permittee shall record the following, and maintain these records for at least five years: 1.) all maintenance performed on the scrubbers, 2.) daily readings of the pressure drop across the scrubber packed bed, the scrubber liquid flow to the packed bed, and the pH of the scrubber liquid.

(e) The permittee shall maintain monthly records for the core making operation, Source 110, of the following:

1. Hours of operation
2. Amount of binder/resin used
3. Amount of catalyst used
4. Amount of sand used
5. Emissions of VOC
6. Amount of cores produced

All records shall be monthly and 12-month rolling totals. The records shall be made available to the Department upon request.

(f) The permittee shall maintain manufacturer provided fact sheets (MSDS or Technical Data Sheets) showing the volatile organic compound content of each part of the binder and the catalyst used in the core making operation, Source 110.

(g) The permittee shall notify the Department in the annual emissions report of any new binders and/or catalyst in the coremaking operation, Source 110.

(h) Equipment (a flow gauge or equivalent, as approved by the Department), shall be maintained so that at any time the scrubber liquid flow to the packed bed of the scrubber (C04) can be measured.

(i) Unless otherwise approved in writing by the Department, the permittee shall operate the packed bed scrubber (C04) within the following parameter ranges:

1.) a pressure drop range of 1 to 3 inches.

2.) a minimum scrubber liquid flow rate to the bed of 115 gallons per minute.

3.) pH range of the scrubber liquid between 0.06 and 4.5.

(j) In accordance with 25 Pa. Code §129.100(i), all records shall be retained by the owner or operator for 5 years and made available to the Department or appropriate approved local air pollution control agency upon receipt of a written request from the Department or appropriate approved local air pollution control agency.

RACT 1:

The facility's RACT 2 application stated that "*On December 22, 2003 Boyertown submitted to the PA DEP its RACT [1] Permit Application and Proposal. That application was accepted and was integrated into Boyertown's Title V Permit No. 06-05063*." The Title V permit addressing RACT 1 was issued on 9/21/14. It does not appear that the RACT 1 requirements in the Title V permit were ever incorporated into the SIP.

Recommendations:

If a source was previously subject to RACT 2 case-by-case determinations, and that source has not been modified or changed, the owner or operator may, in lieu of doing another full case-by-case proposal for RACT III, submit a limited analysis, as specified in 25 Pa. Code Section 129.114(i). Unless otherwise required, this submission does not need to be part of a plan approval or operating permit modification and no fee would be charged.

No changes are needed to the facility's Title V permit, as the case-by-case determination for RACT 3 for this facility is the same as for RACT 2.

cc: OnBase

RACT 3 Initial Notification Review (Page 1)	
Company Name:	Boyertown Foundry
Site Name:	Boyertown Facility
Municipality:	Boyertown Borough
County:	Berks
Date RACT 3 Initial Notification Received:	11/11/2022
RACt 3 Initial Notification Reviewed By:	W. Weaver WW
Permit Chief:	-
Date Reviewed:	12/1/2022
Major VOC facility ? (if not, explain)	Y
Major NOx facility ? (if not, explain)	N: Per previous RACT 2 CBC review, and RACT 3 notice, the facility only has small combustion sources of NOx, with an estimated PTE of <11.3 tpy
Any <1 tpy sources or Ch 129 exempt sources? (Y/N)	Y
Any presumptive sources (O&M or otherwise)? (Y/N)	N
Any case-by-case sources? (Y/N)	Y
Immediate Followup Needed?	No

§ 129.115(a) Initial Notification Requirement	Notification is adequate? Y/N/NA/Comment	Comments
(2) - (3) This notification shall identify the air contamination sources in § 129.111(a) [or (b)] as one of the following:		
(i) Subject to a RACT requirement or RACT emission limitation in §§ 129.112—129.114.	Y	
(ii) Exempted from §§ 129.112—129.114.	Y	per clarification in co. emails on 11/22/22 and 12/1/22
(4) [The notification shall identify] The air contamination sources identified in § 129.111(c) that have a potential to emit less than 1 TPY of NOx located at a major NOx emitting facility subject to § 129.111(a) or (b) or a VOC air contamination source that has the potential to emit less than 1 TPY of VOC located at a major VOC emitting facility subject to § 129.111(a) or (b).	Y	see above
(5) - (6) [The notification shall identify] The following information for each air contamination source listed in paragraph (2) [or (3)]:		
(i) A description, including make, model and location, of each source.	Y	
(ii) The applicable RACT requirement or RACT emission limitation, or both, in §§ 129.112—129.114 for each source listed in accordance with paragraph (2)(i) [or (3)(i)].	Y	see above
(iii) How the owner or operator shall comply with subparagraph (ii) for each source listed in subparagraph (i).	Y	see above
(iv) The reason why the source is exempt from the RACT requirements and RACT emission limitations in §§ 129.112—129.114 for each source listed in accordance with paragraph (2)(ii) [or (3)(ii)].	Y	see above
(7) The following information for each air contamination source listed in paragraph (4):		
(i) A description, including make, model and location, of each source.	Y	
(ii) Information sufficient to demonstrate that the source has a potential to emit less than 1 TPY of NOx or 1 TPY of VOC, as applicable.	Y	see above

RACT 3 Initial Notification Review (Page 1): Boyertown Foundry-Page2

List all T5 Source #s		Exempt due to other Ch 129 reg (say which)?	< 1 tpy VOC	1<x<2.7 tpy VOC (presumptive O&M)	<1 tpy NOx	1<x<5 tpy NOx (presumptive O&M)	RACT 3 Presumptive: >5 tpy NOx or >2.7 tpy VOC?	RACT 3 case-by-case
031	BOILERS (>2.5 MMBTU)	N	Y	NA	Y	NA	NA	NA
032	BOILERS (<2.5 MMBTU)	N	Y	NA	Y	NA	NA	NA
033	MAKE-UP AIR UNITS	N	Y	NA	Y	NA	NA	NA
034	SPACE HEATERS	N	Y	NA	Y	NA	NA	NA
101	IRON CUPOLA	N	Y	NA	Y	NA	NA	NA
104	SEVEN SAND SILOS & BINS	N	Y	NA	Y	NA	NA	NA
105	SAND MULLOR	N	Y	NA	Y	NA	NA	NA
107	SHOTBLAST MACHINE 2	N	Y	NA	Y	NA	NA	NA
108	STAND GRINDER 1	N	Y	NA	Y	NA	NA	NA
109	STAND GRINDER 2	N	Y	NA	Y	NA	NA	NA
110	CORE MAKING AREA	N	N	N	Y	NA	N	Y
111	SHOTBLAST MACHINE 1	N	Y	NA	Y	NA	NA	NA
112	HYDROSLINGER SAND SYSTEM- AMEREX	N	N	N	Y	NA	N	Y
113	METALLIC SCRAP STORAGE AREAS	N	Y	NA	Y	NA	NA	NA
114	GRIT BLAST ROOM	N	Y	NA	Y	NA	NA	NA
115	KUNKEL WAGNER MOLDING LINE	N	N	N	Y	NA	N	Y
116	COLD CLEANER	129.63	NA	NA	NA	NA	NA	NA

Weaver, William (DEP)

From: Joseph Guimond Jr <jguimondjr@GuimondAssoc.com>
Sent: Thursday, December 1, 2022 11:11 AM
To: Weaver, William (DEP)
Cc: Mark Reinsmith
Subject: RE: [External] Boyertown Foundry RACT III Proposal

Bill—

Sorry, I thought this information had already been sent to you, but obviously it was not.

The 12 MCF of gas use for all of Source 034 is well above the actual use rate. In 2014, Boyertown converted all oil fired units to natural gas firing, and after careful evaluation we conservatively estimated approximately 20% of the facility natural gas use went to Source 034 (Space Heaters) during heating months. In 2022 the highest month's NG use was 4,332 MCF with 744 hours of operation (January). The 034 Source use was therefore 866.4 MCF for the month. The hourly rate was 1.16 MCF. We also calculated use based on BTUs, and get the same result.

Based on these actual use rates we can be certain that all of the small natural gas fired units combined are less than 12 MCF/hr, and that in 2022, for example, our highest monthly use was only 5.82 MCF/hr for all natural gas use for all sources in the facility. Hope this clears up any questions.

Again, thanks for your help and have a great holiday season.

Skip Guimond
Consultant for Boyertown Foundry Co.

From: Weaver, William (DEP) <wiweaver@pa.gov>
Sent: Wednesday, November 30, 2022 3:38 PM
To: Joseph Guimond Jr <jguimondjr@GuimondAssoc.com>
Cc: Mark Reinsmith <mreinsmithbfc@gmail.com>
Subject: RE: [External] Boyertown Foundry RACT III Proposal

Will you be able to answer the below question soon? We are hoping to complete our review of this ASAP.

From: Weaver, William (DEP)
Sent: Wednesday, November 23, 2022 1:57 PM
To: Joseph Guimond Jr <jguimondjr@GuimondAssoc.com>
Cc: Mark Reinsmith <mreinsmithbfc@gmail.com>
Subject: RE: [External] Boyertown Foundry RACT III Proposal

Just one other clarification—the 51 small natural gas fired space heaters are stated below to have a maximum firing rate of <12.0 mcf. Does that mean for all of them together? (12 mcf/hr is roughly equal to 12 MMBtu/hr)

William Weaver | Air Quality Program Manager
Department of Environmental Protection

Southcentral Regional Office
909 Elmerton Avenue | Harrisburg, PA 17110
Phone: 717.705.4868
wiweaver@pa.gov

From: Joseph Guimond Jr <jguimondjr@GuimondAssoc.com>
Sent: Tuesday, November 22, 2022 1:57 PM
To: Weaver, William (DEP) <wiweaver@pa.gov>
Cc: Mark J. Reinsmith - Boyertown Foundry Co. (mreinsmithbfc@gmail.com) <mreinsmithbfc@gmail.com>
Subject: [External] Boyertown Foundry RACT III Proposal

Dear Bill—

With regard to your two questions in the 11/17/2022 e-mail:

1. You are correct—The Coating Booth was removed from the TV permit, and most of the equipment has also been removed. Source 117 has ceased to exist, and no VOC releases are possible.

2. Presumptive RACT VOC Sources (Table 1):

    a. Source 031 (Boilers >2.5 MMBTU) consists of two (2) 2.5 mmbtuh natural gas fired boilers designated as Pangborn 1 and Pangborn 2 by BFC.
    b. Source 032 (Boilers <2.5MMBTU) consists of four (4) natural gas fired small boilers designated as:
        i. 1.7 mmbtuh Foundry Shower Room
        ii. 1.8 mmbtuh Maintenance Area
        iii. 2.0 mmbtuh Pattern Shop Area
        iv. 0.125 mmbtuh Assembly Shower Room
        (note: The Isocure B & P and Isocure Shalco units have been removed)
    c. Source 033 (Make-Up Air Units) consists of four (4) natural gas fired Make-Up Air Units designated as:
        i. Applied Air Unit rated at 2.074 mmbtuh in the Isocure Area
        ii. #1 Aerovent Unit rated at 9.0 mmbtuh in the Hydroline Area
        iii. #2 Aerovent Unit rated at 9.0 mmbtuh in the Hydroline Area
        iv. Rapid Engineering Unit rated at 2.0 mmbtuh in the Hydroline Area
    d. Source 034 (Space Heaters) currently consists of 51 small natural gas fired space heaters with a maximum firing rate of <12.0 mcf per hour. The TV permits requires BFC to maintain an inventory of the units in this source updated NLT February 1st of each year.

Please note that all of these combustion units are fired only with natural gas as a fuel, and each unit is <10.0 MMBTU.

If you have any additional questions, or require additional input, please let us know.

Regards—

J. Skip Guimond
Consultant for Boyertown Foundry Co.

Weaver, William (DEP)

From: Weaver, William (DEP)
Sent: Thursday, November 17, 2022 9:32 AM
To: Mark Reinsmith
Cc: Skip Guimond
Subject: Boyertown Foundry RACT III Revised Submission

Mark,

I took a close look over your RACT 3 proposal. The few questions I have at this point are as follows:

1.) The Source 117 Coating Booth was removed from the BF's Title V permit in 2020, because the booth had not been used in over a year. However the RACT 3 proposal stated facility PTE of 93.77 tons VOC appears to include 2.69 tons of emissions from that booth. Please verify if the booth remains out of service, and should be omitted from the facility PTE total.

2.) Regarding the RACT 3 proposal Table 1 pasted below, how many of each type of unit are there? For instance, for Source 032, are there 10 units, or 6? For Source 034, are there 40 units or 51? Also, please provide a list of the units associated with each source ID, as well MMBtu/hr heat input for each source.

Table 1 Presumptive RACT VOC Sources (reference Title V Permit Application)
Boilers, 2, >2.5MMBTU (Source 031) Two Natural Gas/Oil Boilers >2.5 mmbtuh
Boilers, 10, <2.5 MMBTU (Source 032) Six Natural Gas/Oil Boilers <2.5 mmbtuh
Make-Up Air Units, 4 (Source 033) Four Natural Gas Make-Up Air Units
Space Heaters, 40 (Source 034) Fifty-One Natural Gas Space Heaters

William Weaver | Air Quality Program Manager
Department of Environmental Protection
Southcentral Regional Office
909 Elmerton Avenue | Harrisburg, PA 17110
Phone: 717.705.4868
wiweaver@pa.gov

From: Mark Reinsmith <mreinsmithbfc@gmail.com>
Sent: Friday, November 11, 2022 7:57 AM
To: Weaver, William (DEP) <wiweaver@pa.gov>

Cc: Skip Guimond <jguimondjr@guimondassoc.com>
Subject: [External] Fwd: RACT III Revised Submission

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Boyertown Foundry RACT III Revised Submission

Mr. William Weaver, Program Manager

PA DEP, Southcentral Region

Dear Mr. Weaver:

We are attaching Boyertown Foundry Company's revised RACT III Proposal in accordance with §129.114 and the guidance suggested by the SCR. Boyertown has not modified or changed a source that commenced operation on or before October 24, 2016 and has not installed and commenced operation on a new source after October 24, 2016. After in-dept research to determine if any new VOC air cleaning devices, air pollution control technology or technique has been developed we have found that no new technology or products have been developed since the submission and approval of our RACT 2 Proposal as detailed in the attached document.

We have also attached a copy of the full Excel spreadsheets detailing the cost data and analysis for each of the five case-by-case sources. This will allow for a complete evaluation of the calculations.

We believe that Boyertown has complied with all of the requirements required by the department in order to fully analyze our proposal, however, should you wish any additional information or justification please let us know.

Again, we wish to thank you for all of your assistance and guidance in this matter especially given the short time period for submission. PLEASE ACKNOWLEDGE RECEIPT OF OUR PROPOSAL VIA E-MAIL.

Sincerely,

Mark Reinsmith, Manager of Manufacturing

Boyertown Foundry
9th & Rothermel Drive
New Berlinville, PA., 19545-0443
Ph-610473-1004
F-610-473-1031
mreinsmithbfc@gmail.com

Weaver, William (DEP)

From: Mark Reinsmith <mreinsmithbfc@gmail.com>
Sent: Friday, November 11, 2022 7:57 AM
To: Weaver, William (DEP)
Cc: Skip Guimond

Subject: [External] Fwd: RACT III Revised Submission
Attachments: BFC RACT III Appln 11-22_R1.pdf; Copy of Cost Analysis Core Rev 8-19-DEP-1R.xlsx; Copy of Cost Analysis HS Pour 8-19 Rev-DEP-1.xlsx; Copy of Cost Analysis HS SO 8-19 Rev-DEP-2R.xlsx; Copy of Cost Analysis KW Pour 8-19 Rev-DEP-1R.xlsx; Copy of Cost Analysis KW SO 8-19 Rev-DEP-1R.xlsx

Boyertown Foundry RACT III Revised Submission

Mr. William Weaver, Program Manager

PA DEP, Southcentral Region

Dear Mr. Weaver:

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Again, we wish to thank you for all of your assistance and guidance in this matter especially given the short time period for submission. PLEASE ACKNOWLEDGE RECEIPT OF OUR PROPOSAL VIA E-MAIL.

Sincerely,

Mark Reinsmith, Manager of Manufacturing

Boyertown Foundry
9th & Rothermel Drive
New Berlinville, PA., 19545-0443
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mreinsmithbfc@gmail.com

VOLATILE ORGANIC COMPOUND REASONABLY AVAILABLE CONTROL TECHNOLOGY (VOC RACT) DETERMINATION & PERMIT APPLICATION (RACT III)

BOYERTOWN FOUNDRY COMPANY

NEW BERLINVILLE, PA 19545

November 11, 2022

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List of Tables

Attachments

Source Flow Schematic: VOC RACT Permits
Source Flow Schematic: Foundry Flow Diagram
Cost Data & Analysis; Regenerative Thermal Oxidizer & Bag Filter Collector

Section 1
Introduction

Boyertown Foundry Company (Boyertown) operates an iron foundry in Boyertown Borough and Colebrookdale Township, Berks County Pennsylvania. On September 25, 2019 the PA DEP completed its RACT 2 Review of Boyertown's Application and the provisions of that review were integrated into the Title V Operating Permit issued on June 16, 2020.

Boyertown's facility continues to operate a gray iron foundry with a potential melting capacity of 16 tons per hour. The foundry incorporates a single cupola melting furnace and two (2) green sand molding lines to produce gray iron castings. The facility produces the majority of its own cores primarily utilizing the Isocure process, with limited shell sand and oil sand production also used as required.

The PA DEP notified Boyertown that it was subject to the recently promulgated Additional RACT Requirements for Major Sources of NOx and VOCs (RACT III) electronically on September 22, 2022, and that if the source has not been modified or changed since the submission of the RACT 2 Application we can submit a limited analysis for RACT III. Boyertown's facility is a major stationary source (MSS) and has clearly outlined its potential to emit (PTE) volatile organic compounds and all other priority pollutants and HAPs in its Title V Permit Renewal Application submitted to the DEP in November 2002, and subsequent dates. Based on these documents it is clear that the Boyertown facility does not trigger major status in the emission or potential emission of nitrogen oxides, NO_X. The facility has not been modified or changed since the RACT 2 Application was submitted, and we are therefore utilizing the RACT 2 case-by-case proposal for the RACT III submission.

Boyertown retained Joseph A. Guimond & Associates, Inc., of Souderton, Pennsylvania to assist them in the preparation of the 2003 RACT Proposal, the RACT 2 Proposal and this Proposal for RACT III. This application has been prepared utilizing the best information available at this time including US EPA emission factors and other industry related emission data previously used for RACT 2.

Boyertown Foundry has not conducted any VOC stack testing, and therefore has relied upon US EPA emission factors (FIRE and Chief) for the estimation of the shakeout and pouring/casting VOC emissions. For the Core Making Area (Source 110) we have used the Isocure Manufacturer's actual test results (OCMA 168 Hour protocol) to estimate the emissions. These test results were provided to the PA DEP at the time the source was permitted, and whenever there was a change in the resin formulation. The VOC emissions from the Cupola Furnace (Source 101) has previously been estimated using the US EPA SCC 30400301, or 0.18 lb VOC per ton of metal charged after being afterburned. We believe this should be considered a presumptive source.

In preparation for our submission of this RACT III proposal, and in accordance with the provisions of §129.114, Boyertown has conducted in-dept research to determine if any new VOC air cleaning devices, air pollution control technology or technique has been developed since the preparation and submission of our RACT 2 Proposal. The results of our evaluation were as follows:

a) Boyertown Foundry continually reviews new manufacturing techniques, products, equipment, and alternative chemical resins and binders in its on-going efforts to reduce VOC emissions from not only the case-by-case sources included in this Proposal, but all VOC releases from the facility. In addition to these efforts Boyertown contacted the following foundry industry trade associations that include environmental issues in their areas of concern:
   - American Foundry Society (AFS)
   - Steel Foundry Society of America (SFSA)
   - Non Ferrous Foundry Society (NFFS)

   None of the trade associations were aware of new technology or products having been developed during the time in question. We also contacted our environmental consultants, Joseph A. Guimond & Associates, and requested that they review the state-of-the-art control technology and methods for these sources. They also reported that they were not aware of any new technology or techniques for these sources.

b) The list of the technically feasible control technology and techniques considered for each of the four (4) case-by-case emission sources therefore remains unchanged from the Proposal submitted in Boyertown's RACT 2 Proposal approved in September 2019. A copy of this evaluation has been attached.

c) The economic feasibility analysis for each of the four (4) case-by-case emission sources also remains unchanged from the Proposal submitted in Boyertown's RACT 2 Proposal approved in September 2019. A copy of this evaluation has been attached.

d) The evaluation of all four case-by-case economic feasibilities remains above $12,000 per ton of VOC as stated in the DEP's 9/25/2019 RACT 2 Review Memo.

Section 2
Regulatory Issues

The RACT regulations (1, 2, and 3) apply to major NOx and/or VOC emitting facilities. This regulation provides three compliance options: (1) presumptive RACT requirements and/or emission limitations; (2) facility wide or system-wide averaging for compliance with presumptive NOx emission limitations; (3) RACT requirements determined on a case-by-case basis for sources that either do not have an applicable presumptive requirement or emission limitation or cannot comply with the applicable presumptive RACT requirement.

In response to the PA DEP's e-mail of September 22, 2022, Boyertown requested additional guidance regarding its response. Mr. William Weaver promptly provided specific and very helpful information with regard to Boyertown's requirements for RACT III.

This proposal is based on that information.

Section 3
Facility Description

(Unchanged from the RACT 2 Petition)

Location

Boyertown Foundry Company's facility is located in both Boyertown Borough and Colebrookdale Township in Berks County. The facility is located in a mixed commercial and residential area.

3.1 Operations

The Boyertown Facility is a traditional iron foundry with one cupola furnace, two Green Sand Molding Lines (each including a green sand handling system), a casting finishing department, and a core making department. An office area and other support facilities are present in the main manufacturing building.

A variety of natural gas and oil fired (alternative emergency fuel only) combustion units including space heaters, boilers, and make-up air units were evaluated as part of the emissions survey. VOC emissions from the combustion units consist of products of combustion of natural gas.

There have been no significant changes in the affected sources, production levels, hours of operation or potential/actual emissions since the 2003 RACT Proposal.

3.1.1 Melting Operations

One Cupola furnace provides the foundry iron melting capability. The maximum capacity of the furnaces is 16 tons of iron per hour. Emissions from the Cupola Furnace are controlled by a high efficiency wet venturi scrubber and a natural gas fired afterburner.

3.1.2 Casting Operations & Sand System

The two Green Sand Molding Lines are complete with their own pouring/casting and shakeout operations as well as the sand system that is used to mix sand with binders for the making of molds. Emissions from molding, pouring, cooling, shakeout, and sand reclamation are controlled by fabric collectors.

3.1.3 Core Making

The Core Making Area consists primarily of two Isocure Core Machine (one small shell machine and an oil core oven are maintained for limited specialty cores). Emissions from the Isocure machines are controlled by a wet acid scrubber. In the 2003 proposal it was reported that based on the data submitted with the original Application for Plan

Approval, VOC emissions were insignificant from the core making operation. Subsequently, new testing has been able to quantify the VOC releases from the isocure core making operation, and these releases have been reported in the annual AIMS Report for numerous years. While, as noted above, the emissions from the isocure core machines are controlled by a wet scrubber, the VOC emissions reported are released from the produced cores as they cure for a period of up to 168 hours.

Section 4
VOC Sources and Emissions

(Unchanged from the RACT 2 Petition)

VOC Sources

In the preparation for this and the 2003 RACT VOC Proposals, the initial requirement is to identify all sources at the facility that will produce VOC emissions. After all of the sources of VOC emissions have been identified, the next step involves categorizing them by their regulatory significance. There are four applicable categories for all of the VOC sources: insignificant activities, presumptive RACT, case-by-case RACT, and those covered by an existing US EPA CTG. Each of these categories is described below and the applicable VOC sources are identified for each.

4.1.1 Insignificant Activities

This list includes those sources which the PA DEP has determined do not create air pollution in significant amounts. These insignificant activities do not need to be described in a Title V or state-only operating permit application. These activities also do not require a plan approval.

An extensive listing of insignificant activities was included in Boyertown's initial Title V Permit Application. Due to their nature, and their inclusion in the PA DEP regulations, these individual sources are not identified in the Title V Permit.

4.1.2 Presumptive RACT

The PA DEP provides presumptive RACT emission limitations for major NO_x emitting sources at 25 PA § 129.93. These are emission limitations which are established by PA DEP as an alternative to developing and implementing a RACT emission limitation on a case-by-case basis. Although these limitations are not applicable to the minor VOC sources at the foundry, it is logical to consider these minor VOC sources in the same manner.

25 PA § 129.93 (c) addresses "Boilers and other combustion sources with individual rated gross heat inputs less than 20 million Btu/hour of operation" and "Any fuel-burning equipment, gas turbine or internal combustion engine with an annual capacity factor of less than 5 percent, or an emergency standby engine operating less than 500 hours in a consecutive 12-month period." 25 PA § 129.93 (c) (1) states that "presumptive RACT limitations are the installation, maintenance, and operation of the source in accordance with manufacturers specifications." At Boyertown there are four sources that fall into this category. They are listed in Table 1.

The Cupola Furnace (Source 101) VOC emissions now appear to qualify for a Presumptive RACT limit based on DEP comments.

4.1.3 Sources Covered by an Existing Control Techniques Guidance (CTG)

Sources operating in full compliance with PA DEP regulations as well as a US EPA Control Techniques Guidance (CTG) are exempt from the requirement to prepare a case by case RACT analysis. The Boyertown Facility does not have any source that falls into this category.

4.1.4 Case By Case RACT

This list includes those sources which are not covered by the three categories above. All sources of VOC emissions at a MSS for which no RACT requirements have been established must prepare a written proposal for RACT for each source at the facility.

The applicable case-by-case sources for the Boyertown Facility are listed in Table 2. The VOC emissions are generated by various operations such as melting, pouring/casting, shakeout, core making, and the iron cupola furnace.

Table 1 **Presumptive RACT VOC Sources** **(reference Title V Permit Application)**
Boilers, 2, >2.5MMBTU (Source 031) Two Natural Gas/Oil Boilers >2.5 mmbtuh
Boilers, 10, <2.5 MMBTU (Source 032) Six Natural Gas/Oil Boilers <2.5 mmbtuh
Make-Up Air Units, 4 (Source 033) Four Natural Gas Make-Up Air Units
Space Heaters, 40 (Source 034) Fifty-One Natural Gas Space Heaters

Table 2 **Case-By-Case VOC Sources**
Iron Cupola (Source 101) Iron Cupola Furnace (possible Presumptive Source)
Kunkle Wagner Line Sand System (Source 115) Kunkle Wagner Line Molding Operations and combined Sand Handling System. This source includes the shakeout and pouring/casting operations for the Kunkle Wagner Line.
Core Making (Source 110) Core Making includes the two production isocure core machines and specialty core areas
Hydroslinger Molding Line (Source 112) Hydroslinger Line Molding Operations including shakeout and pouring/casting operations.

4.2 VOC Emissions

After determination of the VOC sources at Boyertown, the next step was to calculate the actual and potential emissions from each source. This had recently been completed as a part of the submission of the Title V Permit Application and the associated CAM Plan. Emission factors from EPA databases such as AP-42, and the Factor Information Retrieval (FIRE) Data System, and the OCMA were used to calculate emissions from the various sources.

The potential to emit (PTE) was calculated for all VOC emitting case by case sources. The PTE is based on the Title V Application and does not have restrictions other than the cupola hours of operation limit (5,760 hours per calendar year) and restrictions to sand and resin use in core making previously established by PA DEP. The actual emissions used in the application were also taken from the Title V Application and represent the emissions from the facility as reported in the CY 2015 AIMS Report.

Table 3 summarizes the actual reported VOC emissions and the potential to emit for all of the VOC emission sources at the facility.

Table 3
Summary of VOC Emissions

Sources	2015 Actual Emissions TPY	Potential to Emit VOC - TPY
Iron Cupola (Source 101)	0.14	0.83
Kunkle Wagner Line (Source 115)	3.58	35.00
Core Making Area (Source 110)	6.32	20.65
Hydroslinger Line (Source 112)	6.65	31.00
Misc. presumptive and insignificant sources	0.60	6.29
Totals	**17.29**	**93.77**

Note: PTE for core making area based on existing federally enforceable resin/sand limit and actual 2015 emissions.

Iron Cupola emissions adjusted to reflect a 90% thermal destruction by the existing thermal afterburner.

Section 5
Control Technologies

A review of control technologies for RACT 2 was conducted for the primary source of VOC emissions at Boyertown from the case-by-case RACT sources. These operations have two elements which comprise the majority of the VOC emissions: the pouring/casting and shakeout areas and the core making area. Reasonably available add-on control options for VOC control are basically limited to some form of thermal oxidation or through the use of sonoperoxone treatment systems (SP). The emission of small quantities of VOC from the Cupola Furnace is already subject to an afterburner installation that the Title V Permit requires operate at a minimum temperature of 1,400° F. Virtually all applicable engineering evaluations, including the BACT/LAER Clearinghouse, have established high temperature afterburners as the optimum control for organic emissions from metal melting operations. We note that the highest control efficiency of all of the control technologies described below is associated with thermal oxidation—or an afterburner as already in place and permitted by our TV permit. Also included in the TVOP are sufficient permit requirements and monitoring/recordkeeping to ensure proper operation of the controls as detailed below.

There are numerous control techniques that have been proposed and utilized for VOC abatement. Those shown in this document were selected on the basis of potential performance in VOC control in iron foundries. The variety of VOC compounds present in this facility makes the control method evaluation process important for abatement purposes as well as long term operating flexibility.

As previously detailed on page 2 of this application, Boyertown conducted an in-depth evaluation for any new VOC air cleaning devices, air pollution control technology or technique developed since the preparation and submission our RACT 2 Proposal. We did not find any new devices, technology, or techniques which are applicable to our sources.

Low VOC binders for both cores and the green sand, which would lower the VOC emissions, are under development and are undergoing evaluation and testing by the vendors. Boyertown is continually working with the vendors to determine whether these binders can be developed into an operationally acceptable system before attempting to use them in this facility. We also note that in spite of numerous indications from vendors of potential major breakthroughs for the past several years, there have been no significant new developments that are applicable to foundry operations such as those operating at Boyertown. Boyertown has changed the resin and binder products for its core making (Source 110) twice within the past 10 years. In 2008 a new resin system was used, after approval by the DEP, but it was not successful. In 2011 another new resin system was used, again after approval by the DEP, and it was successful. This newer resin has been successful in reducing the average resin level.

Boyertown and their environmental consultant, Joseph A Guimond & Associates, conducted an in-depth review of potentially new air pollution control technologies and/or techniques which may have been developed since our RACT 2 proposal in 2019. As noted in Section 1 of this report we have been unable to find any new such new control technology.

The following sections discuss the available technologies for VOC control and the determination of those that are technically feasible for the Boyertown facility.

5.1 Thermal Oxidation

One of the most frequently used forms of VOC control is thermal oxidation. Thermal oxidizers regularly achieve 97 - 99 percent destruction efficiencies because of the inherent efficiency of combustion processes. At operating temperatures of 1400 - 1500°F and residence times of 0.5 seconds, 98 percent VOC removal is commonly achieved. Thermal oxidizers typically consist of an enclosed combustion chamber with an auxiliary burner fired by a conventional fuel. The firing rate of the burner is automatically controlled to maintain a preset combustion chamber temperature. Thermal oxidizers provide maximum operating flexibility because they can handle most known VOC at a wide range of concentrations and flows. *However, thermal oxidizers require high fuel input because of the required operating temperatures.* Heat recovery is frequently used with thermal oxidation systems to minimize the fuel operating cost, especially with low concentrations of VOC. Heat recovery devices used in VOC systems are most commonly indirect recuperative heat exchangers or thermal mass regenerative heat exchangers.

5.2 Recuperative Thermal Oxidizer

This type of thermal oxidizer uses an indirect heat exchange device to preheat the VOC laden fume. These heat exchangers are constructed of heat resistant materials which are usually austenitic stainless steel or high nickel alloys. They are applied to oxidizers which operate as high as 1800°F. They are either shell-and-tube or plate type exchangers. *Thermal efficiencies up to 70 percent are economically viable.* The maximum design efficiency is usually dictated by the exchanger outlet temperature and the VOC in the stream.

5.3 Regenerative Thermal Oxidizer

These units employ a large thermal mass to collect the heat and return it to the incoming fume. Each oxidizer is supplied with several large “cells” which are filled with ceramic packing. The cells are alternated from heat up to cool-down cycles for fume preheat by a series of dampers and ducts on the outlet side of the system. These units can achieve high removal efficiencies (97-99 percent) at relatively low temperatures (1400-1500°F) because of the thorough mixing in the ceramic packing sections. These systems are more maintenance intensive than recuperative types because of the mechanical system which performs the alternating of cells.

5.4 Catalytic

Depending upon the concentration and type of VOC in the vent stream, VOC control can be affected using catalytic oxidation. Removal efficiencies of 95 percent are commonly achieved, and some units are designed for 98 percent. Catalytic oxidation units consist of an enclosed combustion chamber with an auxiliary burner firing on a conventional fuel gas followed by a catalyst section. The burner is used to heat the contaminated air stream gas to approximately 600°F before it contacts the catalyst. Here, oxidation of the organic occurs, and the gases exit the catalyst bed at a higher temperature related to VOC concentration. The principal advantage of the catalytic system is lower operating temperatures and the resulting lower fuel consumption. *Catalytic systems handle a wide range of VOC but are less flexible than thermal oxidizers.* Catalytic systems are usually limited to 1100-1300°F outlet temperatures which limits VOC inputs to a maximum of 25 percent of LEL. As with the thermal oxidizers, fume preheating devices are commonly used to minimize operating costs.

Catalytic oxidizers can be grouped into two basic types, Precious Metal Type - (Platinum, Palladium, etc) and Non-Precious Metal Type - (Chrome based, or Manganese Dioxide), defined by the metal used for the catalyst.

5.4.1 Precious Metal Type - (Platinum, Palladium, etc.).

Usually are constructed of a ceramic or metallic substrate with the catalyst applied to the substrate. The catalyst assembly is stationary. These catalysts are highly efficient in a clean state but are subject to deactivation by several mechanisms. Sulfur, halogens, zinc, or blinding by solid organics are typical deactivators which are reversible. Poisoning of the catalyst bed by phosphorus, bismuth, lead, arsenic, antimony, mercury, iron oxide, tin, or silicon is non-reversible. *A thorough understanding of the VOC constituents is necessary to apply this type of control device.*

5.4.2 Non-Precious Metal Type - (Chrome based, or Manganese Dioxide).

These systems are usually less susceptible to poisoning and deactivation but required larger amounts of catalyst. They are usually in bulk form, applied to a ceramic substrate, and are arranged on a grid or screen. Catalyst beds are usually fixed relative to fume flow; however, there are fluidized bed types which negate the blinding by organic solids. *The VOC constituents must be known to apply this control device.*

5.5 Carbon Adsorption

Activated carbon is a standard adsorbent for organic vapors. Carbon adsorption systems are typically used for, but not limited, to non-water-soluble solvents. As the carbon absorbs VOC, it becomes saturated and must be reactivated. Steam is used to remove the VOC from the carbon bed and the resulting VOC/water condensate can then be decanted to recover the solvent. Carbon beds ranging in size from several pounds to several thousand pounds are currently used to remove VOC from exhaust air streams prior to discharge to the atmosphere. These beds may be once through units which are replaced when the carbon becomes saturated with organics or they can be regenerative units which use steam or some other energy source to "reactivate" the carbon bed when it becomes saturated. *The VOC constituents must be known to apply this control device or testing must be conducted to determine if the method is applicable.*

5.6 Combination Systems

The use of combinations of the classic systems sometimes has advantages. For example: the carbon absorber can be used as a pre-concentrator for the thermal oxidizer. These VOC concentrators take a variety of forms.

5.6.1 VOC Concentrators/Thermal or Catalytic Oxidizers

VOC concentrators convert a high-volume air flow with a low VOC concentration to a low volume air flow with a high VOC concentration. Concentrators use one of two adsorbents, activated carbon or hydrophobic zeolite. The two basic designs currently used are rotor rotating wheels and multiple fixed bed concentrators. The multiple fixed bed concentrators typically use an oxidizer to destroy the VOC and supply the energy source for the desorption of the beds. The contaminated air stream passes through one of several fixed bed absorbers where the VOC are removed and concentrated. Periodically as the "in use" adsorber module becomes saturated, it is taken offline and replaced by a "cleaned" module. Hot gases from the thermal oxidizer are then passed through the saturated adsorber bed, the VOC are desorbed, and the resulting organically rich gas stream is fed into the oxidizer.

Rotating wheel concentrators use honeycomb structured elements made of activated carbon or hydrophobic zeolite. Each of these adsorbents offers distinct advantages which are application specific. The wheels are typically divided into two sectors, one for adsorption and one for desorption. The adsorption section is usually proceeded by a static bed of granulated activated carbon (GAC) which prevents high boiling organic compounds from entering the rotor and also serves to distribute the flow. The VOC/air mixture passes through the GAC filter, then through the rotor where the VOC are removed, and the clean air is exhausted to the atmosphere. Simultaneous with this process, another section of the wheel is being desorbed with hot air which carries the VOC to an oxidizer. The volume of the desorption flow is typically 10 percent of the original contaminated air volume which reduces the oxidizer size.

5.7 Sonoperoxone Treatment Systems (SP)

The SP technology uses the combination of coal in the mold sand mix and hydrogen peroxide, ozone, and sonication to oxidize VOC from pouring, cooling, and shakeout. In this system, the dust from the baghouse is blown into a Sono-Peroxone Plasma (SPP) reactor where it is contacted with city water, ozone, and hydrogen peroxide. It is theorized that the coal in the mold sand is activated in the pouring operation. This then allows the VOC from the pouring, cooling, and shakeout areas to be adsorbed onto the activated carbon particles. These VOC are then oxidized in the SPP reactor.

The blow down from the SPP reactor consists of a slurry of waste sand and black water. These two components are separated in a clarifier. The sand slurry is recycled for reuse in sand mixing and the black water is then further treated prior to final discharge.

SP is currently an unproven technology. Several foundries are presently operating SPP reactors in order to determine the practicality of this technology and to establish the actual emission reductions, if any, which can be achieved. Since our original 2003 proposal, SP technology has achieved successful results in few, if any, foundry applications which are used at Boyertown. Boyertown will continue to monitor this technology as it applies to the iron and steel foundry industry, but at this time it is clearly an unproven VOC control for foundries.

5.8 Summary of Technically Feasible Technologies

A review of the RACT/BACT/LAER Clearinghouse indicates that VOC emissions from sand mixing and molding, and pouring, cooling, and shakeout have not been controlled with add-on controls. The best and most feasible method of VOC control will be the use of low VOC binders in the process. Boyertown continues to work closely with binder and core resin suppliers to replace existing binders and resins with lower VOC alternatives while maintaining the same quality of molding sand, cores, and castings. In the core making process the facility already uses a wet acid scrubber to achieve 90+ percent reductions in the VOC catalyst releases. These releases take place primarily during the core making process (inside the core machine). More recent testing methods (the OCMA test protocol) was developed to provide emission factors for the overall release of VOC from the core itself after it is made for a period of 168 hours. This release, previously unaccounted, is substantial, not completely defined, and is detailed in this proposal.

Thermal oxidation is a preferred method of VOC control for many processes, including the VOC producing processes at Boyertown, where the definition of the waste gas stream and the nature of the VOC is not completely defined. Basically, thermal oxidation will oxidize any organic compound given enough time and temperature. The previous sections consider three forms of thermal oxidation and two types of catalytic oxidation. The catalytic oxidizers were eliminated from consideration due to the unknown composition of the VOC stream to the oxidizer and the sensitivity of both precious and non-precious catalysts to poisoning and fouling.

Straight thermal oxidation has been utilized for the cupola melt furnace at Boyertown for many years and is incorporated in the existing TVOP as Control C01 for Source 101. The existing permit requires a minimum afterburner combustion temperature of 1,400^{o} F with a retention time of at least 0.75 seconds. The monitoring and record keeping requirements of the TVOP cover the installation, use, and record keeping for these parameters. We also note that the existing venturi liquid scrubber (Control C02) provides some VOC control efficiency after entry into the afterburner combustion chamber, but this level of control is considered insignificant in comparison to the thermal afterburner efficiency.

Straight thermal oxidation, recuperative, and regenerative oxidation remain potential technologies for VOC control of the remaining VOC sources at Boyertown. The use of straight thermal oxidation is prohibitive due to the extremely high fuel requirements without any heat recovery. The recuperative oxidizer would be an acceptable technology and with the capability for about 70 percent heat recovery it would significantly reduce fuel consumption, however the Boyertown VOC sources which remain are all at or near ambient temperature. Regenerative oxidation offers the advantage of 95 percent heat recovery with thermal oxidation as the means for VOC control, and again this technology is not practical for ambient temperature sources.

While carbon adsorption seems to offer many potential advantages, the same concern of sensitivity to the composition of the VOC as with catalytic oxidation exists. Since carbon adsorption has not been used for VOC control in an iron foundry, there is concern both for the adsorption efficiency and for being able to desorb the organics from the carbon after collection. Since there was no information available for review and design, this technology was not considered in the final analysis.

The combination systems were not considered due to the relatively low flows of the operations. There would be no significant operating or cost advantage to adding an additional unproven technology.

The SP technology was not considered for several reasons as discussed above. The SP process is not a proven process for VOC removal. While it has shown promising results in controlled non-production test environments, further research and development is being conducted to determine both how it works and its applicability in the foundry. Past evaluation by the various regional offices of the PA DEP have been in full accord with this position.

Section 6
Cost Estimating Procedures

(Unchanged from the RACT 2 Petition)

Capital Costs

Capital costs of the VOC control techniques were developed from the standard methodology described in the OAQPS Control Cost Manual, Sixth Edition, EPA-452/B-02-001, January 2002 (11/17 revision for oxidizers). Capital costs typically depend upon 1) total vent volume, 2) temperature of vent, 3) VOC content, and 4) natural or forced draft vent delivery system.

6.1 Annualized Costs

Annualized costs include the operating and maintenance costs and the capital recovery cost. The capital recovery cost is estimated for each VOC control technique by multiplying the capital costs for that technique by the capital recovery cost factor (CRF).

The capital cost recovery factor is estimated by the following method:

$CRF = [I * (1+I)^n]/[(1+I)^n - 1]$

where

I = pretax marginal rate of return (10 percent), and

n = equipment economic life (10 years).

This follows the standard methodology described in the OAQPS Control Cost Manual, Sixth Edition, EPA-452/B-02-001, January 2002.

The annual operating costs of electricity and fuel are given below (2015 values). We have used the EPA values for oxidizers which are lower.:

- Electricity $ 0.0674/kwh
- Natural gas $ 0.0083377/scf

6.2 Cost Effectiveness

The cost effectiveness in dollars per ton of VOC reduced is calculated by dividing the total annualized cost above by the total annual VOC reduction in tons.

6.3 Incremental Cost

As defined in 25 PA § 129.92(b)(4)(iv), the incremental cost effectiveness is calculated by:

$$\text{IC (Incremental \$ / Incremental Ton Removed)} = \frac{\text{[Control Option TAC (\$ / yr) - Next Most Stringent TAC]}}{\text{Next most stringent ER (TPY) - Control Option ER}}$$

where TAC - Total Annualized Cost and ER = Emission Rate

A summary of the cost per ton analysis is as follows (extracted from the 9/25/2019 DEP RACT 2 Review Memo):

Source	VOC PTE	$/Ton	Submission Date
KW Shakeout	31.34	$13,772	9/9/2019
KW Pour	3.66	$63,552	9/9/2019
HS Shakeout	27.76	$24,475	9/20/2019
HS Pour	3.24	$118,559	9/9/2019

Section 7
RACT Analysis

(Unchanged from the RACT 2 Petition)

The RACT evaluation will follow a format similar to the BACT "top-down" methodology used for PSD review in attainment areas. The approach is to determine, for the emission source under consideration, the most effective control technique available for a similar or identical source or source category. If it can be demonstrated that the control technique which is most effective in reducing emissions of the pollutant under consideration is technically or economically unfeasible or is environmentally unacceptable for the source in question, then the next most stringent level of control is determined and similarly evaluated. The process continues until the level under consideration cannot be eliminated by any material or unique technical, economic, or environmental objections.

In this analysis it has been determined that regenerative thermal oxidation is the only technology which would be applicable for VOC control.

7.1 Operational Issues

The basis for the RACT analysis was to address the major VOC sources from the facility. This would then provide the best opportunity to determine the reasonably available control for the operations. The Kunkle-Wagner Line (Source 115) and Hydroslinger Line (Source 112) account for 66.00 TPY of the 93.77 TPY potential to emit VOC (70.38%). The remainder of the VOC emission sources are the cupola furnace (0.83 TPY) which is already controlled by a thermal afterburner, the core making (20.65 TPY), and presumptive combustion sources, therefore, it was determined that the mold line operations and core making operations require a detailed case by case cost evaluation. The mold line VOC emissions are a combination of the VOC emissions from shakeout (SCC 3-04-003-31) and pouring/casting operations (SCC 3-04-003-20).

The use of a regenerative thermal oxidizer to control the VOC emissions from the shakeout and casting/cooling operations from both lines would require the installation of an independent baghouse to remove particulate from the input gas stream (the emissions from all but the Hydro Slinger pouring/casting operation, which is uncontrolled, are presently routed to one of three large permitted baghouses which also control releases which do not contain VOC). Therefore, the cost analysis for the shakeout and pouring/casting operations must include the total annualized costs from the operation of the oxidizer and a new dedicated baghouse. There is no practical way to utilize the installed baghouses to filter the particulate from only the VOC containing gases. A pulse-jet baghouse was selected because Boyertown currently utilizes this type of baghouse in controlling other emissions at the foundry, and the overall efficiency of a well-designed pulse-jet unit is excellent.

PA DEP has questioned why it is necessary to use separate baghouses and RTO devices for the shakeout and pouring/casting operations. Day-to-day operations at the Boyertown Foundry are based on market demand. At the present time, for example, pouring does not take place every operating day, and shakeout is certainly not a full-time operation. Due to the high fuel and power cost to operate the control systems it is cost efficient to ensure that each system operate only when its process operates as mandated by the TVOP. The two molding lines (Kunkle Wagner and Hydro Slinger) can operate independently or at the same time.

The Kunkle Wagner Line shakeout operation has a lower collection volume due to its smaller flask size and the fact that the molding line is fully mechanized. The individual exhaust points which comprise the “Shakeout Operation” and the “Pouring Operation” are already hooded and vented to the Amerex Model RP-12-705-D4 bag filter collector. It is, of course, impractical to consider add-on controls to the entire existing collector therefore the new pulse-jet collector will be evaluated only for the exhaust volume currently exhausted from the individual operations, for the shakeout operation—12,550 cfm, for the Pouring Operation – 5,000 cfm. The existing Amerex RP-12-705-D4 collector would continue to provide particulate control for the non-shakeout portions of the Kunkle Wagner Sand System.

The PTE from the shakeout operation is 31.34 tons per year (89.55% of the TV VOC “cap” of 35 TPY). The destruction efficiency of the regenerative thermal oxidizer was taken as 95 percent—a common engineering factor in the industry. Although many of these types of units achieve efficiencies in the 98 percent range, the unknown nature of the VOC caused a more conservative estimate of 95 percent to be used.

Our analysis has concluded that regenerative thermal oxidation is the only technology which would be applicable for VOC control. At Boyertown the hoods and some of the ductwork are already in place and need not be added prior to the installation of regenerative thermal oxidizer. For the KW Shakeout a new 12,550 cfm bag filter dust collector must be added, however, to remove the particulate contaminants prior to entering the thermal oxidizer.

The total annualized cost for the shakeout operation is $410,088.30 for a 12,550 cfm requirement. This yields a total annualized cost effectiveness of $13,772.39 per ton of VOC removed with a 95% efficiency. This value is consistent with similar RACT evaluations for facilities of like size.

For the Pouring Operation a new 5,000 cfm bag filter dust collector must be added to remove the particulate contaminants prior to entering the thermal oxidizer. The total annualized cost for the KW Pouring Operation is $220,771.17 for a 5,000 cfm requirement. This yields a total annualized cost effectiveness of $63,551.74 per ton of VOC removed with a 95% efficiency. This value is consistent with similar RACT evaluations for facilities of like size.

To fully evaluate the scope of VOC control costs we have also evaluated the “shakeout and pouring operations” for the older Hydro Slinger Line. The shakeout operation is already hooded and vented to the Amerex Model RP-12-1026-D4 bag filter collector. It is, of course, impractical to consider add-on controls to the entire existing collector therefore the new pulse-jet collector will be evaluated only for the exhaust volume currently exhausted from the shakeout operation—26,500 cfm.

The PTE from the shakeout operation is 27.76 (89.55% of the TV VOC "cap" of 31 TPY). The destruction efficiency of the regenerative thermal oxidizer was taken as 95 percent—a common engineering factor in the industry. Although many of these types of units achieve efficiencies in the 98 percent range, the unknown nature of the VOC caused a more conservative estimate of 95 percent to be used.

Our analysis has concluded that regenerative thermal oxidation is the only technology which would be applicable for VOC control. At Boyertown the hoods and some of the ductwork are already in place and need not be added prior to the installation of regenerative thermal oxidizer. For the HS Shakeout a new 26,500 cfm bag filter dust collector must be added how to remove the particulate contaminants prior to entering the thermal oxidizer.

The total annualized cost for the shakeout operation is $2,088,625.63 for a 26,500 cfm requirement. This yields a total annualized cost effectiveness of $79,198.61 per ton of VOC removed with a 95% efficiency. This value is consistent with similar RACT evaluations for facilities of like size.

For the HS Pouring Operation a new 10,000 cfm (based on engineering evaluation of this currently uncontrolled emission source which requires a higher exhaust volume due to the larger flask size and equipment configuration) bag filter dust collector must be added to remove the particulate contaminants prior to entering the thermal oxidizer. The total annualized cost for the HS Pouring Operation is $364,924.52 for a 10,000 cfm requirement. This yields a total annualized cost effectiveness of $118,558.97 per ton of VOC removed with a 95% efficiency. This value is consistent with similar RACT evaluations for facilities of like size.

The cost differential on a dollar per cfm basis between the larger Hydro Slinger Line and the smaller Kunkle Wagner Line is typical. Cost per cfm on both a capital and annualized basis is substantially higher for smaller systems. We must also note the fact that we have not included the cost for the modification of the existing baghouse systems to allow them to continue to provide particulate control for the non-VOC portions of both the Kunkle Wagner and Hydro Slinger Sand Systems. This cost is difficult to estimate and apportion to each source but will be significant.

The core making area (Source 110) consists of the two isocure core making units and the handling and storage facilities use to store the cores prior to their use in the molds. As discussed above, the wet acid scrubber provides control of the catalyst released in the core machines. The unspeciated VOC release from the "gas-off" and curing of the cores for up to 168 hours after production takes place in the core making area and the large storage and core racks used to hold the cores before they are transported to the two molding areas. There is no hooding or enclosures of the existing core making areas.

The cores, after production, are manually stored in racks or on the floor in two areas. The combined areas are approximately 150 feet wide by 300 feet long and 30 feet high. The VOC release in this area is low (approximately 168 hours), and the emissions are unspeciated (they are the result of a complex catalytic reaction). This area is currently part of the large open bay and in order to capture and exhaust the VOCs it will be necessary to enclose this large area and exhaust it to a control device. With the high cost per CFM of the control devices available the enclosure will have to be as tight as possible and be limited to minimum openings to facilitate the loading and unloading of the cores. A conservative estimate of the exhaust volume required would be 50,000 cfm—and we have used this value in our cost analysis.

The PTE from the core making operation is 20.65 tons per year (OCMA tests of the actual core resin system in use which have been provided to the PA DEP previously). The destruction efficiency of the regenerative thermal oxidizer was taken as 95 percent—a common engineering factor in the industry. Although many of these types of units achieve efficiencies in the 98 percent range, the unknown nature of the VOC caused a more conservative estimate of 95 percent to be used.

Our analysis has concluded that regenerative thermal oxidation is the only technology which would be applicable for VOC control. When these systems were installed Boyertown was unable to obtain any guarantees of capture/destruction efficiency of the unspeciated VOC releases from this core operation, and recent inquiries have confirmed that this is still the case. At Boyertown the hoods and some of the ductwork are already in place at the core machines, but new enclosures for the core racks and conveyors will be necessary prior to the installation of regenerative thermal oxidizer. This work will require substantial modification of the existing structure as noted in our conservative cost estimate. There is no significant particulate matter associated with the exhaust for this source, therefore a fabric filter will not be necessary.

The total annualized cost for the core making operation is $843,660.40 for a 50,000 cfm requirement. This yields a total annualized cost effectiveness of $43,005.50 per ton of VOC removed with a 95% efficiency. This value is consistent with similar RACT evaluations for facilities of like size and reflects the lower cost without a bag filter collector.

Table 4 shows a comparison of the five VOC emitting sources not covered by a CTG or existing best available controls (the cupola) and the approximate cost effectiveness per ton of VOC eliminated. It is obvious that the Shakeout Operations with their far higher VOC emission PTE have the lowest cost per ton of VOC reduction.

TABLE 4
SOURCE COST EFFECTIVENESS

Source	VOC Emissions Controlled (T) @ 95% Eff.	Exhaust Volume, cfm	Annualized Cost	Cost Effectiveness, $ / Ton
K-W Shakeout	29.78	12,550	$410,088.30	$13,772.39
K-W Pour/Cast	3.47	5,000	$220,771.17	$63,551.74
Hydro Sling S/O	26.37	26,500	$2,088,625.63	$79,198.61
Hydro Sling Pour	3.08	10,000	$364,924.52	$118,558.97
Core Making Area	19.62	50,000	$843,660.40	$43,005.50

Note: All CFM values are "standard cubic feet" (SCFM)

Therefore, the cost effectiveness for all sources requiring a case-by-case evaluation at the Boyertown Foundry Company facility is far higher per ton than the PA DEP trigger level for RACT implementation or more detailed evaluation.

The Cupola Furnace (Source 101) is already equipped with a thermal afterburner and as detailed above, there are no other feasible or practical control measures available, or in use, for the iron foundry industry for this source.

7.2 Feasibility and Efficiency Rankings

7.2.1 Regenerative Thermal Oxidizer and Baghouse

Shakeout Operation K-W Line

Baseline VOC Emission Rate: 31.34 tons VOC/year
VOC Control Efficiency: 95 percent
VOC Reduction Rate: 29.78 tons VOC/year

Shakeout Operation Hydro Slinger Line

Baseline VOC Emission Rate: 27.76 tons VOC/year
VOC Control Efficiency: 95 percent
VOC Reduction Rate: 26.37 tons VOC/year

Pouring/Casting Operation K-W Line

Baseline VOC Emission Rate: 3.66 tons VOC/year
VOC Control Efficiency: 95 percent
VOC Reduction Rate: 3.47 tons VOC/year

Pouring/Casting Operation Hydro Slinger Line

Baseline VOC Emission Rate:	3.24 tons VOC/year
VOC Control Efficiency:	95 percent
VOC Reduction Rate:	3.08 tons VOC/year

Core Making Operation

Baseline VOC Emission Rate:	20.65 tons VOC/year
VOC Control Efficiency:	95 percent
VOC Reduction Rate:	19.62 tons VOC/year

7.3 Cost Effectiveness of Control Technologies

7.3.1 Regenerative Thermal Oxidizer and Baghouse

Shakeout Operation K-W Line

Annualized Cost Estimate:	$410,088.30
Baseline VOC Emission Rate:	31.34 tons VOC/year
VOC Reduction Rate:	29.78 tons VOC/year
Average Cost Effectiveness:	$13,772.39/ton of VOC removed

Shakeout Operation Hydro Slinger Line

Annualized Cost Estimate:	$2,088,635.63
Baseline VOC Emission Rate:	27.76 tons VOC/year
VOC Reduction Rate:	26.37 tons VOC/year
Average Cost Effectiveness:	$79,198.61/ton of VOC removed

Pouring/Casting Operation K-W Line

Annualized Cost Estimate:	$220,771.17
Baseline VOC Emission Rate:	3.66 tons VOC/year
VOC Reduction Rate:	3.47 tons VOC/year
Average Cost Effectiveness:	$63,551.74/ton of VOC removed

Pouring/Casting Operation Hydro Slinger Line

Annualized Cost Estimate:	$364,924.52
Baseline VOC Emission Rate:	3.24 tons VOC/year
VOC Reduction Rate:	3.08 tons VOC/year
Average Cost Effectiveness:	$118,558.97/ton of VOC removed

Core Making Operation (Thermal Oxidizer Only)

Annualized Cost Estimate:	$843,660.40
Baseline VOC Emission Rate:	20.65 tons VOC/year
VOC Reduction Rate:	19.62 tons VOC/year
Average Cost Effectiveness:	$43,005.50/ton of VOC removed

Section 8
VOC RACT III Conditions

Boyertown Foundry's existing Title V Operating Permit, No. 06-05063 issued 6/16/2020, contains numerous conditions which the company feels are appropriate to fulfill RACT 2 and RACT III. In general, these conditions were utilized to fulfill RACT 1, and have been present in the TVOP since its first issuance. Boyertown must note that its RACT 1 proposal did not result in the issuance of a special RACT permit, nor were any of the conditions of the TVOP changed based on RACT 1 requirements. RACT 2 placed metal output limits on Sources 112 and 115, and limits on binder/resin and catalyst on Source 110.

The existing requirements contained in the TVOP (SG05 – RACT 2 case-by-case) adequately ensure proper operation of both the controls and processes releasing VOC from the facility.

<u>Hydro Slinger System (Shakeout and Pouring are included as Source 112):</u>

(a) The permittee shall limit the throughput of Sources 112 and 115 combined to not greater than 7,680 tons of metal per month.

(b) The permittee shall maintain and adhere to an operation and maintenance plan for the above sources, which shall address good operation and maintenance practices for the minimization VOC emissions.

(c) The permittee shall maintain records of any maintenance or modifications performed on above sources

(d) The permittee shall calculate and record the actual fuel and/or process thruput amounts, and actual monthly and 12-month rolling VOC emissions from the above sources.

(e) The permittee shall maintain written documentation of the items in (b)-(c) above for five years. The records shall be made available to the Department upon written request pursuant to 25 Pa. Code §129.100(d) and (i).

<u>Kunkle Wagner System (Shakeout and Pouring are included as Source 115):</u>

(a) The permittee shall limit the throughput of Sources 112 and 115 combined to not greater than 7,680 tons of metal per month.

(b) The permittee shall maintain and adhere to an operation and maintenance plan for the above sources, which shall address good operation and maintenance practices for the minimization VOC emissions.

(c) The permittee shall maintain records of any maintenance or modifications performed on above sources

(d) The permittee shall calculate and record the actual fuel and/or process thruput amounts, and actual monthly and 12-month rolling VOC emissions from the above sources.

(e) The permittee shall maintain written documentation of the items in (b)-(c) above for five years. The records shall be made available to the Department upon written request pursuant to 25 Pa. Code §129.100(d) and (i).

Core Making:

(a) The permittee shall limit binder/resin usage at Source 110 to 35,552 pounds per month, and shall also limit catalyst usage at Source 110 to 2,222 pounds per month.

(b) The permittee shall utilize the coremaking scrubber for controlling VOC emissions. The scrubber shall be in operation at all times that the associated coremaking process is in operation.

(c) The permittee shall continuously monitor and display the pressure drop across the scrubber packed bed, the scrubber liquid flow to the packed bed, and the pH of the scrubber liquid.

(d) The permittee shall record the following, and maintain these records for at least five years: 1.) all maintenance performed on the scrubbers, 2.) daily readings of the pressure drop across the scrubber packed bed, the scrubber liquid flow to the packed bed, and the pH of the scrubber liquid.

(e) The permittee shall maintain monthly records for the core making operation, Source 110, of the following:

1. Hours of operation
2. Amount of binder/resin used
3. Amount of catalyst used
4. Amount of sand used
5. Emissions of VOC
6. Amount of cores produced

All records shall be monthly and 12-month rolling totals. The records shall be made available to the Department upon request.

(f) The permittee shall maintain manufacturer provided fact sheets (MSDS or Technical Data Sheets) showing the volatile organic compound content of each part of the binder and the catalyst used in the core making operation, Source 110.

(g) The permittee shall notify the Department in the annual emissions report of any new binders and/or catalyst in the coremaking operation, Source 110.

(h) Equipment (a flow gauge or equivalent, as approved by the Department), shall be maintained so that at any time the scrubber liquid flow to the packed bed of the scrubber (C04) can be measured.

(i) Unless otherwise approved in writing by the Department, the permittee shall operate the packed bed scrubber (C04) within the following parameter ranges:

1.) a pressure drop range of 1 to 3 inches.

2.) a minimum scrubber liquid flow rate to the bed of 115 gallons per minute.

3.) pH range of the scrubber liquid between 0.06 and 4.5.

(j) In accordance with 25 Pa. Code §129.100(i), all records shall be retained by the owner or operator for 5 years and made available to the Department or appropriate approved local air pollution control agency upon receipt of a written request from the Department or appropriate approved local air pollution control agency.

Section 9
VOC RACT Proposal Summary

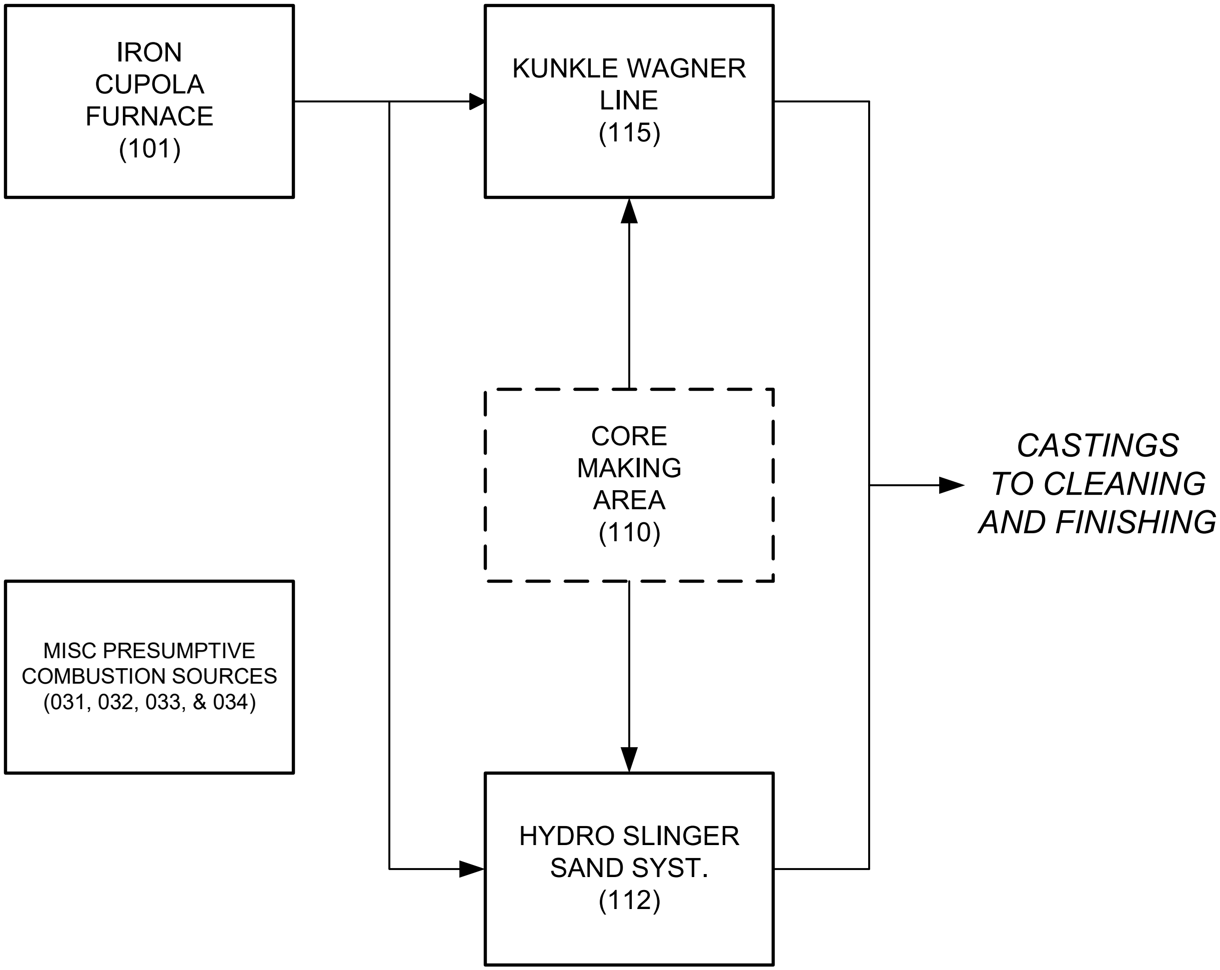
The case-by-case RACT Analysis performed in Section 7 above indicates that the use of "end-of-pipe" control devices for VOC control from the sources at Boyertown, other than the Cupola Furnace which is already equipped with a thermal oxidizer, is not cost effective on a dollar per ton removed basis for both RACT 2 and RACT III. As previously noted, the Shakeout Operations and Core Making offered the best opportunity for cost effectiveness since the quantity of VOC was highest with a relatively low proportion of the total volumetric flow at the facility. The conclusion of this RACT analysis is that all of the existing manufacturing methods used by Boyertown should be maintained. Boyertown Foundry shall work to minimize VOC emissions by an emphasis on development and adoption of low VOC sand binder formulations as they become practical and feasible.

We must also note that the Shakeout Operation PTE values for both VOC and NOx emissions can never be achieved—even using the theoretical concept of "Potential to Emit". This can be seen by adding the VOC emission caps for the two shakeout and pouring casting sources, 13 TPY for source 112, and 35 TPY for source 115. The total emission is 66 TPY or 132,000 lb/yr. As detailed earlier in this report the estimated emissions are based on 1.34 lb VOC per ton poured. The Title V cap on cupola production is 16 TPH of melt rate for 5,760 hr/yr or 92,160 TPY. 132,000 lb/yr of VOC emission would require the melting of 98,507.47 Tons of metal (132,000 lb VOC ÷ 1.34 lb/T). The actual annual VOC PTE is therefore 92,160 TPY X 1.34 lb VOC/T or 123,494.40 Lbs (61.75 T). The 4.25 T VOC emission differential (66.0 – 61.75) is caused by the individual emission caps placed on the two molding lines. As discussed earlier in this report, this flexibility is necessary to allow for the broad variations in casting orders for a jobbing foundry.

The results of this evaluation are consistent with evaluations for other iron and steel foundries of similar size conducted in the Commonwealth of Pennsylvania, and throughout the entire country.

Attachments

1. Source Flow Schematic; VOC RACT Permits
2. Source Flow Schematic: Foundry Flow Schematic
3. Cost Data and Analysis; Regenerative Thermal Oxidizer and Bag Filter Collector

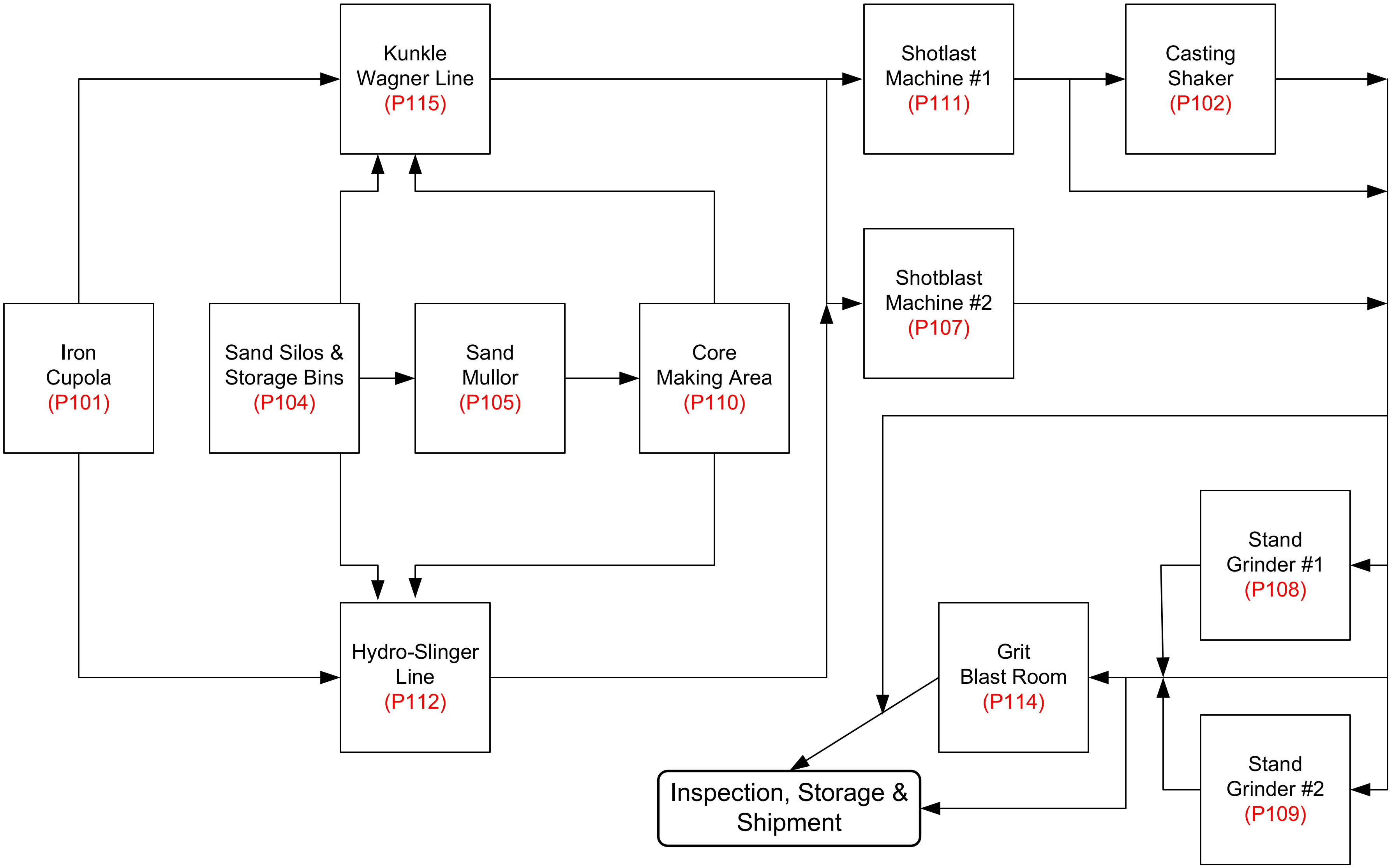


BOYERTOWN FOUNDRY COMPANY
New Berlinville, PA 19545

SOURCE FLOW SCHEMATIC
VOC RACT PERMIT

Revised: 2/6/18

Note: All significant VOC Sources are shown. Source Numbers are shown as using their Title V designation. Sources without known or insignificant VOC emissions are shown with a dashed line.



Space Heaters (C034)	Boilers >2.5 mmbtuh (C031)	Boilers <2.5 mmbtuh (C032)	Make-Up Air Units (C033)

Source Numbers Shown in RED

Revised 02/06/2018

BOYERTOWN FOUNDRY CO.
New Berlinville, PA 19545

FOUNDRY FLOW DIAGRAM
RACT Permit

BOYERTOWN FOUNDRY COMPANY
Boyertown, PA

VOC RACT Analysis -- K-W Line Shakeout

Total Installed Capital Cost	Regenerative Thermal Oxidizer	Bag Filter	Combined Controls
Total Purchased Equipment Cost	$ 508,521.40	$ 59,919.59	$ 568,440.99
Total Direct Installation Cost	$ 152,556.42	$ 44,340.49	$ 196,896.91
Total Indirect Cost	$ 222,732.37	$ 28,294.03	$ 251,026.40
TOTALS	**$ 883,810.19**	**$ 132,554.11**	**$ 1,016,364.30**

Total Annualized Cost	Regenerative Thermal Oxidizer	Bag Filter	Combined Controls
Total Direct Operating Costs	$ 184,745.63	$ 68,263.39	$ 253,009.02
Total Indirect Operating Costs	$ 118,863.74	$ 38,215.54	$ 157,079.28
TOTALS	**$ 303,609.36**	**$ 106,478.93**	**$ 410,088.30**

Uncontrrolled VOC Emission Rate, TPY	31.34
VOC Control Efficiency	95%
VOC Removed By Controls	29.78

Cost Effectiveness, $/Ton Removed **$ 13,772.39**

Revised: 09/18/2019

CAPITAL COST
Bag Filter Collector
K-W Line Shakeout Operation

1. PURCHASED EQUIPMENT	
A. Collector & Aux. Equipment {12,550 cfm} (A)	$52,103.99
B. Instrumentation & Controls (0.10 A)	$5,210.40
C. Freight (0.05A)	$2,605.20
Total Purchased Equipment Cost (B)	$59,919.59
2. DIRECT INSTALLATION COSTS	
A. Foundations & Supports (0.04 B)	$2,396.78
B. Erection & Handling (0.50 B)	$29,959.79
C. Electrical (0.08 B)	$4,793.57
D. Piping (0.01 B)	$599.20
E. Insulation (0.07 B)	$4,194.37
F. Painting (0.04 B)	$2,396.78
G. Site Preparation (as req'd)	0
H. Building (as req'd)	0
Total Indirect Installation Costs	$44,340.49
3. TOTAL CAPITAL COSTS (Purchased & Installation)	**$104,260.08**
4. INDIRECT COSTS	
A. Engineering & Supervision; (0.10 B)	$5,991.96
B. Contruction & Field Expenses; (0.20 B)	$11,983.92
C. Contractors Fees; (0.10 B)	$5,991.96
D. Start-Up; (0.01 B)	$599.20
E. Performance Test; (0.01 B)	$599.20
E. Contingency; (0.03 B)	$3,127.80
Total Indirect Cost	**$28,294.03**
TOTAL INSTALLED CAPITAL COST	**$132,554.11**

Revised: 09/03/2019

CAPITAL COST
Bag Filter Collector
<u>K-W Line Shakeout Operation</u>

Fabric Filter, 12,550 cfm, 5.0 AC Ratio, Polyester Bags, 14.0" wg

Purchase Costs (1998 dollars from US EOA Cost Manual)

Fabric Filter:	$20,286.13
Filter Bags (Polyester 2510 net sq ft, 2937 gross)	$1,967.79
Bag Cages ($3.0807^{0.5240}$ x 2510)	$4,526.03
Fabric Filter (1988 $):	**$26,779.95**

Based on the US Bureau of Labor Statistics the consumer price index prices in 1998 were 47.70% higher than prices in 1988 dollars.

Fabric Filter (1998 $):	**$39,553.99**
Centrifugal Fan (Note #1):	**$12,550.00**
TOTAL COLLECTOR (A) =	**$52,103.99**

Note: US EPA cost guidance on centrifugal fans is not clear. We have assumed a cost of $1.00 per cfm to be very conservative. Actual experience has shown the actual cost is closer to $1.39 per cfm

Revised: 07/24/2019

CAPITAL COST
Regenerative Thermal Oxidizer
K-W Line Shakeout Operation

1. PURCHASED EQUIPMENT	
A. Basic Equipment & Auxiliaries {12,550 cfm} (A) (See EPA Cost Worksheet)	$442,192.52
B. Instrumentation & Controls (0.10 A)	$44,219.25
C. Freight (0.05A)	$22,109.63
Total Purchased Equipment Cost (B)	$508,521.40
2. DIRECT INSTALLATION COSTS	
A. Foundations & Supports (0.08 B)	$40,681.71
B. Erection & Handling (0.14 B)	$71,193.00
C. Electrical (0.04 B)	$20,340.86
D. Piping (0.02 B)	$10,170.43
E. Insulation (0.01 B)	$5,085.21
F. Painting (0.01 B)	$5,085.21
G. Site Preparation (as req'd)	0
H. Building (as req'd)	0
Total Direct Installation Costs	$152,556.42
3. TOTAL CAPITAL COSTS (Purchased & Installation)	**$661,077.82**
4. INDIRECT COSTS	
A. Engineering & Supervision; (0.10 B)	$50,852.14
B. Contruction & Field Expenses; (0.05 B)	$25,426.07
C. Start-Up; (0.02 B)	$10,170.43
D. Contractor Fees	$50,852.14
E. Performance Test	$5,085.21
F. Contingency; (CF, IC+DC)	$80,346.38
Total Indirect Cost	**$222,732.37**
TOTAL INSTALLED CAPITAL COST	**$883,810.19**

Revised: 09/03/2019

ANNUALIZED COST

Bag Filter Collector
K-W Line Shakeout Operation

DIRECT OPERATING COSTS

1. Operating Labor; 1.5 hr/day X 365 days/Yr X $25/H	$13,687.50
2. Supervisory Labor, 0.15 X (1)	$2,053.13
3. Maintenance Labor (3 Shift)	$13,687.50
4. Replacement Parts, etc (100% labor)	$13,687.50
5. Utilities	
Electricity	$17,724.86
0.000117 x (12,550 cfm) x (20 in wg) x 0.0689 x 8760	
Compressed Air (see below for Cost Manual Calc)	$1,506.00
Waste Disposal (see below for Cost Manual Calc)	$5,916.90
TOTAL DIRECT OPERATING COST	**$68,263.39**

INDIRECT OPERATING COSTS

6. Overhead - 60% Oper Labor+Supv+Maint Labor	$17,656.88
7. Property Tax; 0.01 Capital Cost	$0.00
8. Insurance; 0.01 Capital Cost	$1,042.60
9. Administration; 0.02 Capital Cost	$2,085.20
10. Capital Recovery Factor	
(10% Interest; 15 year life) = 0.1315	$17,430.87
TOTAL INDIRECT COST	**$38,215.54**
TOTAL ANNUALIZED COST	**$106,478.93**

5. Comp. Air: 12,550 cfm @ 20 cfm per 10,000 = (12,550 ÷ 10,000) X 20 = 25.10 cfm
25.10 cfm X 60 min/hr X 4,000 hr/yr = 6,024,000 cfm/yr
($0.25/1,000) X 6,024,000 cfm = $1,506.00 (1998)

6. Waste Disposal: 12,550 cfm X 0.5 gr/dscf X 60 min/hr ÷ 7,000 gr/lb = 53.79 lb/hr dust
53.79 lb/hr X 4,000 hr/yr ÷ 2,000 lb/T X $55.00 T (Disp = transp)
= $5,916.90

Revised: 07/25/2019

ANNUALIZED COST

Regenerative Thermal Oxidizer
K-W Line Shakeout Operation

DIRECT OPERATING COSTS	
1. Operating Labor	$13,687.50
2. Supervisory Labor, 0.15 X (1)	$2,053.13
3. Maintenance Labor	$13,687.50
4. Replacement Parts, etc (100% of labor)	$13,687.50
5. Utilities	
Fuel (EPA Worksheet)	$108,199.73
Electricity (EPA Worksheet)	$33,430.28
TOTAL DIRECT OPERATING COST	**$184,745.63**
INDIRECT OPERATING COSTS	
6. Overhead	$25,869.38
7. Property Tax; 0.01 Capital Cost	$0.00
8. Insurance; 0.01 Capital Cost	$8,838.10
9. Administration; 0.02 Capital Cost	$17,676.20
10. Capital Recovery Factor	$66,480.06
TOTAL INDIRECT COST	**$118,863.74**
TOTAL ANNUALIZED COST	**$303,609.36**

Revised: 07/31/2019

EPA WORKSHEEP -- KW Shakeout Thermal Oxidixer

Cost Estimate

Direct Costs

Total Purchased equipment costs (in 2016 dollars)

Incinerator + auxiliary equipment[a] (A) =			
Equipment Costs (EC) for Regenerative Oxidizer	=[2.664 x 100,000 + (13.98 x Qtot)] x (2016 CEPI/2016 CEPCI) =	$442,193	in 2016 dollars
Instrumentation[b] =	0.10 × A =	$44,219	
Sales taxes =	0.03 × A =	$0	
Freight =	0.05 × A =	$22,110	
	Total Purchased equipment costs (B) =	$508,521	in 2016 dollars

Footnotes

a - Auxiliary equipment includes equipment (e.g., duct work) normally not included with unit furnished by incinerator vendor.

b - Includes the instrumentation and controls furnished by the incinerator vendor.

Direct Installation Costs (in 2016 dollars)

Foundations and Supports =	0.08 × B =	$40,682	
Handlong and Errection =	0.14 × B =	$71,193	
Electrical =	0.04 × B =	$20,341	
Piping =	0.02 × B =	$10,170	
Insulation for Ductwork =	0.01 × B =	$5,085	
Painting =	0.01 × B =	$5,085	
Site Preparation (SP) =		$0	
Buildings (Bldg) =		$0	
	Total Direct Installaton Costs =	$152,556	
Total Direct Costs (DC) =	Total Purchase Equipment Costs (B) + Total Direct Installation Costs =	$661,078	in 2016 dollars

Total Indirect Installation Costs (in 2016 dollars)

Engineering =	0.10 × B =	$50,852	
Construction and field expenses =	0.05 × B =	$25,426	
Contractor fees =	0.10 × B =	$50,852	
Start-up =	0.02 × B =	$10,170	
Performance test =	0.01 × B =	$5,085	
	Total Indirect Costs (IC) =	$142,386	
Continency Cost (C) =	CF(IC+DC)=	$80,346	
Total Capital Investment =	**DC + IC +C =**	**$883,810**	**in 2016 dollars**

Direct Annual Costs

Annual Electricity Cost	= Fan Power Consumption × Operating Hours/year × Electricity Price =	$33,430	
Annual Fuel Costs for Natural Gas	= $Cost_{fuel}$ × Fuel Usage Rate × 60 min/hr × Operating hours/year	$108,200	
Operating Labor	Operator = 0.5hours/shift × Labor Rate × (Operating hours/8 hours/shift)	$13,688	
	Supervisor = 15% of Operator	$2,053	
Maintenance Costs	Labor = 0.5 hours/shift × Labor Rate × (Operating Hours/8 hours/shift)	$13,688	
	Materials = 100% of maintenance labor	$13,688	
Direct Annual Costs (DC) =		**$184,746**	**in 2016 dollars**

Indirect Annual Costs

Overhead	= 60% of sum of operating, supervisor, maintenance labor and maintenance materials	$25,869	
Administrative Charges	= 2% of TCI	$17,676	
Property Taxes	= 1% of TCI	$0	
Insurance	= 1% of TCI	$8,838	
Capital Recovery	= CRF[TCI-1.08(cat. Cost)]	$66,480	
Indirect Annual Costs (IC) =		**$118,864**	**in 2016 dollars**
Total Annual Cost =	**DC + IC =**	**$303,609**	**in 2016 dollars**

BOYERTOWN FOUNDRY COMPANY
Boyertown, PA

VOC RACT Analysis -- K-W Line Pouring

Total Installed Capital Cost	Regenerative Thermal Oxidizer	Bag Filter	Combined Controls
Total Purchased Equipment Cost	$ 386,902.39	$ 26,157.89	$ 413,060.28
Total Direct Installation Cost	$ 116,070.72	$ 19,356.84	$ 135,427.56
Total Indirect Cost	$ 171,057.96	$ 12,351.76	$ 183,409.71
TOTALS	**$ 674,031.06**	**$ 57,866.49**	**$ 731,897.55**

Total Annualized Cost	Regenerative Thermal Oxidizer	Bag Filter	Combined Controls
Total Direct Operating Costs	$ 52,351.45	$ 51,252.32	$ 103,603.78
Total Indirect Operating Costs	$ 90,535.63	$ 26,631.76	$ 117,167.39
TOTALS	**$ 142,887.08**	**$ 77,884.08**	**$ 220,771.17**

Uncontrrolled VOC Emission Rate, TPY	3.66
VOC Control Efficiency	95%
VOC Removed By Controls	3.47

Cost Effectiveness, $/Ton Removed **$ 63,551.74**

Revised: 09/18/2019

CAPITAL COST
Bag Filter Collector
<u>K-W Line Pouring Operation</u>

1. PURCHASED EQUIPMENT	
A. Collector & Aux. Equipment {5,000 cfm} (A)	$22,745.99
B. Instrumentation & Controls (0.10 A)	$2,274.60
C. Freight (0.05A)	$1,137.30
Total Purchased Equipment Cost (B)	$26,157.89
2. DIRECT INSTALLATION COSTS	
A. Foundations & Supports (0.04 B)	$1,046.32
B. Erection & Handling (0.50 B)	$13,078.95
C. Electrical (0.08 B)	$2,092.63
D. Piping (0.01 B)	$261.58
E. Insulation (0.07 B)	$1,831.05
F. Painting (0.04 B)	$1,046.32
G. Site Preparation (as req'd)	0
H. Building (as req'd)	0
Total Indirect Installation Costs	$19,356.84
3. TOTAL CAPITAL COSTS (Purchased & Installation)	**$45,514.73**
4. INDIRECT COSTS	
A. Engineering & Supervision; (0.10 B)	$2,615.79
B. Contruction & Field Expenses; (0.20 B)	$5,231.58
C. Contractors Fees; (0.10 B)	$2,615.79
D. Start-Up; (0.01 B)	$261.58
E. Performance Test; (0.01 B)	$261.58
E. Contingency; (0.03 B)	$1,365.44
Total Indirect Cost	**$12,351.76**
TOTAL INSTALLED CAPITAL COST	**<u>$57,866.49</u>**

Revised: 08/01/2019

CAPITAL COST
Bag Filter Collector
K-W Line Pouring Operation

Fabric Filter, 5,000 cfm, 5.0 AC Ratio, Polyester Bags, 14.0" wg

Purchase Costs (1998 dollars from US EOA Cost Manual)

Fabric Filter:	$9,470.00
Filter Bags (Polyester 1000 net sq ft, 1107 gross)	$741.69
Bag Cages ($3.0807^{0.5240}$ x 1000)	$1,803.20
Fabric Filter (1988 $):	**$12,014.89**

Based on the US Bureau of Labor Statistics the consumer price index prices in 1998 were 47.70% higher than prices in 1988 dollars.

Fabric Filter (1998 $):	**$17,745.99**
Centrifugal Fan (Note #1):	**$5,000.00**
TOTAL COLLECTOR (A) =	**$22,745.99**

Note: US EPA cost guidance on centrifugal fans is not clear. We have assumed a cost of $1.00 per cfm to be very conservative. Actual experience has shown the actual cost is closer to $1.39 per cfm

Revised: 07/24/2019

CAPITAL COST
Regenerative Thermal Oxidizer
K-W Line Pouring Operation

1. PURCHASED EQUIPMENT	
A. Basic Equipment & Auxiliaries {5,000 cfm} (A) (See EPA Cost Worksheet)	$336,436.86
B. Instrumentation & Controls (0.10 A)	$33,643.69
C. Freight (0.05A)	$16,821.84
Total Purchased Equipment Cost (B)	$386,902.39
2. DIRECT INSTALLATION COSTS	
A. Foundations & Supports (0.08 B)	$30,952.19
B. Erection & Handling (0.14 B)	$54,166.33
C. Electrical (0.04 B)	$15,476.10
D. Piping (0.02 B)	$7,738.05
E. Insulation (0.01 B)	$3,869.02
F. Painting (0.01 B)	$3,869.02
G. Site Preparation (as req'd)	0
H. Building (as req'd)	0
Total Direct Installation Costs	$116,070.72
3. TOTAL CAPITAL COSTS (Purchased & Installation)	**$502,973.11**
4. INDIRECT COSTS	
A. Engineering & Supervision; (0.10 B)	$38,690.24
B. Contruction & Field Expenses; (0.05 B)	$19,345.12
C. Contractor Fees	$38,690.24
C. Start-Up; (0.02 B)	$7,738.05
D. Performance Test	$3,869.02
E. Contingency; (CF, IC+DC)	$62,725.29
Total Indirect Cost	**$171,057.96**
TOTAL INSTALLED CAPITAL COST	**$674,031.06**

Revised: 09/03/2019

ANNUALIZED COST

Bag Filter Collector
K-W Line Pouring Operation

DIRECT OPERATING COSTS

1. Operating Labor; 1.5 hr/day X 365 days/Yr X $25/H	$13,687.50
2. Supervisory Labor, 0.15 X (1)	$2,053.13
3. Maintenance Labor (3 shifts)	$13,687.50
4. Replacement Parts, etc (100% labor)	$13,687.50
5. Utilities	
Electricity	$7,061.70
0.000117x (5000) x (20") x 0.0689 x 8760	
Compressed Air ($0.15 /cfm)	$750.00
Waste Disposal ($650 /10,000 cfm)	$325.00
TOTAL DIRECT OPERATING COST	**$51,252.32**

INDIRECT OPERATING COSTS

6. Overhead - 60% Oper Labor+Supv+Maint Labor	$17,656.88
7. Property Tax; 0.01 Capital Cost	$0.00
8. Insurance; 0.01 Capital Cost	$455.15
9. Administration; 0.02 Capital Cost	$910.29
10. Capital Recovery Factor	
(10% Interest; 15 year life) = 0.1315	$7,609.44
TOTAL INDIRECT COST	**$26,631.76**
TOTAL ANNUALIZED COST	**$77,884.08**

Revised: 09/03/2019

ANNUALIZED COST

Regenerative Thermal Oxidizer
K-W Line Pouring Operation

DIRECT OPERATING COSTS

1. Operating Labor	$9,562.97
2. Supervisory Labor, 0.15 X (1)	$1,434.45
3. Maintenance Labor (3 shift)	$9,846.88
4. Replacement Parts, etc (100% of labor)	$9,846.88
5. Utilities	
Fuel (EPA Worksheet)	$12,969.48
Electricity ($5.32 /cfm)	$8,690.81
TOTAL DIRECT OPERATING COST	**$52,351.45**

INDIRECT OPERATING COSTS

6. Overhead	$18,414.70
7. Property Tax; 0.01 Capital Cost	$0.00
8. Insurance	$6,740.31
9. Administration; 0.02 Capital Cost	$13,480.62
10. Capital Recovery Factor	$51,900.00
TOTAL INDIRECT COST	**$90,535.63**
TOTAL ANNUALIZED COST	**$142,887.08**

Revised: 07/31/2019

EPA WORKSHEETP -- KW Pouring Thermal Oxidixer

Cost Estimate

Direct Costs

Total Purchased equipment costs (in 2016 dollars)			
Incinerator + auxiliary equipment[a] (A) =			
Equipment Costs (EC) for Regenerative Oxidizer	=[2.664 x 100,000 + (13.98 x Qtot)] x (2016 CEPI/2016 CEPCI) =	$336,437	in 2016 dollars
Instrumentation[b] =	0.10 × A =	$33,644	
Sales taxes =	0.03 × A =	$0	
Freight =	0.05 × A =	$16,822	
	Total Purchased equipment costs (B) =	$386,902	in 2016 dollars

Footnotes

a - Auxiliary equipment includes equipment (e.g., duct work) normally not included with unit furnished by incinerator vendor.

b - Includes the instrumentation and controls furnished by the incinerator vendor.

Direct Installation Costs (in 2016 dollars)			
Foundations and Supports =	0.08 × B =	$30,952	
Handlong and Errection =	0.14 × B =	$54,166	
Electrical =	0.04 × B =	$15,476	
Piping =	0.02 × B =	$7,738	
Insulation for Ductwork =	0.01 × B =	$3,869	
Painting =	0.01 × B =	$3,869	
Site Preparation (SP) =		$0	
Buildings (Bldg) =		$0	
	Total Direct Installaton Costs =	$116,071	
Total Direct Costs (DC) =	Total Purchase Equipment Costs (B) + Total Direct Installation Costs =	$502,973	in 2016 dollars

Total Indirect Installation Costs (in 2016 dollars)			
Engineering =	0.10 × B =	$38,690	
Construction and field expenses =	0.05 × B =	$19,345	
Contractor fees =	0.10 × B =	$38,690	
Start-up =	0.02 × B =	$7,738	
Performance test =	0.01 × B =	$3,869	
	Total Indirect Costs (IC) =	$108,333	
Continency Cost (C) =	CF(IC+DC)=	$62,725	
Total Capital Investment =	**DC + IC +C =**	**$674,031**	**in 2016 dollars**

Direct Annual Costs

Annual Electricity Cost	= Fan Power Consumption × Operating Hours/year × Electricity Price =	$8,691	
Annual Fuel Costs for Natural Gas	= $Cost_{fuel}$ × Fuel Usage Rate × 60 min/hr × Operating hours/year	$12,969	
Operating Labor	Operator = 0.5hours/shift × Labor Rate × (Operating hours/8 hours/shift)	$9,563	
	Supervisor = 15% of Operator	$1,434	
Maintenance Costs	Labor = 0.5 hours/shift × Labor Rate × (Operating Hours/8 hours/shift)	$9,847	
	Materials = 100% of maintenance labor	$9,847	
Direct Annual Costs (DC) =		**$52,351**	**in 2016 dollars**

Indirect Annual Costs

Overhead	= 60% of sum of operating, supervisor, maintenance labor and maintenance materials	$18,415	
Administrative Charges	= 2% of TCI	$13,481	
Property Taxes	= 1% of TCI	$0	
Insurance	= 1% of TCI	$6,740	
Capital Recovery	= CRF[TCI-1.08(cat. Cost)]	$51,900	
Indirect Annual Costs (IC) =		**$90,536**	**in 2016 dollars**
Total Annual Cost =	**DC + IC =**	**$142,887**	**in 2016 dollars**

BOYERTOWN FOUNDRY COMPANY
Boyertown, PA

VOC RACT Analysis -- Hydro Slinger Shakeout

Total Installed Capital Cost	Regenerative Thermal Oxidizer	Bag Filter	Combined Controls
Total Purchased Equipment Cost	$ 733,234.67	$ 122,167.03	$ 855,401.69
Total Direct Installation Cost	$ 219,970.40	$ 90,403.60	$ 310,374.00
Total Indirect Cost	$ 321,156.78	$ 54,975.16	$ 376,131.95
TOTALS	**$ 1,274,361.85**	**$ 267,545.79**	**$ 1,541,907.64**

Total Annualized Cost	Regenerative Thermal Oxidizer	Bag Filter	Combined Controls
Total Direct Operating Costs	$ 330,070.52	$ 96,215.33	$ 426,285.84
Total Indirect Operating Costs	$ 159,957.52	$ 59,216.26	$ 219,173.78
TOTALS	**$ 490,028.03**	**$ 155,431.59**	**$ 645,459.63**

Uncontrrolled VOC Emission Rate, TPY	27.76
VOC Control Efficiency	95%
VOC Removed By Controls	26.37

Cost Effectiveness, $/Ton Removed **$ 24,475.19**

Revised: 09/20/2019

CAPITAL COST
Bag Filter Collector
<u>Hydro Slinger Shakeout Operation</u>

1. PURCHASED EQUIPMENT	
A. Collector & Aux. Equipment {See Next Pg} (A)	$106,232.20
B. Instrumentation & Controls (0.10 A)	$10,623.22
C. Freight (0.05A)	$5,311.61
Total Purchased Equipment Cost (B)	$122,167.03
2. DIRECT INSTALLATION COSTS	
A. Foundations & Supports (0.04 B)	$4,886.68
B. Erection & Handling (0.50 B)	$61,083.51
C. Electrical (0.08 B)	$9,773.36
D. Piping (0.01 B)	$1,221.67
E. Insulation (0.07 B)	$8,551.69
F. Painting (0.04 B)	$4,886.68
G. Site Preparation (as req'd)	0
H. Building (as req'd)	0
Total Indirect Installation Costs	$90,403.60
3. TOTAL CAPITAL COSTS (Purchased & Installation)	**$212,570.63**
4. INDIRECT COSTS	
A. Engineering & Supervision; (0.10 B)	$12,216.70
B. Contruction & Field Expenses; (0.20 B)	$24,433.41
C. Contractors Fees; (0.10 B)	$12,216.70
D. Start-Up; (0.01 B)	$1,221.67
E. Performance Test; (0.01 B)	$1,221.67
F. Contingency; (0.03 B)	$3,665.01
Total Indirect Cost	**$54,975.16**
TOTAL INSTALLED CAPITAL COST	**<u>$267,545.79</u>**

Note #1: EPA cost guidance for centrifugal fans in this type application is vague. We have used $1.00 per CFM to be very conservative normal value is approx. $1.39 per CFM.

Revised: 07/30/2018

CAPITAL COST
Bag Filter Collector
Hydro Slinger Shakeout Operation

Fabric Filter, 26,500 cfm, 5.0 AC Ratio, Polyester Bags, 14.0" wg

Purchase Costs (1998 dollars from US EOA Cost Manual)

Fabric Filter:	$40,270.90
Filter Bags (Polyester 5300 net sq ft, 6201 gross)	$4,154.67
Bag Cages ($3.0807^{0.5240}$ x 5300)	$9,556.96
Fabric Filter (1988 $):	**$53,982.53**

Based on the US Bureau of Labor Statistics the consumer price index prices in 1998 are 47.70% higher than prices in 1988 dollars.

Fabric Filter (1998 $):	**$79,732.20**
Centrifugal Fan (Note #1):	**$26,500.00**
TOTAL COLLECTOR (A) =	**$106,232.20**

Note: US EPA cost guidance on centrifugal fans is not clear. We have assumed a cost of $1.00 per cfm to be very conservative. Actual experience has shown the actual cost is closer to $1.39 per cfm

Revised: 07/24/2019

CAPITAL COST
Regenerative Thermal Oxidizer
Hydro Slinger Shakeout Operation

1. PURCHASED EQUIPMENT	
A. Basic Equipment & Auxiliaries {26,500 cfm} (A)	$637,595.36
(See EPA Worsheet for details)	
B. Instrumentation & Controls (0.10 A)	$63,759.54
C. Freight (0.05A)	$31,879.77
Total Purchased Equipment Cost (B)	$733,234.67
2. DIRECT INSTALLATION COSTS	
A. Foundations & Supports (0.08 B)	$58,658.77
B. Erection & Handling (0.14 B)	$102,652.85
C. Electrical (0.04 B)	$29,329.39
D. Piping (0.02 B)	$14,664.69
E. Insulation (0.01 B)	$7,332.35
F. Painting (0.01 B)	$7,332.35
G. Site Preparation (as req'd)	0
H. Building (as req'd)	0
Total Direct Installation Costs	$219,970.40
Total Equip + Direct Installation	$953,205.07
Contingency Cost (CF*(DC+IC)	$115,851.08
3. TOTAL CAPITAL COSTS (Purchased & Installation)	**$953,205.07**
4. INDIRECT COSTS	
A. Engineering & Supervision; (0.10 B)	$73,323.47
B. Contruction & Field Expenses; (0.05 B)	$36,661.73
C. Contractor Fees	$73,323.47
C. Start-Up; (0.02 B)	$14,664.69
D. Performance Test	$7,332.35
Total Indirect Cost	**$205,305.71**
TOTAL INSTALLED CAPITAL COST	**$1,274,361.85**
(Tot Equip&Install+Total IC+Contingency)	

Revised: 09/20/2019

ANNUALIZED COST

Bag Filter Collector
Hydro Slinger Shakeout Operation

DIRECT OPERATING COSTS

1. Operating Labor; 1.5 hr/day X 365 days/Yr X $25/H	$13,687.50
2. Supervisory Labor, 0.15 X (1)	$2,053.13
3. Maintenance Labor (3 shift)	$13,687.50
4. Maintenance Parts, etc (100% labor) (5% of purchased equipment)	$13,687.50
5. Utilities	
Electricity	$37,427.00
0.000117 x (26,500 cfm) x (20 in wg)x0.0689x8760	
Compressed Air (see below for Cost Manual Calc)	$3,180.00
Waste Disposal (see below for Cost Manual Calc)	$12,492.70
TOTAL DIRECT OPERATING COST	**$96,215.33**

INDIRECT OPERATING COSTS

6. Overhead - 60% Oper Labor+Supv+Maint Labor	$17,656.88
7. Property Tax; 0.01 Capital Cost	$0.00
8. Insurance; 0.01 Capital Cost	$2,125.71
9. Administration; 0.02 Capital Cost	$4,251.41
10. Capital Recovery Factor (10% Interest; 15 year life) = 0.1315	$35,182.27
TOTAL INDIRECT COST	**$59,216.26**
TOTAL ANNUALIZED COST	**$155,431.59**

5. Comp. Air: 26,500 cfm @ 20 cfm per 10,000 = (26,500 ÷ 10,000) X 20 = 53.00 cfm
53.00 cfm X 60 min/hr X 4,000 hr/yr = 12,720,000 cfm/yr
($0.25/1,000) X 12,720,000 cfm = $3,180.00

6. Waste Disposal: 26,500 cfm X 0.5 gr/dscf X 60 min/hr ÷ 7,000 gr/lb = 113.57 lb/hr dust
113.57 lb/hr X 4,000 hr/yr ÷ 2,000 lb/T X $55.00 T (Disp + transp)
= $12,492.70

Revised: 07/25/2019

ANNUALIZED COST

Regenerative Thermal Oxidizer
Hydro Slinger Shakeout Operation

DIRECT OPERATING COSTS	
1. Operating Labor; 0.5 hr/shift	$13,687.50
2. Supervisory Labor, 0.15 X (1)	$2,053.13
3. Maintenance Labor (3 Shift)	$13,687.50
4. Maintenance Parts, etc (100% labor)	$13,687.50
5. Utilities	
Fuel (EPA Worksheet) @ $0.0083777/cf	$228,469.54
Electricity (EPA Worksheet) @ 0.0680/kW	$58,485.35
TOTAL DIRECT OPERATING COST	**$330,070.52**
INDIRECT OPERATING COSTS	
6. Overhead (EPA Worksheet)	$25,869.38
7. Property Tax; 0.01 Capital Cost	$0.00
8. Insurance; 0.01 Capital Cost	$12,743.62
9. Administration; 0.02 Capital Cost	$25,487.24
10. Capital Recovery Factor (EPA Worksheet)	$95,857.29
TOTAL INDIRECT COST	**$159,957.52**
TOTAL ANNUALIZED COST	**$490,028.03**

Revised: 09/3/2019

Cost Estimate

RTO For Hydro Slinger Shakeout

Direct Costs

Total Purchased equipment costs (in 2016 dollars)

Incinerator + auxiliary equipment[a] (A) =			
Equipment Costs (EC) for Regenerative Oxidizer	=[2.664 x 100,000 + (13.98 x Qtot)] x (2016 CEPI/2016 CEPCI) =	$637,595	in 2016 dollars
Instrumentation[b] =	0.10 × A =	$63,760	
Sales taxes =	0.03 × A =	$0	
Freight =	0.05 × A =	$31,880	
	Total Purchased equipment costs (B) =	$733,235	in 2016 dollars

Footnotes

a - Auxiliary equipment includes equipment (e.g., duct work) normally not included with unit furnished by incinerator vendor.

b - Includes the instrumentation and controls furnished by the incinerator vendor.

Direct Installation Costs (in 2016 dollars)

Foundations and Supports =	0.08 × B =		$58,659	
Handlong and Errection =	0.14 × B =		$102,653	
Electrical =		26500	$29,329	
Piping =		26500	$14,665	
Insulation for Ductwork =	0.01 × B =		$7,332	
Painting =	0.01 × B =		$7,332	
Site Preparation (SP) =			$0	
Buildings (Bldg) =			$0	
	Total Direct Installaton Costs =		$219,970	
Total Direct Costs (DC) =	Total Purchase Equipment Costs (B) + Total Direct Installation Costs =		$953,205	in 2016 dollars

Total Indirect Installation Costs (in 2016 dollars)

Engineering =	0.10 × B =	$73,323	
Construction and field expenses =	0.05 × B =	$36,662	
Contractor fees =	0.10 × B =	$73,323	
Start-up =	0.02 × B =	$14,665	
Performance test =	0.01 × B =	$7,332	
	Total Indirect Costs (IC) =	$205,306	
Continency Cost (C) =	CF(IC+DC)=	$115,851	
Total Capital Investment =	**DC + IC +C =**	**$1,274,362**	**in 2016 dollars**

Direct Annual Costs

Annual Electricity Cost	= Fan Power Consumption × Operating Hours/year × Electricity Price =	$58,485	
Annual Fuel Costs for Natural Gas	= $Cost_{fuel}$ × Fuel Usage Rate × 60 min/hr × Operating hours/year	$228,470	
Operating Labor	Operator = 0.5hours/shift × Labor Rate × (Operating hours/8 hours/shift)	$13,688	
	Supervisor = 15% of Operator	$2,053	
Maintenance Costs	Labor = 0.5 hours/shift × Labor Rate × (Operating Hours/8 hours/shift)	$13,688	
	Materials = 100% of maintenance labor	$13,688	
Direct Annual Costs (DC) =		**$330,071**	**in 2016 dollars**

Indirect Annual Costs

Overhead	= 60% of sum of operating, supervisor, maintenance labor and maintenance materials	$25,869	
Administrative Charges	= 2% of TCI	$25,487	
Property Taxes	= 1% of TCI	$0	
Insurance	= 1% of TCI	$12,744	
Capital Recovery	= CRF[TCI-1.08(cat. Cost)]	$95,857	
Indirect Annual Costs (IC) =		**$159,958**	**in 2016 dollars**
Total Annual Cost =	**DC + IC =**	**$490,028**	**in 2016 dollars**

Cost Effectiveness

Cost Effectiveness = (Total Annual Cost)/(Annual Quantity of VOC/HAP Pollutants Destroyed)

Total Annual Cost (TAC) =	$490,028	per year in 2016 dollars
VOC/HAP Pollutants Destroyed =	26.4	tons/year
Cost Effectiveness =	$18,583	per ton of pollutants removed in 2016 dollars

BOYERTOWN FOUNDRY COMPANY
Boyertown, PA

VOC RACT Analysis -- Hydro Slinger Pouring

Total Installed Capital Cost	Regenerative Thermal Oxidizer	Bag Filter	Combined Controls
Total Purchased Equipment Cost	$ 467,444.78	$ 49,136.69	$ 516,581.47
Total Direct Installation Cost	$ 140,233.43	$ 36,361.15	$ 176,594.58
Total Indirect Cost	$ 204,740.81	$ 22,111.51	$ 226,852.32
TOTALS	**$ 812,419.03**	**$ 107,609.35**	**$ 920,028.38**

Total Annualized Cost	Regenerative Thermal Oxidizer	Bag Filter	Combined Controls
Total Direct Operating Costs	$ 156,046.79	$ 63,153.31	$ 219,200.11
Total Indirect Operating Costs	$ 111,351.97	$ 34,372.44	$ 145,724.41
TOTALS	**$ 267,398.76**	**$ 97,525.75**	**$ 364,924.52**

Uncontrrolled VOC Emission Rate, TPY	3.24
VOC Control Efficiency	95%
VOC Removed By Controls	3.08

Cost Effectiveness, $/Ton Removed **$ 118,558.97**

Revised: 09/18/2019

CAPITAL COST
Bag Filter Collector
Hydro Slinger Pouring Operation

1. PURCHASED EQUIPMENT	
A. Collector & Aux. Equipment {see next page} (A)	$42,727.56
B. Instrumentation & Controls (0.10 A)	$4,272.76
C. Freight (0.05A)	$2,136.38
Total Purchased Equipment Cost (B)	$49,136.69
2. DIRECT INSTALLATION COSTS	
A. Foundations & Supports (0.04 B)	$1,965.47
B. Erection & Handling (0.50 B)	$24,568.34
C. Electrical (0.08 B)	$3,930.94
D. Piping (0.01 B)	$491.37
E. Insulation (0.07 B)	$3,439.57
F. Painting (0.04 B)	$1,965.47
G. Site Preparation (as req'd)	0
H. Building (as req'd)	0
Total Indirect Installation Costs	$36,361.15
3. TOTAL CAPITAL COSTS (Purchased & Installation)	**$85,497.84**
4. INDIRECT COSTS	
A. Engineering & Supervision; (0.10 B)	$4,913.67
B. Contruction & Field Expenses; (0.20 B)	$9,827.34
C. Contractors Fees; (0.10 B)	$4,913.67
D. Start-Up; (0.01 B)	$491.37
E. Performance Test; (0.01 B)	$491.37
F. Contingency; (0.03 B)	$1,474.10
Total Indirect Cost	**$22,111.51**
TOTAL INSTALLED CAPITAL COST	**$107,609.35**

Revised: 07/31/2018

CAPITAL COST
Bag Filter Collector
<u>Hydro Slinger Pouring Operation</u>

Fabric Filter, 10,000 cfm, 5.0 AC Ratio, Polyester Bags, 14.0" wg

Purchase Costs (1998 dollars from US EOA Cost Manual)

Fabric Filter:	$16,633.00
Filter Bags (Polyester 2000 net sq ft, 2,234 gross)	$1,496.78
Bag Cages ($3.0807^{0.5240}$ x 2234)	$4,028.35
Fabric Filter (1988 $):	**$22,158.13**

Based on the US Bureau of Labor Statistics the consumer price index prices in 1998 were 47.70% higher than prices in 1988 dollars.

Fabric Filter (1998 $):	**$32,727.56**
Centrifugal Fan (Note #1):	**$10,000.00**
TOTAL COLLECTOR (A) =	**$42,727.56**

Note: US EPA cost guidance on centrifugal fans is not clear. We have assumed a cost of $1.00 per cfm to be very conservative. Actual experience has shown the actual cost is closer to $1.39 per cfm

Revised: 07/24/2019

CAPITAL COST
Regenerative Thermal Oxidizer
Hydro Slinger Pouring Operation

1. PURCHASED EQUIPMENT	
A. Basic Equipment & Auxiliaries {10,000 cfm} (A) (see EPA Worksheet for details)	$406,473.72
B. Instrumentation & Controls (0.10 A)	$40,647.37
C. Freight (0.05A)	$20,323.69
Total Purchased Equipment Cost (B)	$467,444.78
2. DIRECT INSTALLATION COSTS	
A. Foundations & Supports (0.08 B)	$37,395.58
B. Erection & Handling (0.14 B)	$65,442.27
C. Electrical (0.04 B)	$18,697.79
D. Piping (0.02 B)	$9,348.90
E. Insulation (0.01 B)	$4,674.45
F. Painting (0.01 B)	$4,674.45
G. Site Preparation (as req'd)	0
H. Building (as req'd)	0
Total Direct Installation Costs	$140,233.43
Contingency Cost (CF*(DC+IC)	$73,856.28
3. TOTAL CAPITAL COSTS (Purchased & Installation)	**$607,678.21**
4. INDIRECT COSTS	
A. Engineering & Supervision; (0.10 B)	$46,744.48
B. Contruction & Field Expenses; (0.05 B)	$23,372.24
C. Contractors Fees	$46,744.48
C. Start-Up; (0.02 B)	$9,348.90
D. Performance Test	$4,674.45
Total Indirect Cost	**$130,884.54**
TOTAL INSTALLED CAPITAL COST	**$812,419.03**

Revised: 09/03/2019

ANNUALIZED COST

Bag Filter Collector
Hydro Slinger Pouring Operation

DIRECT OPERATING COSTS

1. Operating Labor; 1.5 hr/day X 365 days/Yr X $25/H	$13,687.50
2. Supervisory Labor, 0.15 X (1)	$2,053.13
3. Maintenance Labor (3 shift @ 1.5 hr/shift)	$13,687.50
Materials (100% ofmaint. Labor)	$13,687.50
5. Utilities	
Elect (0.000117x(10,000 cfm)x(20)x0.0687x8760)	$14,123.40
Compressed Air (see below for Cost Manual Calc)	$1,200.00
Waste Disposal (see below for Cost Manual Calc)	$4,714.29
TOTAL OPERATING COST	**$63,153.31**

INDIRECT OPERATING COSTS

6. Overhead - 60% Oper Labor+Supv+Maint Labor	$17,656.88
7. Property Tax; 0.01 Capital Cost	$0.00
8. Insurance; 0.01 Capital Cost	$854.98
9. Administration; 0.02 Capital Cost	$1,709.96
10. Capital Recovery Factor	
(10% Interest; 15 year life) = 0.1315	$14,150.63
TOTAL INDIRECT COST	**$34,372.44**
TOTAL ANNUALIZED COST	**$97,525.75**

5. Comp. Air: 10,000 cfm @ 20 cfm per 10,000 = (10,000 ÷ 10,000) X 20 = 20.00 cfm
20.00 cfm X 60 min/hr X 4,000 hr/yr = 4,800,000 cfm/yr
($0.25/1,000 X 4,800,000 cfm = $1,200.00

6. Waste Disposal: 10,000 cfm X 0.5 gr/dscf X 60 min/hr ÷ 7,000 gr/lb = 42.86 lb/hr dust
42.86 lb/hr X 4,000 hr/yr ÷ 2,000 lb/T X $55.00 T (Disp + transp)
= $4,714.29

Revised: 08/09/2019

ANNUALIZED COST

Regenerative Thermal Oxidizer
Hydro Slinger Pouring Operation

DIRECT OPERATING COSTS

1.	Operating Labor; 1.5 H/day X 365 Day/yr X $25/H	$13,687.50
2.	Supervisory Labor, 0.15 X (1)	$2,053.13
3.	Maintenance Labor (3 shift)	$13,687.50
4.	MaintenanceParts, etc (100% of labor)	$13,687.50
5.	Utilities	
	Fuel (EPA Worksheet)	$86,214.92
	Electricity (EPA Worksheet)	$26,716.25
TOTAL DIRECT OPERATING COST		**$156,046.79**

INDIRECT OPERATING COSTS

6.	Overhead - 80% Oper Labor+Supv+Maint Labor	$25,869.38
7.	Property Tax; 0.01 Capital Cost	$0.00
8.	Insurance; 0.01 Capital Cost	$8,124.19
9.	Administration; 0.02 Capital Cost	$16,248.38
10.	Capital Recovery Factor	
	(10% Interest; 15 year life) = 0.1315	$61,110.03
TOTAL INDIRECT COST		**$111,351.97**
TOTAL ANNUALIZED COST		**$267,398.76**

Revised: 09/03/2019

EPA WORKSHEEP -- HS Pouring Thermal Oxidixer

Cost Estimate

Direct Costs

Total Purchased equipment costs (in 2016 dollars)

Incinerator + auxiliary equipment[a] (A) =			
Equipment Costs (EC) for Regenerative Oxidizer	=[2.664 x 100,000 + (13.98 x Qtot)] x (2016 CEPI/2016 CEPCI) =	$406,474	in 2016 dollars
Instrumentation[b] =	0.10 × A =	$40,647	
Sales taxes =	0.03 × A =	$0	
Freight =	0.05 × A =	$20,324	
	Total Purchased equipment costs (B) =	$467,445	in 2016 dollars

Footnotes

a - Auxiliary equipment includes equipment (e.g., duct work) normally not included with unit furnished by incinerator vendor.

b - Includes the instrumentation and controls furnished by the incinerator vendor.

Direct Installation Costs (in 2016 dollars)

Foundations and Supports =	0.08 × B =	$37,396	
Handlong and Errection =	0.14 × B =	$65,442	
Electrical =	0.04 × B =	$18,698	
Piping =	0.02 × B =	$9,349	
Insulation for Ductwork =	0.01 × B =	$4,674	
Painting =	0.01 × B =	$4,674	
Site Preparation (SP) =		$0	
Buildings (Bldg) =		$0	
	Total Direct Installaton Costs =	$140,233	
Total Direct Costs (DC) =	Total Purchase Equipment Costs (B) + Total Direct Installation Costs =	$607,678	in 2016 dollars

Total Indirect Installation Costs (in 2016 dollars)

Engineering =	0.10 × B =	$46,744	
Construction and field expenses =	0.05 × B =	$23,372	
Contractor fees =	0.10 × B =	$46,744	
Start-up =	0.02 × B =	$9,349	
Performance test =	0.01 × B =	$4,674	
	Total Indirect Costs (IC) =	$130,885	
Contінency Cost (C) =	CF(IC+DC)=	$73,856	
Total Capital Investment =	**DC + IC +C =**	**$812,419**	**in 2016 dollars**

Direct Annual Costs

Annual Electricity Cost	= Fan Power Consumption × Operating Hours/year × Electricity Price =	$26,716	
Annual Fuel Costs for Natural Gas	= $Cost_{fuel}$ × Fuel Usage Rate × 60 min/hr × Operating hours/year	$86,215	
Operating Labor	Operator = 0.5hours/shift × Labor Rate × (Operating hours/8 hours/shift)	$13,688	
	Supervisor = 15% of Operator	$2,053	
Maintenance Costs	Labor = 0.5 hours/shift × Labor Rate × (Operating Hours/8 hours/shift)	$13,688	
	Materials = 100% of maintenance labor	$13,688	
Direct Annual Costs (DC) =		**$156,047**	**in 2016 dollars**

Indirect Annual Costs

Overhead	= 60% of sum of operating, supervisor, maintenance labor and maintenance materials	$25,869	
Administrative Charges	= 2% of TCI	$16,248	
Property Taxes	= 1% of TCI	$0	
Insurance	= 1% of TCI	$8,124	
Capital Recovery	= CRF[TCI-1.08(cat. Cost)]	$61,110	
Indirect Annual Costs (IC) =		**$111,352**	**in 2016 dollars**
Total Annual Cost =	**DC + IC =**	**$267,399**	**in 2016 dollars**

BOYERTOWN FOUNDRY COMPANY
Boyertown, PA

VOC RACT Analysis -- Core Making Area

Total Installed Capital Cost	Regenerative Thermal Oxidizer
Total Purchased Equipment Cost	$ 1,111,783.90
Total Direct Installation Cost	$ 394,863.17
Total Indirect Cost	$ 493,094.15
TOTALS	**$ 1,999,741.22**

Total Annualized Cost	Regenerative Thermal Oxidizer
Total Direct Operating Costs	$ 607,378.58
Total Indirect Operating Costs	$ 236,281.82
TOTALS	**$ 843,660.40**

Uncontrrolled VOC Emission Rate, TPY	20.65
VOC Control Efficiency	95%
VOC Removed By Controls	19.62

Cost Effectiveness, $/Ton Removed **$43,005.50**

Revised: 09/18/2019

CAPITAL COST
Regenerative Thermal Oxidizer
<u>Core Making Area</u>

1. PURCHASED EQUIPMENT	
A. Basic Equipment & Auxiliaries {50,000 cfm} (A)	$966,768.61
(See EPA Cost Estimate Worksheet)	
B. Instrumentation & Controls (0.10 A)	$96,676.86
C. Freight (0.05A)	$48,338.43
Total Purchased Equipment Cost (B)	$1,111,783.90
2. DIRECT INSTALLATION COSTS	
A. Foundations & Supports (0.08 B)	$88,942.71
B. Erection & Handling (0.14 B)	$155,649.75
C. Electrical (0.04 B)	$44,471.36
D. Piping (0.02 B)	$22,235.68
E. Insulation (0.01 B)	$11,117.84
F. Painting (0.01 B)	$11,117.84
G. Core Room Enclosure (see next page)	$61,328.00
Total Direct Installation Costs	$394,863.17
3. TOTAL CAPITAL COSTS (Purchased & Installation)	**$1,506,647.07**
4. INDIRECT COSTS	
A. Engineering & Supervision; (0.10 B+encl)	$111,178.39
B. Contruction & Field Expenses; (0.05 B+encl)	$55,589.20
C. Start-Up; (0.02 B)	$22,235.68
D. Performance Test	$11,117.84
E. Contractor Fees	$111,178.39
E. Contingency; (CF, IC+DC)	$181,794.66
Total Indirect Cost	**$493,094.15**
TOTAL INSTALLED CAPITAL COST	**<u>$1,999,741.22</u>**

Revised: 08/09/2019

CAPITAL COST
Regenerative Thermal Oxidizer
Core Making Area

CORE ROOM ENCLOSURE COST ESTIMATE (EPA Control Cost Manual)
All Costs in 1997 dollars

Total enclosure area for core making and core storage (emissions from cored cores) covers 5,160 Sq Ft. The area includes both single story and 2-story areas. Existing walls will be used when possible, and the total square footage of new wall area is 2,550 sq ft. The existing walls are primarily sheet metal, and that material is used for the new additions.

The estimated cost, based on the EPA Control Cost Manual when possibe is as follows:

1. Sheet metal ($1.69 sq ft)	$4,309.50
2. Installation (** $19.37 sq ft)	$49,393.50
3. Roll up Doors (2 req'd @ $3,910)	$6,380.00
4. Man-Doors (3 req'd @ $415)	$1,245.00
TOTAL ENCLOSURES:	**$61,328.00**

** *The Cost Manual indicates a cost of $12.90 per square foot of sheet metal for installation. A factor of 1.5 for moderate obstructions in this restricted area has been applied per the manual for an final cost of $19.37.*

Boyertown Foundry also notes that EPA Cost Manual does not provide for the numerous costs associated with the required modifications to existing wiring, HVAC and other general utilities. The actual cost of the enclosure is expected to far exceed the EPA estimates.

ANNUALIZED COST

Regenerative Thermal Oxidizer
Core Making Area

DIRECT OPERATING COSTS

1. Operating Labor; 1.5 H/day X 365 Day/yr X $25/H	$13,687.50
2. Supervisory Labor, 0.15 X (1)	$2,053.13
3. Maintenance Labor (3 shift)	$13,687.50
4. Maintenance Parts, etc (100% of labor)	$13,687.50
(5% of total purchased equipment)	
5. Utilities	
Fuel (EPA Worksheet)	$431,074.60
Electricity ($5.32 /cfm)	$133,188.35
TOTAL DIRECT OPERATING COST	**$607,378.58**

INDIRECT OPERATING COSTS

6. Overhead - 80% Oper Labor+Supv+Maint Labor	$25,869.38
7. Property Tax; 0.01 Capital Cost	$0.00
8. Insurance; 0.01 Capital Cost	$19,997.41
9. Administration; 0.02 Capital Cost	$39,994.82
10. Capital Recovery Factor	
(10% Interest; 15 year life) = 0.1315	$150,420.20
TOTAL CAPITAL COST	**$236,281.82**
TOTAL ANNUALIZED COST	**$843,660.40**

Revised: 09/03/2019

EPA WORKSHEEP -- Core Making Thermal Oxidixer

Cost Estimate

Direct Costs			
Total Purchased equipment costs (in 2016 dollars)			
Incinerator + auxiliary equipment[a] (A) =			
Equipment Costs (EC) for Regenerative Oxidizer	=[2.664 x 100,000 + (13.98 x Qtot)] x (2016 CEPI/2016 CEPCI) =	$966,769	in 2016 dollars
Instrumentation[b] =	0.10 × A =	$96,677	
Sales taxes =	0.03 × A =	$0	
Freight =	0.05 × A =	$48,338	
	Total Purchased equipment costs (B) =	$1,111,784	in 2016 dollars
Footnotes			
a - Auxiliary equipment includes equipment (e.g., duct work) normally not included with unit furnished by incinerator vendor.			
b - Includes the instrumentation and controls furnished by the incinerator vendor.			
Direct Installation Costs (in 2016 dollars)			
Foundations and Supports =	0.08 × B =	$88,943	
Handlong and Errection =	0.14 × B =	$155,650	
Electrical =	0.04 × B =	$44,471	
Piping =	0.02 × B =	$22,236	
Insulation for Ductwork =	0.01 × B =	$11,118	
Painting =	0.01 × B =	$11,118	
Site Preparation (SP) =		$0	
Buildings (Bldg) =		$61,328	
	Total Direct Installaton Costs =	$394,863	
Total Direct Costs (DC) =	Total Purchase Equipment Costs (B) + Total Direct Installation Costs =	$1,506,647	in 2016 dollars
Total Indirect Installation Costs (in 2016 dollars)			
Engineering =	0.10 × B =	$111,178	
Construction and field expenses =	0.05 × B =	$55,589	
Contractor fees =	0.10 × B =	$111,178	
Start-up =	0.02 × B =	$22,236	
Performance test =	0.01 × B =	$11,118	
	Total Indirect Costs (IC) =	$311,299	
Continency Cost (C) =	CF(IC+DC)=	$181,795	
Total Capital Investment =	**DC + IC +C =**	**$1,999,741**	**in 2016 dollars**
Direct Annual Costs			
Annual Electricity Cost	= Fan Power Consumption × Operating Hours/year × Electricity Price =	$133,188	
Annual Fuel Costs for Natural Gas	= $Cost_{fuel}$ × Fuel Usage Rate × 60 min/hr × Operating hours/year	$431,075	
Operating Labor	Operator = 0.5hours/shift × Labor Rate × (Operating hours/8 hours/shift)	$13,688	
	Supervisor = 15% of Operator	$2,053	
Maintenance Costs	Labor = 0.5 hours/shift × Labor Rate × (Operating Hours/8 hours/shift)	$13,688	
	Materials = 100% of maintenance labor	$13,688	
Direct Annual Costs (DC) =		**$607,379**	**in 2016 dollars**
Indirect Annual Costs			
Overhead	= 60% of sum of operating, supervisor, maintenance labor and maintenance materials	$25,869	
Administrative Charges	= 2% of TCI	$39,995	
Property Taxes	= 1% of TCI	$0	
Insurance	= 1% of TCI	$19,997	
Capital Recovery	= CRF[TCI-1.08(cat. Cost)]	$150,420	
Indirect Annual Costs (IC) =		**$236,282**	**in 2016 dollars**
Total Annual Cost =	**DC + IC =**	**$843,660**	**in 2016 dollars**