REGIONAL HAZE FOUR-FACTOR ANALYSIS

COLLINS PRODUCTS, LLC—KLAMATH FALLS FACILITY

Prepared for
COLLINS PRODUCTS, LLC
KLAMATH FALLS FACILITY
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ACRONYMS AND ABBREVIATIONS

$/ton	dollars per ton of pollutant controlled
°F	degrees Fahrenheit
Analysis	Regional Haze Four Factor Analysis
CAA	Clean Air Act
CFR	Code of Federal Regulations
Control Cost Manual	USEPA Air Pollution Control Cost Manual
Collins	Collins Products, LLC
DEQ	Oregon Department of Environmental Quality
ESP	electrostatic precipitator
existing permit	Title V Operating Permit No. 18-0013-TV-01
facility	wood products manufacturing facility located at 6410 Highway 66, Klamath Falls, Oregon 97601
Federal Guidance Document	Guidance on Regional Haze State Implementation Plans for the Second Implementation Period (August 2019), EPA-457/B-19-003
HAP	hazardous air pollutant
HB	hardboard
MFA	Maul Foster & Alongi, Inc.
NESHAP	National Emission Standards for Hazardous Air Pollutants
NO	nitric oxide
NO_X	oxides of nitrogen
PB	particleboard
PCWP MACT	Plywood and Composite Wood Products Maximum Achievable Control Technology
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
RCO	Regenerative Catalytic Oxidizer
SCR	selective catalytic reduction
SIP	State Implementation Plan
SNCR	selective non-catalytic reduction
SO_2	sulfur dioxide
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

1 INTRODUCTION

The Oregon Department of Environmental Quality (DEQ) is developing a State Implementation Plan (SIP) as part of the Regional Haze program in order to protect visibility in Class I areas. The SIP developed by the DEQ covers the second implementation period ending in 2028, and must be submitted to the U.S. Environmental Protection Agency (USEPA) for approval. The second implementation period focuses on making reasonable progress toward national visibility goals, and assesses progress made since the 2000 through 2004 baseline period.

In a letter dated December 23, 2019, the DEQ requested that 31 industrial facilities conduct a Regional Haze Four Factor Analysis (Analysis). The Analysis estimates the cost associated with reducing visibility-impairing pollutants including, particulate matter with an aerodynamic diameter of 10 microns or less (PM_{10}), oxides of nitrogen (NO_X), and sulfur dioxide (SO_2). The four factors that must be considered when assessing the states' reasonable progress, which are codified in Section 169A(g)(1) of the Clean Air Act (CAA), are:

(1) The cost of control,

(2) The time required to achieve control,

(3) The energy and non-air-quality environmental impacts of control, and

(4) The remaining useful life of the existing source of emissions.

The DEQ has provided the following three guidance documents for facilities to reference when developing their Analysis:

1) USEPA Guidance on Regional Haze State Implementation Plans for the Second Implementation Period (August 2019), EPA-457/B-19-003 (Federal Guidance Document).

2) USEPA Air Pollution Control Cost Manual, which is maintained online and includes separate chapters for different control devices as well as several electronic calculation spreadsheets that can be used to estimate the cost of control for several control devices (Control Cost Manual).

3) Modeling Guidance for Demonstrating Air Quality Goals for Ozone, particulate matter with an aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$), and Regional Haze (November 2018), EPA-454/R-18-009.

The development of this Analysis has relied on these guidance documents.

1.1 Facility Description

Collins Products, LLC (Collins) owns and operates a wood products manufacturing facility located at 6410 Highway 66, Klamath Falls, Oregon 97601 (the "facility"). The facility produces hardboard (HB) and particleboard (PB). The facility currently operates under Addendum No. 4 to Oregon Title V

Operating Permit No. 18-0013-TV-01 issued by the DEQ on March 14, 2019. The facility is a major source of criteria pollutants and hazardous air pollutants (HAPs). As a result, the facility is subject to the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Plywood and Composite Wood Products, codified in Title 40 Code of Federal Regulations (CFR) Part 63 Subpart DDDD (PCWP MACT). Compliance with the limits and controls associated with this standard require controls that result in significant particulate reductions.

The facility is located just outside the urban growth boundary of Klamath Falls. The urban growth boundary is also the administrative boundary of the Klamath Falls maintenance area for PM_{10} and carbon monoxide. However, the facility is located inside the Klamath Falls nonattainment area for $PM_{2.5}$. The nearest federal Class I Area is the Mountain Lakes Wilderness Area, approximately 24 kilometers northwest of the facility.

1.2 Process Description

1.2.1 Particleboard Plant

Raw materials are delivered to the facility by truck. Raw materials, or furnish (e.g., green and pre-dried wood shavings, sawdust, and chips), are stored, sorted by size, and dried. Dried furnish is separated into core or face grade material. The core and face materials are mixed and blended with formaldehyde free resin, formed into mats, and pressed into boards. Boards are then cooled, sanded, and cut to final product dimensions. Fine particulate emissions generated by all major process equipment, except for the press vent area and two process cyclones, are controlled by fabric filters. Emissions from the press are controlled by a Bio-Reactions BioSystem (biofilter).

1.2.2 Hardboard Plant

The primary processes at the HB plant include raw material receipt, fiber production, mat forming, pressing, baking, humidification, sizing and coating. Raw materials for the HB process include wood by-products of various species. The wood chips are processed through defibrators, where they are blended with resin, producing resinated fibers. Resinated fibers are formed, pressed, baked, humidified and then allowed to cool. Trimmed hardboard siding is coated with a water-based primer coat and oven dried. Emissions from the press and the defibrators are controlled by a combination of cyclones, water sprays, baghouses and a Tri-Mer BioSystem (biofilter).

2 APPLICABLE EMISSION SOURCES

Collins retained Maul Foster & Alongi, Inc. (MFA) to assist the facility with completing this Analysis. Emissions rates for each visibility-impairing pollutant (PM_{10}, NO_X, and SO_2) were tabulated. These emissions rates represent a reasonable projection of actual source operation in the year 2028. As stated in the Federal Guidance Document,[1] estimates of 2028 emission rates should be used for the Analysis. It is assumed that current potential to emit emission rates at the facility represent the most reasonable estimate of actual emissions in 2028.

After emission rates were tabulated for each emissions unit, estimated emission rates for each pollutant were sorted from the highest emission rate to the lowest. The emission units collectively contributing at least 90 percent of the total facility emissions rate for a single pollutant were identified and selected for the Analysis.

This method of emission unit selection ensures that larger emission units are included in the Analysis. Larger emission units represent the likeliest potential for reduction in emissions that would contribute to a meaningful improvement in visibility at federal Class I areas. It would not be reasonable to assess many small emission units—neither on an individual basis (large reductions for a small source likely would not improve visibility and would not be cost effective), nor on a collective basis (the aggregate emission rate would be no greater than 10 percent of the overall facility emissions rate, and thus not as likely to improve visibility at federal Class I areas, based solely on the relatively small potential overall emission decreases from the facility).

The following sections present the source selection, associated emission rates that will be used in the Analysis, and pertinent source configuration and exhaust parameters.

2.1 Sources of PM_{10} Emissions

A summary of the selected emission units and associated PM_{10} emission rates included in the analysis is presented in Table 2-1 (attached). A detailed description of each emissions unit is presented below. The permit emission unit ID is shown in parentheses.

2.1.1 HB Defibrators/Dryers 1 through 4 (HB01, HB02, HB03, HB04)

Wood chips are processed through four defibrators where they are blended with resin and dried. Process exhaust from HB Defibrators/Dryers 1, 2, and 3 is routed to individual cyclones, followed by multiple in-duct water sprays, followed by a Tri-Mer BioSystem (biofilter). Process exhaust from HB04 is routed to a cyclone, followed by a baghouse, followed by multiple in-duct water sprays, followed by a biofilter. HB Defibrators/Dryers 1, 2, 3 and 4 are subject to PCWP MACT. Because they are already fully controlled sources for PM_{10} emissions, HB01, HB02, HB03 and HB04 will be excluded from further evaluation in the Analysis.

2.1.2 PB Surface Dryers (PB06)

Surface material is conveyed to two flash tube PB surface dryers. Each PB surface dryer is indirectly heated so there are no entrained combustion emissions. The dryer process exhaust is controlled by a downstream baghouse (control device ID PB44).

[1] See Federal Guidance Document page 17, under the heading "Use of actual emissions versus allowable emissions."

Both PB surface dryers will be excluded from additional analysis for PM control as they are already equipped with best-in-class pollution control technology, which they are required to operate under the federally-enforceable Title V permit. These dryers are also subject to PCWP MACT. Additionally, the surface dryers have potential annual PM_{10} emissions of only 2.54 tons/year. Given the flowrate from this source, MFA is unaware of any additional particulate controls that could be cost effectively applied given the high efficiency of the existing baghouse controls.

2.1.3 HB Cyclone 7 (HB10)

HB cyclone 7 is used to control particulate emissions generated by the former wire negative air system. The exhaust stream enters the cyclone and centrifugal forces are imparted on larger-diameter particles in the conical chamber. The centrifugal forces influence the larger-diameter particles to move toward the cyclone walls, resulting in collection of PM at the bottom of the cone. Smaller-diameter particles in the exhaust stream are emitted to atmosphere, via fluid drag forces, through an opening located on the top of the cyclone.

2.1.4 HB Cyclone 23 (HB14)

HB cyclone 23 is used to control displaced air during loading and unloading of wood chip storage silos 1, 2 and 3. Silos 1, 2 and 3 store raw wood chips from the chipyard before processing. These raw wood chips have a high moisture content and are assumed to generate minimal PM during loading and unloading processes. Displaced air enters HB cyclone 23 where larger-diameter particles impact the conical chamber and are collected at the bottom of the cone. Smaller-diameter particles in the exhaust stream are emitted to atmosphere, via fluid drag forces, through an opening located on the top of the cyclone.

2.1.5 HB Cyclone 27 (HB15)

HB cyclone 27 is used to control particulate emissions generated by the core metering belt shaver system. The fiber exhaust stream enters the cyclone and centrifugal forces are imparted on larger-diameter particles in the conical chamber. The centrifugal forces influence the larger-diameter particles to move toward the cyclone walls, resulting in collection of PM at the bottom of the cone. Smaller-diameter particles in the exhaust stream are emitted to atmosphere, via fluid drag forces, through an opening located on the top of the cyclone.

2.1.6 HB Bake Oven (HB08) and HB Bake Oven Roof Vents (HB09)

The HB bake oven (HB08) is heated by natural gas-fired combustion and was installed after 1970. The HB bake oven roof vents are situated above emission unit HB08, the hardboard bake oven. Process exhaust from HB08 is routed to the Regenerative Catalytic Oxidizer (RCO) for control of volatile organic compound (VOC) emissions. Entrained filterable and condensable particulate emissions are also combusted in the RCO. and the potential to emit of the RCO is only 2.4 tons/year. Operation of the RCO is required in order to demonstrate compliance with PCWP MACT and the federally-enforceable Title V permit requires continuous parametric monitoring of the device. MFA is unaware of any additional particulate controls that could be cost effectively applied to HB08 given the high efficiency of the existing RCO. Therefore, HB08 will be excluded from additional analysis for PM control.

Racks inside the oven act as a seal during operation. At the end of each cycle as racks are pushed out and new racks are pushed in, fugitive emissions are released to atmosphere through the nearby roof vents (HB09).

2.1.7 PB Core Dryers (PB05)

Core materials are conveyed to two rotary drum PB core dryers. Each PB core dryer is heated by natural gas-fired combustion with a maximum rated design capacity of 10.36 million British thermal units per hour. The moisture content of core material entering the PB core dryers is a maximum of 30 percent moisture and exits with approximately 10 percent moisture. Operating temperature is limited to 600°F. The temperature and moisture limits are required by PCWP MACT and the federally-enforceable Title V permit to minimize the formation of organic emissions that would also form condensable particulate. The combined natural gas-fired burner and dryer process exhaust is controlled by two downstream baghouses (control device IDs PB3 and PB4) which were installed in 1995.

Both PB core dryers will be excluded from additional analysis for PM control as they are already equipped with best-in-class pollution control technology, which they are required to operate under the federally-enforceable Title V permit.

2.1.8 PB Press and Unloader (PB01)

The 14-opening PB press applies heat and pressure to activate the resin in order to bond the wood fibers into solids boards. The PB press produces particleboard ranging between 3/8" to 2-3/16" thick. The PB press was installed after 1970.

Fugitive process exhaust produced by the particleboard presses is routed to the PB biofilter. Testing was conducted by the facility to determine the PM, PM_{10} and $PM_{2.5}$ emission reductions and PM emission reduction credits were allowed based on the results. PB01 is subject to PCWP MACT and is required by the federally-enforceable Title V permit to operate the PB biofilter in order to maintain compliance with that standard. In addition, Addendum No. 3, dated April 6, 2018, to Title V Operating Permit expressly requires that the PB biofilter be operated and maintained as a particulate emissions control device.

2.1.9 PB Trim Saw (PB03)

The PB trim saw is used to trim particleboard sides and ends to final product dimensions. Uncontrolled fugitive particulate emissions are release to atmosphere by nearby roof vents.

2.1.10 PB Cyclone 24 (PB24)

Wood dust from the board trimming process are pneumatically conveyed to process PB cyclone 24, which separates larger-diameter particles from the exhaust stream. Centrifugal forces influence the larger-diameter particles to move toward the cyclone walls, resulting in collection of the larger-diameter wood dust at the bottom of the cone. Collected materials are pneumatically conveyed to PB cyclone 15, which dumps collected material to the reclaim storage pile. Smaller-diameter particles in the exhaust stream are emitted to atmosphere, via fluid drag forces, through an opening located on the top of the cyclone.

2.1.11 Cyclones with Secondary Filters (PB10)

The cyclones with secondary filters handle sanderdust from the board finishing area in the PB plant. Sanderdust from the board finishing process is pneumatically conveyed to PB cyclone 10, which separates larger-diameter particles from the exhaust stream. The exhaust stream exiting the top of PB cyclone 10 is routed to a downstream baghouse for control of fine particulate emissions. The particleboard cyclones with secondary filters will be excluded from additional analysis for PM control as they are already equipped with best-in-class pollution control technology, which they are required to operate under the federally-enforceable Title V permit. Additionally, PB10 has potential annual PM_{10} emissions of only 2.98 tons/year. Given the flowrate from this source, MFA is unaware of any additional particulate controls that could be cost effectively applied given the high efficiency of the existing baghouse controls.

2.2 Sources of SO_2 Emissions

A summary of the selected emission units and associated SO_2 emission rates to be evaluated in the Analysis is presented in Table 2-2 (attached). The Title V review report (page 37 of 92) still identifies the facility as having the potential to emit 49.3 tons/year of SO_2 from PB05 based on the combustion of 1.39 million gallons of fuel oil annually. In fact, the fuel oil infrastructure has been removed and as the Title V review report (page 39 of 92) shows, the last time that fuel oil was combusted in the PB core dryers was in 2000 when 333 gallons were consumed. As the PB core dryers no longer have the capacity to burn fuel oil and are now only capable of burning natural gas, the potential to emit equals the device's maximum capacity to emit SO_2 while burning natural gas. References to fuel oil combustion by the PB core dryers will be removed as part of the permit renewal currently underway. The PB core dryers have a combined maximum heat input of 20.7 MMBtu/hr which limits the dryers to an SO_2 potential to emit of 0.5 tons/year. Given that the reductions for small sources likely would not improve visibility and would not be cost effective, these activities will not be evaluated further in the Analysis.

2.3 Sources of NO_X Emissions

A summary of the selected emission units and associated NO_X emission rates to be evaluated in the Analysis is presented in Table 2-3 (attached). As noted in Section 2.2, the PB core dryers no longer have the ability to burn fuel oil. The PB core dryers have a combined maximum heat input of 20.7

MMBtu/hr which limits the dryers to a NOx potential to emit of 8.9 tons per year when burning natural gas.

Because of the limited combustion sources at the facility, the Title V permit contains a generic PSEL for NOx of 39 tons/year. Actual emissions are substantially lower (6.9 tons in 2019). Given that the reductions for small sources likely would not improve visibility and would not be cost effective, these activities will not be evaluated further in the Analysis.

2.4 Emissions Unit Exhaust Parameters

A summary of the emission unit exhaust parameters to be evaluated further in this Analysis is presented in Table 2-4 (attached). Emission units identified in the preceding sections as infeasible for control, already equipped with best-in-class control technologies or otherwise exempt are not presented. These emissions units will not be evaluated further in this Analysis.

3 REGIONAL HAZE FOUR FACTOR ANALYSIS METHODOLOGY

This Analysis has been conducted consistent with the Federal Guidance Document, which outlines six steps to be taken when addressing the four statutorily required factors included in the Analysis. These steps are described in the following sections.

3.1 Step 1: Determine Emission Control Measures to Consider

Identification of technically feasible control measures for visibility-impairing pollutants is the first step in the Analysis. While there is no regulatory requirement to consider all technically feasible measures, or any specific controls, a reasonable set of measures must be selected. This can be accomplished by identifying a range of options, which could include add-on controls, work practices that lead to emissions reductions, operating restrictions, or upgrades to less efficient controls, to name a few.

3.2 Step 2: Selection of Emissions

Section 2 details the method for determining the emission units and emission rates to be used in the Analysis. Potential to emit emission rates were obtained from the existing permit review report.

3.3 Step 3: Characterizing the Cost of Compliance (Statutory Factor 1)

Once the sources, emissions, and control methods have all been selected, the cost of compliance is estimated. The cost of compliance, expressed in units of dollars per ton of pollutant controlled ($/ton), describes the cost associated with the reduction of visibility-impairing pollutants. Specific costs associated with operation, maintenance, and utilities at the facility are presented in Table 3-1 (attached).

The Federal Guidance Document recommends that cost estimates follow the methods and recommendations in the Control Cost Manual. This includes the recently updated calculation spreadsheets that implement the revised chapters of the Control Cost Manual. The Federal Guidance Document recommends using the generic cost estimation algorithms detailed in the Control Cost Manual in cases where site-specific cost estimates are not available.

Additionally, the Federal Guidance Document recommends using the Control Cost Manual in order to effect an "apples-to-apples" comparison of costs across different sources and industries.

3.4 Step 4: Characterizing the Time Necessary for Compliance (Statutory Factor 2)

Characterizing the time necessary for compliance requires an understanding of construction timelines, which include planning, construction, shake-down and, finally, operation. The time that is needed to complete these tasks must be reasonable and does not have to be "as expeditiously as practicable…" as is required by the Best Available Retrofit Technology regulations.

3.5 Step 5: Characterize Energy and non-Air Environmental Impacts (Statutory Factor 3)

Both the energy impacts and the non-air environmental impacts are estimated for the control measures that were costed in Step 3. These include estimating the energy required for a given control method, but do not include the indirect impacts of a particular control method, as stated in the Federal Guidance Document.

The non-air environmental impacts can include estimates of waste generated from a control measure and its disposal. For example, nearby water bodies could be impacted by the disposed-of waste, constituting a non-air environmental impact.

3.6 Step 6: Characterize Remaining Useful Life of Source (Statutory Factor 4)

The Federal Guidance Document highlights several factors to consider when characterizing the remaining useful life of the source. The primary issue is that often the useful life of the control measure is shorter than the remaining useful life of the source. However, it is also possible that a source is slated to be shut down well before a control device would be cost effective.

4 PM10 ANALYSIS

The Analysis for PM_{10} emissions follows the six steps previously described in Section 3.

4.1 Step 1 – Determine PM_{10} Control Measures for Consideration

4.1.1 Baghouse

Baghouses, or fabric filters, are common in the wood products industry. In a fabric filter, flue gas is passed through a tightly woven or felted fabric, causing PM in the flue gas to collect on the fabric by sieving and other mechanisms. Fabric filters may be in the form of sheets, cartridges, or bags, with a number of the individual fabric filter units housed together in a group. Bags are one of the most common forms of fabric filter. The dust cake that forms on the filter from the collected PM can significantly increase collection efficiency. The accumulated particles are periodically removed from the filter surface by a variety of mechanisms and are collected in a hopper for final disposition.

Typical new equipment design efficiencies are between 99 and 99.9 percent. Several factors determine fabric filter collection efficiency. These include gas filtration velocity, particle characteristics, fabric characteristics, and the cleaning mechanism. In general, collection efficiency increases with decreasing filtration velocity and increasing particle size. Fabric filters are generally less expensive than electrostatic precipitators (ESPs) and they do not require complicated control systems. However, fabric filters are subject to plugging for certain exhaust streams and do require maintenance and inspection to ensure that plugging or holes in the fabric have not developed. Regular replacement of the filters is required, resulting in higher maintenance and operating costs.

Certain process limitations can affect the operation of baghouses in some applications. For example, exhaust streams with very high temperatures (i.e., greater than 500 degrees Fahrenheit [°F]) may require specially formulated filter materials and/or render baghouse control infeasible. Additional challenges include the particle characteristics, such as materials that are "sticky" and tend to impede the removal of material from the filter surface. Exhaust gases that exhibit corrosive characteristics may also impose limitations on the effectiveness of baghouses. In wood products applications it is expected that particle characteristics, specifically particle and exhaust moisture content, may limit the feasibility on implementation. However, for some sources, baghouses are considered technically feasible.

4.1.2 Wet Venturi Scrubber

Wet scrubbers remove particulate from gas streams primarily by inertial impaction of the particulate onto a water droplet. In a venturi scrubber, the gas is constricted in a throat section. The large volume of gas passing through a small constriction gives a high gas velocity and a high pressure drop across the system. As water is introduced into the throat, the gas is forced to move at a higher velocity, causing the water to shear into fine droplets. Particles in the gas stream then impact the water droplets. The entrained water droplets are subsequently removed from the gas stream by a cyclonic separator. Venturi scrubber control efficiency increases with increasing pressure drops for a given particle size. Control efficiency increases with increasing liquid-to-gas ratios up to the point where flooding of the system occurs. Control efficiencies are typically around 90 percent for particles with a diameter of 2.5 microns or larger.

Although wet scrubbers mitigate air pollution concerns, they also generate a water pollution concern. The effluent wastewater and wet sludge stream created by wet scrubbers requires that the operating facility have a water treatment system and subsequent disposal system in place. These consequential systems increase the overall cost of wet scrubbers and cause important environmental impacts to consider.

The facility operates a closed-loop wastewater system for its existing process water, stormwater and sanitary water. The system currently operates at maximum capacity for the management of wastewater and wet sludge and is unable to accommodate any additional wastewater streams. Additionally, since there are no municipal water treatment plants approved to accept industrial wastewater effluents, there are no off-site options for wastewater management. Therefore, wet control technologies are considered infeasible for the facility and will not be evaluated further in the Analysis.

4.1.3 Electrostatic Precipitator

ESPs are used extensively for control of PM emissions. An ESP is a particulate control device that uses electrical force to move particles entrained with a gas stream onto collection surfaces. An electrical charge is imparted on the entrained particles as they pass through a corona, a region where gaseous ions flow. Electrodes in the center of the flow lane are maintained at high voltage and generate the corona that charges the particles, thereby allowing for their collection on the oppositely charged collector walls. In wet ESPs, the collectors are either intermittently or continuously washed by a spray of liquid, usually water. Instead of the collection hoppers used by dry ESPs, wet ESPs utilize a drainage system and water treatment of some sort. In dry ESPs, the collectors are knocked, or "rapped," by various mechanical means to dislodge the collected particles, which slide downward into a hopper for collection.

Typical control efficiencies for new installations are between 99 and 99.9 percent. Older existing equipment has a range of actual operating efficiencies of 90 to 99.9 percent. While several factors determine ESP control efficiency, ESP size is the most important because it determines the exhaust residence time; the longer a particle spends in the ESP, the greater the chance of collecting it. Maximizing electric field strength will maximize ESP control efficiency. Control efficiency is also affected to some extent by particle resistivity, gas temperature, chemical composition (of the particle and gas), and particle size distribution.

Similar to wet scrubber control systems, wet ESPs also create a water pollution concern as they reduce air pollution. Use of wet ESPs generates a wastewater and wet sludge effluent that requires treatment and subsequent disposal. As noted in Section 4.1.2, the wastewater system at the facility currently operates at maximum capacity and is unable to accommodate any additional wastewater streams. Therefore, wet ESPs are considered infeasible for the facility and will not be evaluated further in the Analysis.

The use of dry ESPs with suspended particulates is a safety hazard as the particulate dust may explode if exposed to an ignition source such as spark between the charged ESP plates. Thus, based on the low moisture content of the exhaust streams, and the facility's concerns regarding potential fire or explosion hazards, dry ESPs are considered infeasible for the facility and will not be evaluated further in the Analysis.

4.2 Step 2 – Selection of Emissions

See Section 2.1 for descriptions of the PM_{10} emission units and emission rates selected for the Analysis.

4.3 Step 3 – Characterizing the Cost of Compliance

Table 4-2 (attached) presents the detailed cost analyses of the technically feasible PM_{10} control technologies included in the Analysis. A summary of the cost of compliance, expressed in $/ton, is shown below in Table 4-1:

Table 4-1
Cost of Compliance Summary for PM_{10}

Emissions Unit	Emissions Unit ID	Cost of Compliance ($/ton)
		Baghouse
Particleboard Press and Unloader	PB01	36,664
Trim Saw Vent	PB03	24,639
Cyclone PB24	PB08	24,763
Bake Oven Roof Vent	HB09	26,985
Cyclone HB7	HB10	25,942
Cyclone HB23	HB14	25,782
Cyclone HB27	HB15	49,642

4.4 Step 4 – Characterizing the Time Necessary for Compliance

Several steps will be required before the control device is installed and fully operational. After selection of a control technology, all of the following will be required: permitting, equipment procurement, construction, startup and a reasonable shakedown period, and verification testing. It is anticipated that it will take up to 18 months to achieve compliance.

4.5 Step 5 – Characterizing the Energy and non-Air Environmental Impacts

4.5.1 Energy Impacts

Energy impacts can include electricity and/or supplemental fuel used by a control device. Electricity use can be substantial for large projects if the control device uses large fans, pumps, or motors. Baghouse control systems require significant electricity use to operate the powerful fans required to overcome the pressure drop across the filter bags. Dry ESPs are expected to require even more electricity than baghouses, since high-voltage electricity is required for particle collection and removal. Dry ESPs also require powerful fans to maintain exhaust flow through the system. Similarly, wet venturi scrubbers and wet ESPs will use significant amounts of electricity to power large pumps used to supply water for the control device and the subsequent treatment process.

4.5.2 Environmental Impacts

Expected environmental impacts for baghouses and dry ESPs include the management of materials collected by the control devices. For sources where this material is clean wood residuals, it may be possible to reuse the material in the production process. However, collected materials that are degraded or that contain potential contaminants would be considered waste materials requiring disposal at a landfill.

As mentioned above, wet venturi scrubbers and wet ESPs generate liquid waste streams, creating a water pollution issue. The effluent of wastewater and wet sludge generated by both control technologies will require the facility to have in place an appropriately sized water treatment system and subsequent waste disposal system and/or procedure. These systems increase the overall cost of installation and cause important environmental impacts to consider.

While none of the control technologies evaluated in the PM_{10} Analysis would require the direct consumption of fossil fuels, another, less quantifiable, impact from energy use may result from producing the electricity (i.e., increased greenhouse gases and other pollutant emissions). In addition, where fossil fuels are used for electricity production, additional impacts are incurred from the mining/drilling and use of fossil fuels for combustion.

4.6 Step 6 – Characterize the Remaining Useful Life

It is anticipated that the remaining life of the emissions units, as outlined in the Analysis, will be longer than the useful life of the technically feasible control systems. No emissions units are subject to an enforceable requirement to cease operation. Therefore, in accordance with the Federal Guidance Document, the presumption is that the control system would be replaced by a like system at the end of its useful life. Thus, annualized costs in the Analysis are based on the useful life of the control system rather than the useful life of the emissions units.

5 SO_2 ANALYSIS

SO_2 emissions from the plant are negligible. Given the reductions for a small source likely would not improve visibility and would not be cost effective, these activities will not be evaluated further in the Analysis.

6 NO_X ANALYSIS

Because of the limited combustion sources at the facility, the Title V permit contains a generic PSEL for NOx of 39 tons/year. Actual emissions are substantially lower (6.9 tons in 2019). Given that the reductions for small sources likely would not improve visibility and would not be cost effective, these activities will not be evaluated further in the Analysis.

7 CONCLUSION

This report presents cost estimates associated with installing control devices at the Klamath Falls facility in order to reduce visibility-impairing pollutants in Class I areas and provides the Four Factor Analysis conducted consistent with available DEQ and USEPA guidance documents. Collins believes that the above information meets the state objectives and is satisfactory for the DEQ's continued development of the SIP as a part of the Regional Haze program.

Based on the costs described above for the controls under consideration, there does not appear to be any control device that, on a dollar per ton of pollutant-controlled basis, would be considered cost effective. In addition, given the extensive pollution controls already in place at the facility, any additional controls would result in limited visibility improvement. In the absence of significant visibility improvement, it would not be appropriate to require investment in additional controls at a wood products facility in an economically challenged part of the state.

LIMITATIONS

The services undertaken in completing this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this report.

TABLES

Table 2-1
PM_{10} Evaluation for Regional Haze Four Factor Analysis
Collins Products, LLC. - Klamath Falls, Oregon

Emission Units [(1)]	Emission Unit ID(s)	Current PM_{10} Control Technology [(1)]	Pollution Control Device ID	Annual PM_{10} Emissions [(2)] (tons/yr)	Control Evaluation Proposed?	Rationale for Exclusion from Control Evaluation	Emission Controls To Be Evaluated
Defibrators/Dryer (x 3)	HB01-HB03	Cyclone, Biofilter	HB50 (Biofilter)	33.5	No	Sources are already controlled. Process exhaust is routed to individual cyclones, followed by in-duct water sprays, followed by a biofilter.	--
Core Dryers	PB05	Baghouses	PB3, PB4	30.6	No	Sources are already equipped with best-in-class controls. Process exhaust from the core dryers is routed to two downstream baghouses (PB3 and PB4).	--
Particleboard Press and Unloader Area	PB01	Biofilter	PB45	16.1	Yes	--	Baghouses, Venturi Scrubbers, Electrostatic Precipitator
Trim Saw Vent	PB03	--	--	11.9	Yes	--	Baghouses, Venturi Scrubbers, Electrostatic Precipitator
Cyclone PB24	PB08	--	--	11.1	Yes	--	Baghouses, Venturi Scrubbers, Electrostatic Precipitator
Bake Oven Roof Vents	HB09	--	--	10.8	Yes	--	Baghouses, Venturi Scrubbers, Electrostatic Precipitator
Cyclone HB7	HB10	--	--	8.66	Yes	--	Baghouses, Venturi Scrubbers, Electrostatic Precipitator
Cyclone HB23	HB14	--	--	8.71	Yes	--	Baghouses, Venturi Scrubbers, Electrostatic Precipitator
Cyclone HB27	HB15	--	--	4.52	Yes	--	Baghouses, Venturi Scrubbers, Electrostatic Precipitator
Cyclones w/ Secondary Filters	PB10	Bagfilters	PB35, PB36, PB37	2.98	No	Sources already are equipped with best in class controls.	--
Surface Dryers	PB06	Baghouse	PB44	2.54	No	Sources already are equipped with best in class controls.	--
All Other Emission Units	Varies	Varies per Emission Unit	--	13.4 [(3)]	No	These emission units fall below the 90th percentile threshold. Only the top 90th percentile of emission units contributing to the total facility emission rate will be evaluated.	--

NOTES:
PM_{10} = Particulate matter with an aerodynamic diameter of 10 microns or less.

REFERENCES:
(1) Information from the Title V Operating Permit no. 18-0013-TV-01 issued January 6, 2015 by the Oregon DEQ.
(2) Information from the Review Report for the Title V Operating Permit no. 18-0013-TV-01 issued January 6, 2015 by the Oregon DEQ.
(3) The annual PM_{10} emissions estimate of 13.4 tons per year represents the sum total of annual PM_{10} emissions from all emission units collectively comprising less than 10% of the total facility PM_{10} emissions rate.
The maximum annual PM_{10} emissions estimate, from a single emissions unit within this grouping, is only 2.44 tons per year.

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Table 2-2
SO_2 Evaluation for Regional Haze Four Factor Analysis
Collins Products, LLC. - Klamath Falls, Oregon

Emission Units [1]	Emission Unit ID(s)	Current SO_2 Control Technology [1]	Annual SO_2 Emissions [2] (tons/yr)	Control Evaluation Proposed?	Rationale for Exclusion from Control Evaluation	Emission Controls To Be Evaluated
Aggregate Insignificant Activities	Varies	--	1.00	No	Emission controls for 1 ton/yr would not improve visibility and would not be cost effective.	--
Core Dryers	PB05	--	0.50	No	PB Core Dryers no longer have the ability to burn fuel oil and only have the potential to emit 0.5 tons/yr of SO_2 when burning natural gas. Emission controls would not improve visibility and would not be cost effective.	--
All Other Emission Units	Varies	--	0.046	No	These emission units fall below the 90th percentile threshold. Only the top 90th percentile of emission units contributing to the total facility emission rate will be evaluated.	--

NOTES:
SO_x = Sulfur dioxide

REFERENCES:
(1) Information from the Title V Operating Permit no. 18-0013-TV-01 issued January 6, 2015 by the Oregon DEQ.
(2) Information from the Review Report for the Title V Operating Permit no. 18-0013-TV-01 issued January 6, 2015 by the Oregon DEQ.

Table 2-3
NO_X Evaluation for Regional Haze Four Factor Analysis
Collins Products, LLC. - Klamath Falls, Oregon

Emission Units (1)	Emission Unit ID(s)	Current NO_X Control Technology (1)	Annual NO_X Emissions (2) (tons/yr)	Control Evaluation Proposed?	Rationale for Exclusion from Control Evaluation	Emission Controls To Be Evaluated
Core Dryers	PB05	--	8.88	No	PB Core Dryers no longer have the ability to burn fuel oil and only have the potential to emit 8.88 tons/yr of NO_x when burning natural gas. Emission controls would not improve visibility and would not be cost effective.	--
Hardboard Coating Ovens	HB17	--	6.90	Yes	Emission controls would not improve visibility and would not be cost effective.	--
Bake Oven	HB08	--	3.52	Yes	Emission controls would not improve visibility and would not be cost effective.	--
All Other Emission Units	Aggregate Insignificant	--	1.00	No	These emission units fall below the 90th percentile threshold. Only the top 90th percentile of emission units contributing to the total facility emission rate will be evaluated.	--

NOTES:
NO_x = Oxides of nitrogen

REFERENCES:
(1) Information from the Title V Operating Permit no. 18-0013-TV-01 issued January 6, 2015 by the Oregon DEQ.
(2) Information from the Review Report for the Title V Operating Permit no. 18-0013-TV-01 issued January 6, 2015 by the Oregon DEQ.

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Table 2-4
Emissions Unit Input Assumptions and Exhaust Parameters
Collins Products, LLC. - Klamath Falls, Oregon

Emissions Unit ID	Emissions Unit Description	Control Evaluation Proposed? (Yes/No)			Heat Input Capacity (MMBtu/hr)	Exhaust Parameters		
						Exit Temperature (°F)	Exit Flowrate	
		PM_{10}	NO_X	SO_2			(acfm) [1]	(scfm)
HB01 - HB03	Defibrators/Dryers	Yes	No	No	--	199 [1]	56,208	39,029 [a]
HB08	Bake Oven	No	Yes	No	10.6 [1]	271 [1]	28,879	18,056 [1]
HB09	Bake Oven Roof Vents	Yes	No	No	--	70.6 [1]	19,364	16,712 [1]
HB10	Cyclone HB7	Yes	No	No	--	70 [2]	5,827	5,031 [a]
HB14	Cyclone HB23	Yes	No	No	--	70 [2]	5,827	5,031 [a]
HB15	Cyclone HB27	Yes	No	No	--	70 [2]	5,827	5,031 [a]
HB17	Hardboard Coating Ovens	No	Yes	No	38.6 [1]	271 [1]	28,879	18,083 [a]
PB01	Particleboard Press and Unloader Area	Yes	No	No	--	77.7 [1]	78,862	67,165 [1]
PB03	Trim Saw Vent	Yes	No	No	--	220 [1]	19,364	13,027 [a]
PB05	Core Dryers	No	No	No	20.7 [3]	141 [1]	15,160	10,641 [1]
PB08	Cyclone PB24	Yes	No	No	--	70 [2]	15,970	13,788 [a]

NOTES:

acfm = actual cubic feet per minute.

°F = degree fahrenheit

ft/sec = feet per second.

MMBtu/hr = million British thermal units per hour.

NO_x = Oxides of nitrogen

PM_{10} = Particulate matter with an aerodynamic diameter of 10 micron or less

scfm = standard cubic feet per minute.

SO_x = Sulfur dioxide

(a) Exit flowrate (scfm) = (exit flowrate [acfm]) x (1 - [6.73E-06] x [facility elevation above sea level {ft}])$^{5.258}$ x (530) / (460 + [exit temperature {°F}])

Facility elevation above sea level (ft) = 4,094 (4)

REFERENCES:

(1) Data provided by Collins Products, LLC.

(2) Assumes an ambient temperature of 70°F.

(3) Information from the Review Report for the Title V Operating Permit no. 18-0013-TV-01 issued January 6, 2015 by the Oregon DEQ.

(4) Elevation above sea level obtained from publicly available online references.

Table 3-1
Operating and Maintenance Rates
Collins Products, LLC. - Klamath Falls, Oregon

Parameter	Value (units)		
FACILITY OPERATIONS			
Annual Hours of Operation	8,760	(hrs/yr)	(1)
Annual Days of Operation	365	(day/yr)	(1)
Daily Hours of Operation	24.0	(hrs/day)	(1)
UTILITY COSTS			
Electricity Rate	0.064	($/kWh)	(2)
Natural Gas Rate	5.22	($/MMBtu)	(2)
Water Rate	10.0	($/Mgal)	(2)
Compressed Air Rate	0.004	($/Mscf)	(2)
Landfill Disposal Fee	74.0	($/ton)	(2)
LABOR COSTS			
Maintenance Labor Rate	25.18	($/hr)	(2)
Operating Labor Rate	18.63	($/hr)	(2)
Supervisory Labor Rate	35.00	($/hr)	(2)
Typical Shifts per Day	3.00	(shifts/day)	(2)

NOTES:

Mgal = thousand gallons.

MW-hr = megawatt-hour.

scf = standard cubic feet.

REFERENCES:

(1) Assumes continuous annual operation.

(2) Data provided by Collins Products, LLC.

Table 4-2
Cost Effectiveness Derivation for Baghouse Installation
Collins Products, LLC. - Klamath Falls, Oregon

Emissions Unit ID	Emissions Unit Description	Input Parameters		Pollutant Removed by Control Device (a) (tons/yr)	Operating Parameter	
		Exhaust Flowrate (1) (acfm)	PM_{10} Annual Emissions Estimate (2) (tons/yr)		Electrical Requirements (3) (kW)	Number of Filter Bags Required (4)
HB09	Bake Oven Roof Vents	19,364	10.8	10.7	88.7	250
HB10	Cyclone HB7	5,827	8.66	8.57	39.5	82
HB14	Cyclone HB23	5,827	8.71	8.63	39.5	82
HB15	Cyclone HB27	5,827	4.52	4.47	39.5	82
PB01	Particleboard Press and Unloader Area	78,862	16.1	15.9	306.5	987
PB03	Trim Saw Vent	19,364	11.9	11.7	88.7	250
PB08	Cyclone PB24	15,970	11.1	11.0	76.8	208

Emissions Unit ID	Emissions Unit Description	Direct Costs			Total Indirect Costs (d)	Total Capital Investment (e)	Capital Recovery Cost				Direct Annual Costs								Total Direct Annual Costs (14)	Total Indirect Annual Costs (o)	Total Annual Cost (p)	Annual Cost Effectiveness (q)
		Purchased Equipment Cost		Total Direct Cost (c)			Control Device (f)	Replacement Parts			Operating Labor		Maintenance		Utilities							
		Basic Equip./Services Cost (4)	Total (b)					Filter Bag Cost (4)	Bag Labor Cost (h)	Filter Bag (i)	Operator Cost (j)	Supervisor Cost (k)	Labor Cost (j)	Material Cost (14)	Electricity Cost (l)	Compressed Air Cost (m)	Landfill Cost (n)					
USEPA COST MANUAL VARIABLE		A	B	DC	IC	TCI	CRC_D	C_B	C_L	CFC_B	--	--	--	--	--	--	--	DAC	IAC	TAC	($/ton)
HB09	Bake Oven Roof Vents	$106,809	$126,034	$219,300	$56,715	**$276,015**	$21,681	$3,763	$1,574	$1,581	$40,800	$6,120	$27,572	$27,572	$50,053	$40,711	$793	$195,202	$72,279	**$289,162**	**$26,985**
HB10	Cyclone HB7	$76,367	$90,113	$156,796	$40,551	**$197,347**	$15,502	$1,233	$516	$518	$40,800	$6,120	$27,572	$27,572	$22,293	$12,251	$634	$137,760	$69,132	**$222,394**	**$25,942**
HB14	Cyclone HB23	$76,367	$90,113	$156,796	$40,551	**$197,347**	$15,502	$1,233	$516	$518	$40,800	$6,120	$27,572	$27,572	$22,293	$12,251	$638	$137,764	$69,132	**$222,398**	**$25,782**
HB15	Cyclone HB27	$76,367	$90,113	$156,796	$40,551	**$197,347**	$15,502	$1,233	$516	$518	$40,800	$6,120	$27,572	$27,572	$22,293	$12,251	$331	$137,456	$69,132	**$222,090**	**$49,642**
PB01	Particleboard Press and Unloader Area	$240,608	$283,917	$494,016	$127,763	**$621,779**	$48,841	$14,883	$6,213	$6,249	$40,800	$6,120	$27,572	$27,572	$172,874	$165,799	$1,177	$448,163	$86,109	**$583,113**	**$36,664**
PB03	Trim Saw Vent	$106,809	$126,034	$219,300	$56,715	**$276,015**	$21,681	$3,763	$1,574	$1,581	$40,800	$6,120	$27,572	$27,572	$50,053	$40,711	$869	$195,278	$72,279	**$289,238**	**$24,639**
PB08	Cyclone PB24	$99,176	$117,028	$203,629	$52,663	**$256,292**	$20,132	$3,129	$1,309	$1,315	$40,800	$6,120	$27,572	$27,572	$43,324	$33,575	$815	$181,092	$71,490	**$272,714**	**$24,763**

Table 4-2
Cost Effectiveness Derivation for Baghouse Installation
Collins Products, LLC. - Klamath Falls, Oregon

NOTES:

(a) Pollutant removed by control device (tons/yr) = (PM_{10} annual emissions estimate [tons/yr]) x (baghouse control efficiency [%] / 100)

Baghouse control efficiency (%) =	99.0	(4)

(b) Total purchased equipment cost ($) = (1.18) x (basic equipment/services cost [$]); see reference (5).

(c) Total direct cost ($) = (1.74) x (total purchased equipment cost [$]) + (site preparation cost, SP [$]) + (building cost, Bldg. [$]); see reference (5).

Site preparation cost, SP ($) =	0	(6)
Building cost, Bldg. ($) =	0	(6)

(d) Total indirect cost ($) = (0.45) x (total purchased equipment cost [$]); see reference (5).

(e) Total capital investment ($) = (total direct cost [$]) + (total indirect cost [$]); see reference (5).

(f) Control device capital recovery cost ($) = (total capital investment [$]) x (control device capital recovery factor); see reference (7)

Control device capital recovery factor =	0.0786	(g)

(g) Capital recovery factor = (interest rate [%] /100) x (1+ [interest rate {%} / 100]^[economic life {yrs}]) / ([1 + {interest rate |%| / 100}]^[economic life {yrs}] - 1); see reference (8).

Interest rate (%) =	4.75	(9)
Baghouse economic life (yr) =	20	(10)
Filter bag economic life (yr) =	4	(4)

(h) Bag replacement labor cost ($) = (total time required to change one bag [min/bag]) x (hr/60 min) x (number of filter bags required [bags]) x (maintenance labor rate [$/hr])

total time required to change one bag (min/bag) =	15	(12)
Maintenance labor rate ($/hr) =	25.18	(13)

(i) Filter bag capital recovery cost ($) = ([initial filter bag cost {$}] x (1.08) + [bag replacement labor cost {$}]) x (filter bag capital recovery factor); see reference (13).

Filter bag capital recovery factor =	0.2804	(g)

(j) Operator or maintenance labor cost ($) = (operator or maintenance hours per shift [hrs/shift]) x (operating shifts per day [shifts/day]) x (annual days of operation [days/yr]) x (operator or maintenance labor rate [$/hr])

Operating labor hours per shift (hrs/shift) =	2	(13)
Maintenance labor hours per shift (hrs/shift) =	1	(13)
Shifts per day (shifts/day) =	3	(13)
Annual days of operation (days/yr) =	365	(13)
Operator labor rate ($/hr) =	18.63	(13)
Maintenance labor rate ($/hr) =	25.18	(13)

(k) Supervisor labor cost ($) = (0.15) x (operating labor cost [$]); see reference (13).

(l) Annual electricity cost ($) = (electricity rate [$/kWh]) x (total power requirement [kWh]) x (annual hours of operation [hrs/yr])

Electricity rate ($/kWh) =	0.064	(13)
Annual hours of operation (hrs/yr) =	8,760	(13)

(m) Annual compressed air cost ($) = (compressed air cost [$/Mscf]) x (Mscf/1,000 scf) x (exhaust flowrate [acfm]) x (60 min/hr) x (annual hours of operation [hrs/yr])

Compressed air cost ($/Mscf) =	0.0040	(13)
Annual hours of operation (hrs/yr) =	8,760	(13)

(n) Annual landfill cost ($) = (landfill disposal rate [$/ton]) x (pollutant removed by control device [tons/yr])

Landfill disposal rate ($/ton) =	74.00	(13)

(o) Total indirect annual cost ($) = (0.60) x ([operator cost {$}] + [superviser cost {$}] + [maintenance cost {$}] + [maintenance material cost {$}]) + (0.04) x (total capital investment [$]); see reference (13).

(p) Total annual cost ($) = (total direct annual cost [$]) + (total indirect annual cost [$]) + (control device capital recovery cost [$])

(q) Annual cost effectiveness ($/ton) = (total annual cost [$/yr]) / (pollutant removed by control device [tons/yr])

REFERENCES:

(1) See Table 2-4, Emissions Unit Input Assumptions and Exhaust Parameters.
(2) See Table 2-1, PM_{10} Evaluation for Regional Haze Four Factor Analysis.
(3) Western Pneumatics, Inc. Quotation #P30733DJB dated January 28, 2020. In the quote, costs and equipment requirements for three differently sized baghouses (5,000 cfm, 20,000 cfm, and 50,000 cfm) are presented. For the smallest exhaust flowrate above (MC4), these quoted data was scaled using a ratio. All other costs/data were scaled and obtained using tread line formulas. It is important to note that the quoted costs do not include the costs associated with taxes, installation of equipment, all concrete work (excavation, engineering, plumbing, electrical), building/foundation upgrades, and permitting or licensing.
(4) US EPA Air Pollution Control Technology Fact Sheet (EPA-452/F-03-025) for baghouse (fabric filter), pulse-jet cleaned type issued July 15, 2003. Assumes minimum typical new equipment design efficiency.
(5) US EPA Air Pollution Control Cost Manual, Section 6, Chapter 1 "Baghouse and Filters" issued December 1998. See Table 1.9 "Capital Cost Factors for Fabric Filters." The 1.18 factor includes instrumentation, sales tax, and freight.
(6) Conservatively assumes no costs associated with site preparation or building requirements.
(7) US EPA Air Pollution Control Cost Manual, Section 1, Chapter 2 "Cost Estimation: Concepts and Methodology" issued on February 1, 2018. See equation 2.8.
(8) US EPA Air Pollution Control Cost Manual, Section 1, Chapter 2 "Cost Estimation: Concepts and Methodology" issued on February 1, 2018. See equation 2.8a.
(9) See the Regional Haze: Four Factor Analysis fact sheet prepared by the Oregon DEQ. Assumes the EPA recommended bank prime rate of 4.75% as a default.
(10) US EPA Air Pollution Control Cost Manual, Section 6, Chapter 1 "Baghouse and Filters" issued December 1998. See section 1.5.2.
(11) Western Pneumatics, Inc. Quotation #P30733DJB dated January 28, 2020. Typical bag filter life is 4 years.
(12) US EPA Air Pollution Control Cost Manual, Section 6, Chapter 1 "Baghouse and Filters" issued December 1998. See section 1.5.1.4.

(13) See Table 3-1, Utility and Labor Rates.

(14) US EPA Air Pollution Control Cost Manual, Section 6, Chapter 1 "Baghouse and Filters" issued December 1998. See section 1.5.