

Continuous Dry Kiln No. 2 Construction Permit Application

Harrigan Lumber Company

1033 Hornady Road
Monroeville, AL 36460

August 2019

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1 EXECUTIVE SUMMARY

Harrigan Lumber Company (Harrigan) operates a lumber sawmill at 1033 Hornady Road in Monroeville, Monroe County, Alabama. The mill currently operates under Major Source Operating Permit No. 106-S005 effective October 13, 2018.

With this application, Harrigan proposes construction and operation of a continuous lumber drying kiln direct fired by natural gas (CDK-2). The proposed CDK will have the production capacity of 110 million board feet per year (MMBf/yr) and will be directly heated by a 45 MMBtu/hr rated natural gas fired burner. CDK-2 will replace Batch Kiln #3 (K-3) which burned in March 2019. Two kiln condensate evaporators are included in this project (CE-1 and CE-2). The evaporators will each have a natural gas burner capacity of 5.3 MMBtu/hr and allow for one evaporator to be in service while the other is down for maintenance. Aside from the construction of CDK-2 and the evaporators, there will be no other physical modifications to the facility.

The facility equipment proposed for permitting is shown in Table 1-1.

Table 1-1 Permitted Equipment

Emissions Unit	Currently Permitted Equipment	Post Project Permitted Equipment
EU001 Green Lumber Sawing Process	Six (6) Ripping Saws and Two (2) Cut-Off Saws	No Change: Six (6) Ripping Saws and Two (2) Cut-Off Saws
EU003 Lumber Dry Kilns	CDK-1 K-3 K-4	CDK-1 CDK-2 CE-1/CE-2 K-4
EU005 Planer Mill Operations	C-1 C-2A C-2B C-3	No Change: C-1 C-2A C-2B C-3
EU006 Sawdust Transfer and Storage Operations	C-4A C-4B C-5	No Change: C-4A C-4B C-5
E007 Emergency Fire Pump Engine	66 Hp Diesel-Fired Emergency Fire Pump	No Change: 66 Hp Diesel-Fired Emergency Fire Pump

The facility-wide potential emissions before and after the project are shown in Table 1-2.

Table 1-2 Summary of Facility-Wide Potential to Emit

Description	Pollutant	Currently Permitted Emissions (tpy)	Post Project Potential Emissions (tpy)
Criteria Pollutants	PM	52.928	53.575
	PM ₁₀	45.125	45.713
	PM _{2.5}	27.080	27.433
	VOC	328.588	513.005
	SO ₂	8.651	7.151
	CO	207.612	188.247
	NO _x	93.863	75.884
Hazardous Air Pollutants	Highest Single HAP	13.140	20.424
	Total HAP	30.570	41.222
Greenhouse Gases	CO _{2e}	71,604	86,693

The project will increase emissions to the level that review as a major modification of the New Source Review (NSR) program through Prevention of Significant Deterioration (PSD) permitting is required as shown in Table 1-3. Only volatile organic compounds (VOC) requires PSD permitting. This application contains the necessary PSD construction permit and Title V operating permit modification elements related to the proposed project.

Table 1-3 Proposed Project Emission Increases

Pollutant	Total Emission Increase (tpy)	PSD SER Threshold (tpy)	PSD Permitting Triggered?
Particulate Matter (PM)	2.522	25	No
Particulate Matter less than 10 microns (PM ₁₀)	3.809	15	No
Particulate Matter less than 2.5 microns (PM _{2.5})	3.517	10	No
Volatile Organic Compounds (VOC (WPP1))	263.317	40	Yes
Carbon monoxide (CO)	20.055	100	No
Nitrogen oxide (NO _x)	14.214	40	No
Sulfur dioxide (SO ₂)	0.143	40	No
Greenhouse Gases (as CO _{2e})	28,684	75,000	No

Harrigan anticipates commencing construction of the project immediately upon approval by the Department.

As PSD permitting is required for VOC, a Best Available Control Technology (BACT) analysis is included. An ambient air quality modeling review through use of the US EPA's Modeled Emission Rates for Precursors (MERPs) for ozone is provided as demonstration that the air quality in the area is adequately protected. The proposed project will result in increased emissions of certain toxic pollutants from the lumber drying process. The facility is currently subject to the National Emission Standards for Hazardous Air Pollutants: Plywood and Composite Wood Products (PCWP MACT) and the proposed CDK and evaporators will be new affected sources.

The following identifies the organization of the remainder of this application.

Section 2 describes the facility and process and includes process flow diagrams, plot plan, and project drawings.

Section 3 explains the emission calculation methodologies.

Section 4 summarizes the regulatory applicability to the project including the evaluation of NSR permitting applicability.

Section 5 contains the required BACT analysis for VOC and proposed monitoring and recordkeeping.

Section 6 addresses the air quality and additional impacts to address PSD requirements.

Appendix A is the permit application forms required for a construction permit application.

Appendix B provides the emissions calculations.

Appendix C contains reference documentation to include emission factor references, background data, and BACT supporting documentation.

2 PROCESS DESCRIPTION

Harrigan produces dimensional, kiln dried pine lumber and timbers. Logs are delivered by truck to the mill and debarked, sawn into dimensional lumber or timbers based on a computerized optimizer, and stacked on carts for drying. The Green Lumber Sawing Processes is permitted as Emission Unit No. 001. Bark is conveyed by drag chain to truck trailers and sold. Trimmings are processed through a wood hog and shaker screen where the green chips are separated and conveyed by belt to a truck load-out and sold.

As Emission Unit No. 003, the facility operates a 147 MBf direct-fired batch lumber kiln heated by a 32 MMBtu/hr wood-fired slope grate burner (K-4) and one 82.2 MMBf/yr continuous dry kiln with a 32 MMBtu/hr biomass burner (CDK-1) that burns a mix of green sawdust and dry shavings. Batch Kiln #3 (K-3) was damaged by fire and removed from the facility. A 110 MMBf/yr continuous dry kiln with a 45 MMBtu/hr natural gas burner (CDK-2) is proposed as a replacement to K-3. Two kiln condensate evaporators (CE-1 and CE-2) will handle condensate generated by the continuous kilns. The evaporators will each have a 5.3 MMBtu/hr natural gas burner and emissions will be returned into the kiln eliminating additional stacks. The units will be constructed to allow one evaporator to be in service while the other is down for maintenance as required.

Sawdust from the sawmill is pneumatically conveyed via Emission Unit No. 006, Sawdust Transfer and Storage Operations for use in K-4 through Cyclone 4A (C-4A) to the Green Sawdust Silo 1 or through Cyclone 4B (C-4B) to Green Sawdust Silo 2.

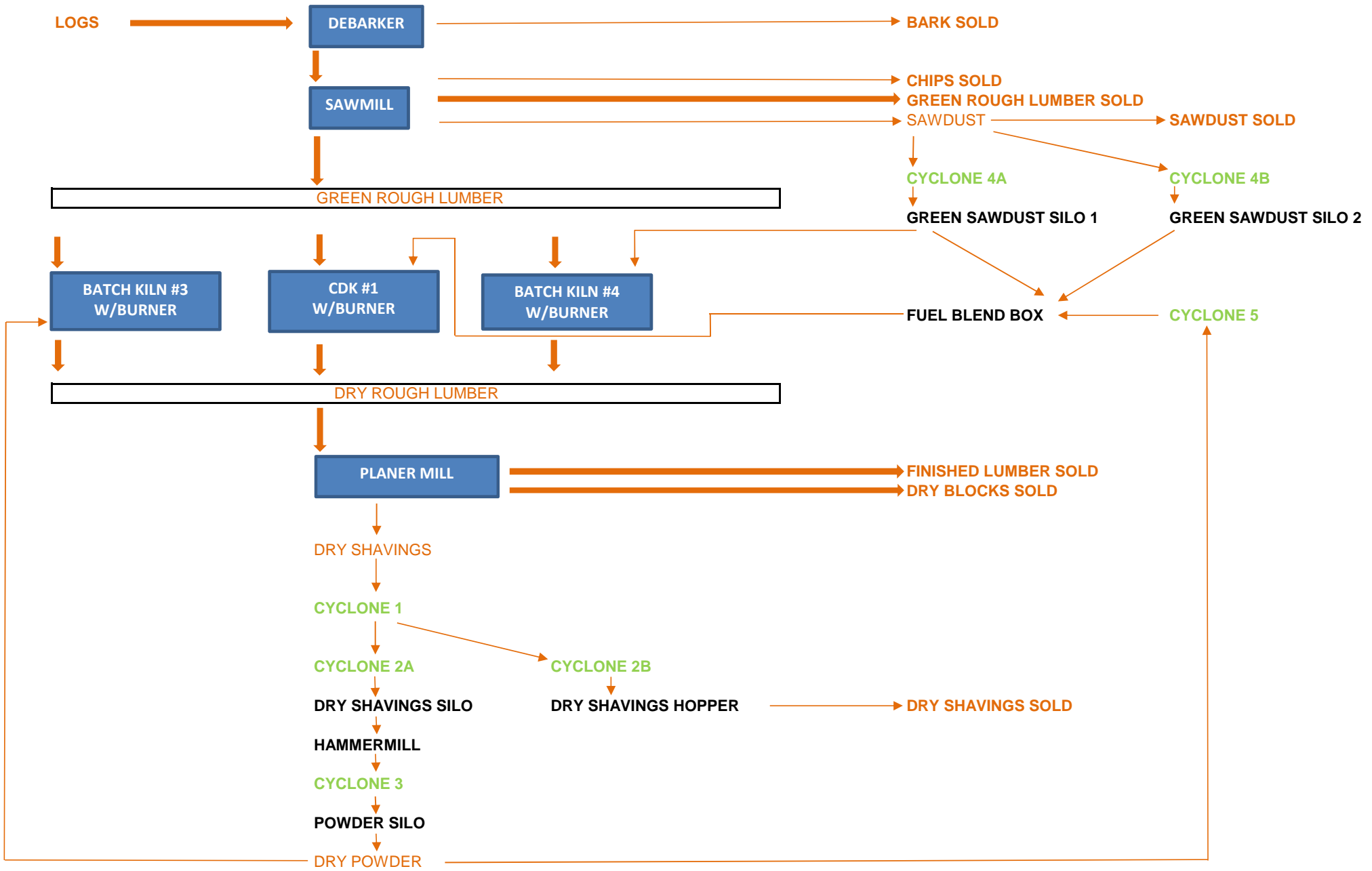
Subsequent to drying, lumber and timbers are processed through the planer mill, trimmed, graded and stacked using an automated sorter. The facility operates three cyclones for particulate control from the planer mill operations as part of Emission Unit No. 005. The Planer Cyclone (C-1) controls planer shavings conveyed from the planer mill to the Shavings Silo through Cyclone 2A (C-2A) which feeds the Hammermill, then the dry shavings powder is routed by Cyclone 3 (C-3) to the Powder Silo. The powder is conveyed with Cyclone 5 (C-5) to a blend box for mixing with sawdust from Green Sawdust Silos as fuel for CDK-1. When the Shavings Silo is full or shavings are not needed as fuel for CDK-1, planer shavings are diverted from Cyclone 2A via a y-valve to the Planer Shavings Hopper through Cyclone 2B (C-2B) and loaded into semi-trailers to ship offsite.

The mill also has an Emergency Fire Pump Engine as Emission Unit No. 007.

The following figures show the existing, Figure 2-1, and proposed, Figure 2-2, mill processes. Figure 2-3 illustrates the facility lay out after the project and Figures 2-4 through 2-6 provide CDK-2 details.

Harrigan Lumber Company
Process Schematic
EXISTING

Figure 2-1



Harrigan Lumber Company
Process Schematic
PROPOSED

Figure 2-2

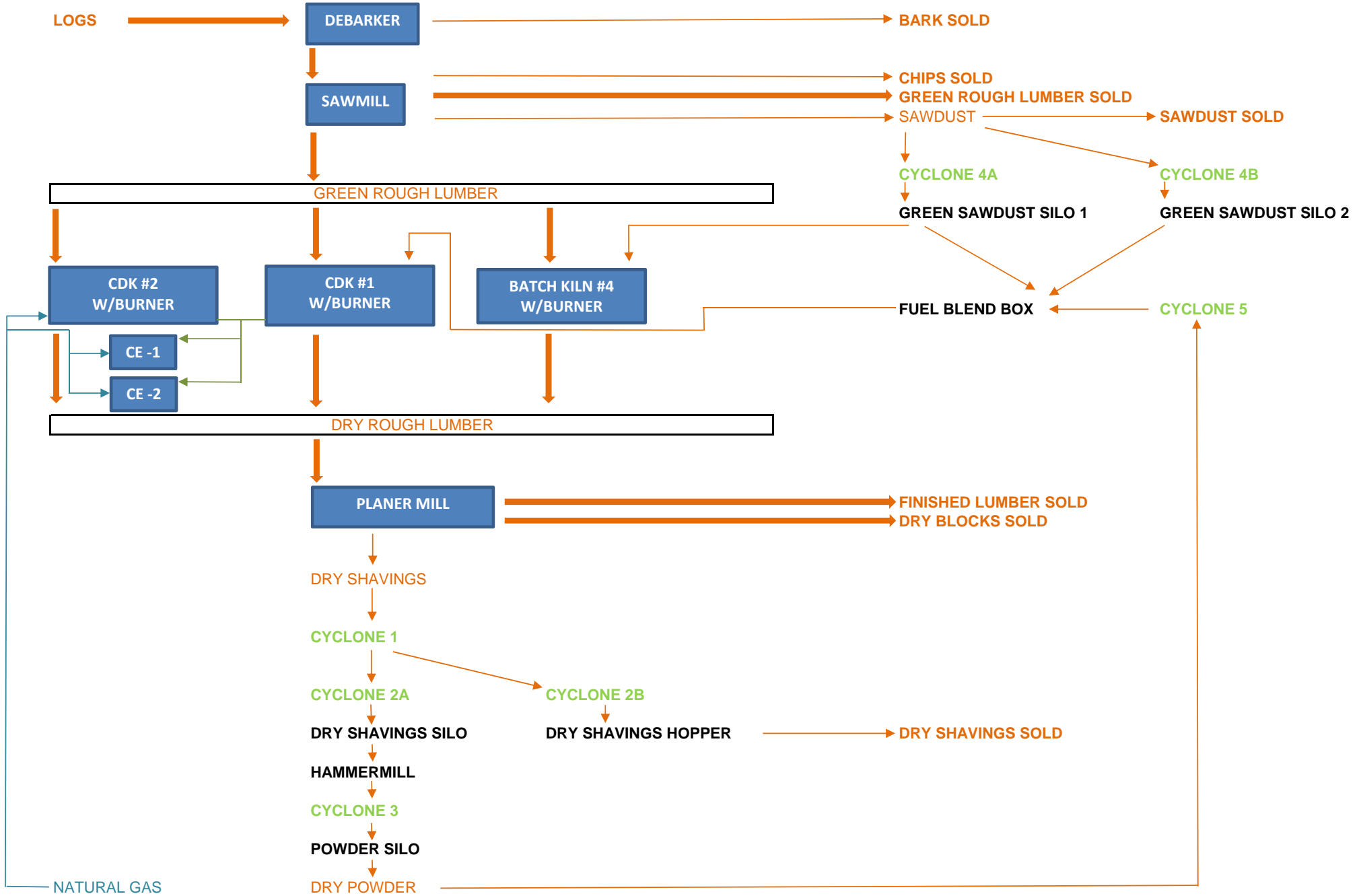


Figure 2-3

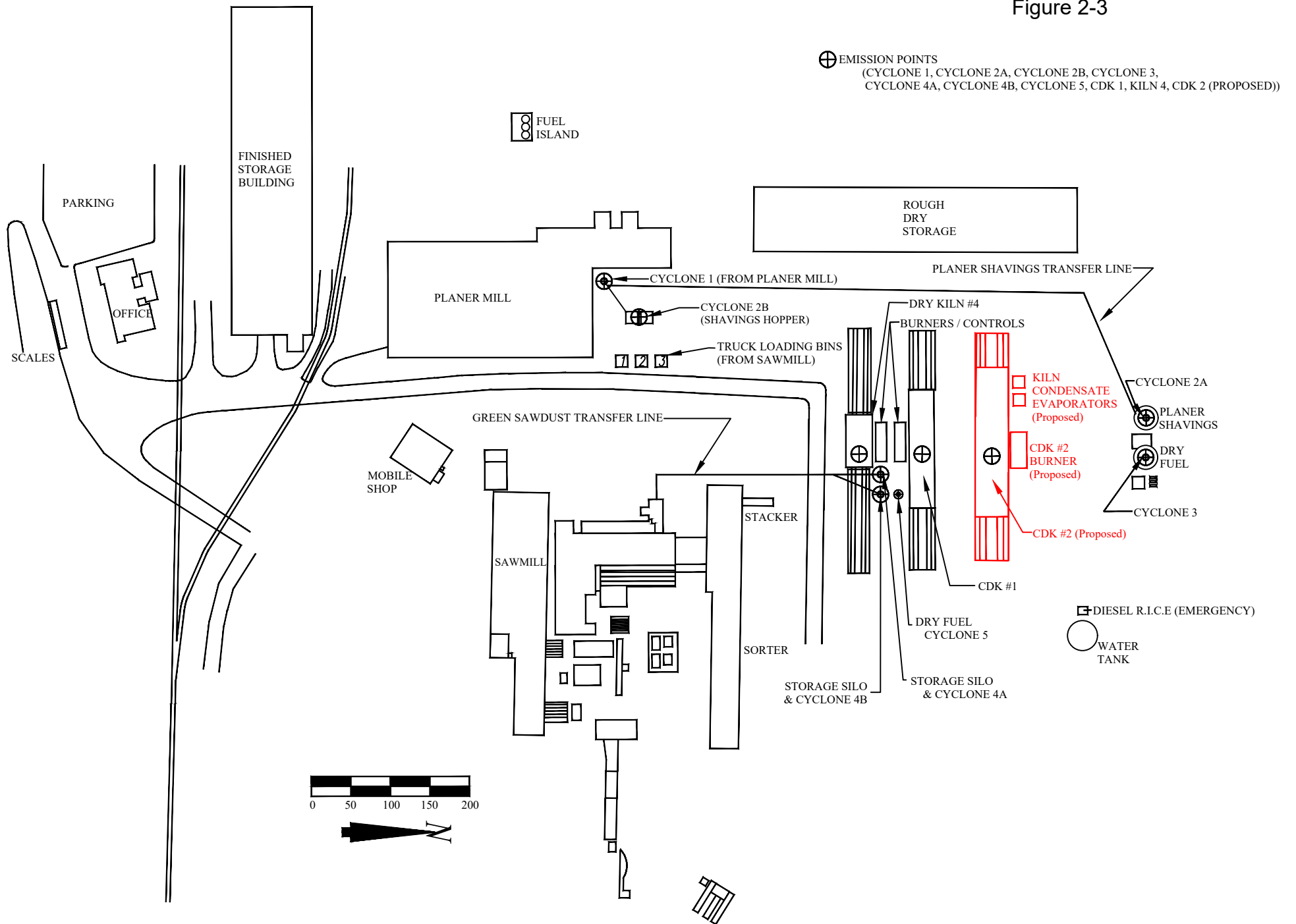




Figure 2-4

DeITech Manufacturing
A Division of Bid Group Technologies US Inc.
 930 Molly Pond Road
 Augusta, GA 30901
 Ph: 250-564-3585 Fax: 250-562-9655

2 SYSTEM SPECIFICATIONS

Customer's Load Configuration

Item	Size
Species	SYP
Product Target Size (Thickness)	1.72"
Sticker Thickness	3/4"
Number of Tiers per Package	22
Number of Stickers per Package	21
Package Width	8'-0"
Packages per Track	1 wide x 3 high
Bunk Size	3.5"
Total Load Height (needs to be confirmed)	14' – 1 3/4"
Cart Height (standard unit)	~ 18"
Average Inbound Moisture Content	75%MCdb (average)
Target Moisture Content	~ 15%MCdb (average)

Kiln Configuration

Item	Size
Overall Kiln Building Width	33' (nominal)
Overall Kiln Building Length	220' (nominal)
Typical Door Opening (to be confirmed at generation of X Section)	16' – 9" (TBC)
Drying Chamber Length	100'
Conditioning Chamber Length (each)	60'
Loading Area Length	50'
Total Rail Length per Track	320' (1280' of rail)
Annual Up-time	8,400 hrs
Expected Annual Production	≈110MM FBM/yr.

Heating System Configuration

Item	Size
Energy Source	Natural Gas – Direct Fired
Burner Input Capacity	45 MMBtu/hr
Nominal Heating Consumption	~34 MMBtu/hr
Design Kiln Operating Temperature	240°F

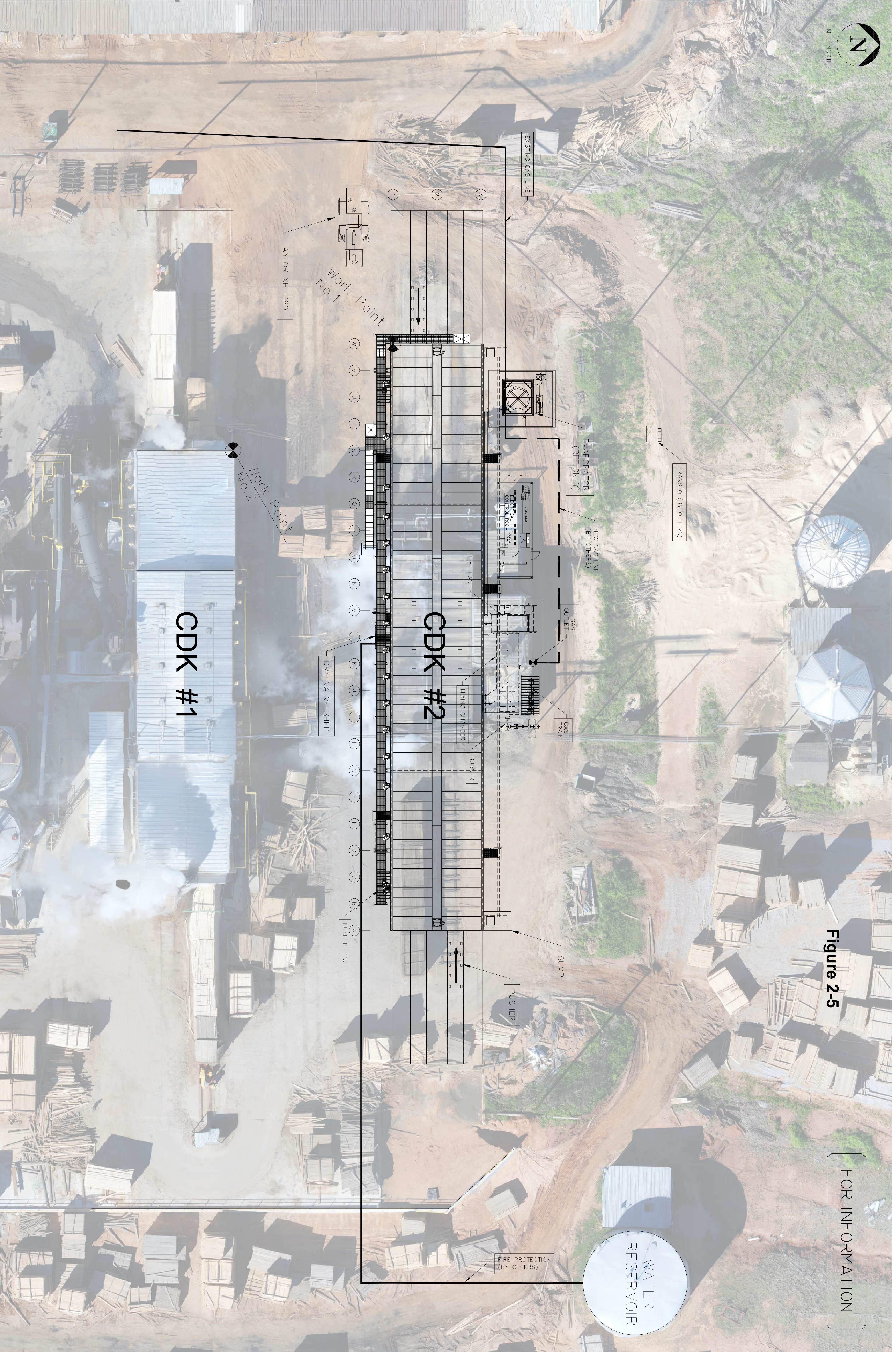
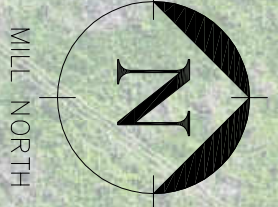
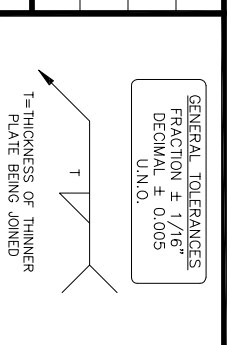


Figure 2-5

FOR INFORMATION

REV	DATE	BY	CHKD	REVISION DESCRIPTION

REV	DATE	BY	CHKD	REVISION DESCRIPTION
E	AUG 01/19	SR	SR	ISSUED FOR PERMIT APPLICATION



PRODUCTION ENGINEER
 STEVEN ROY
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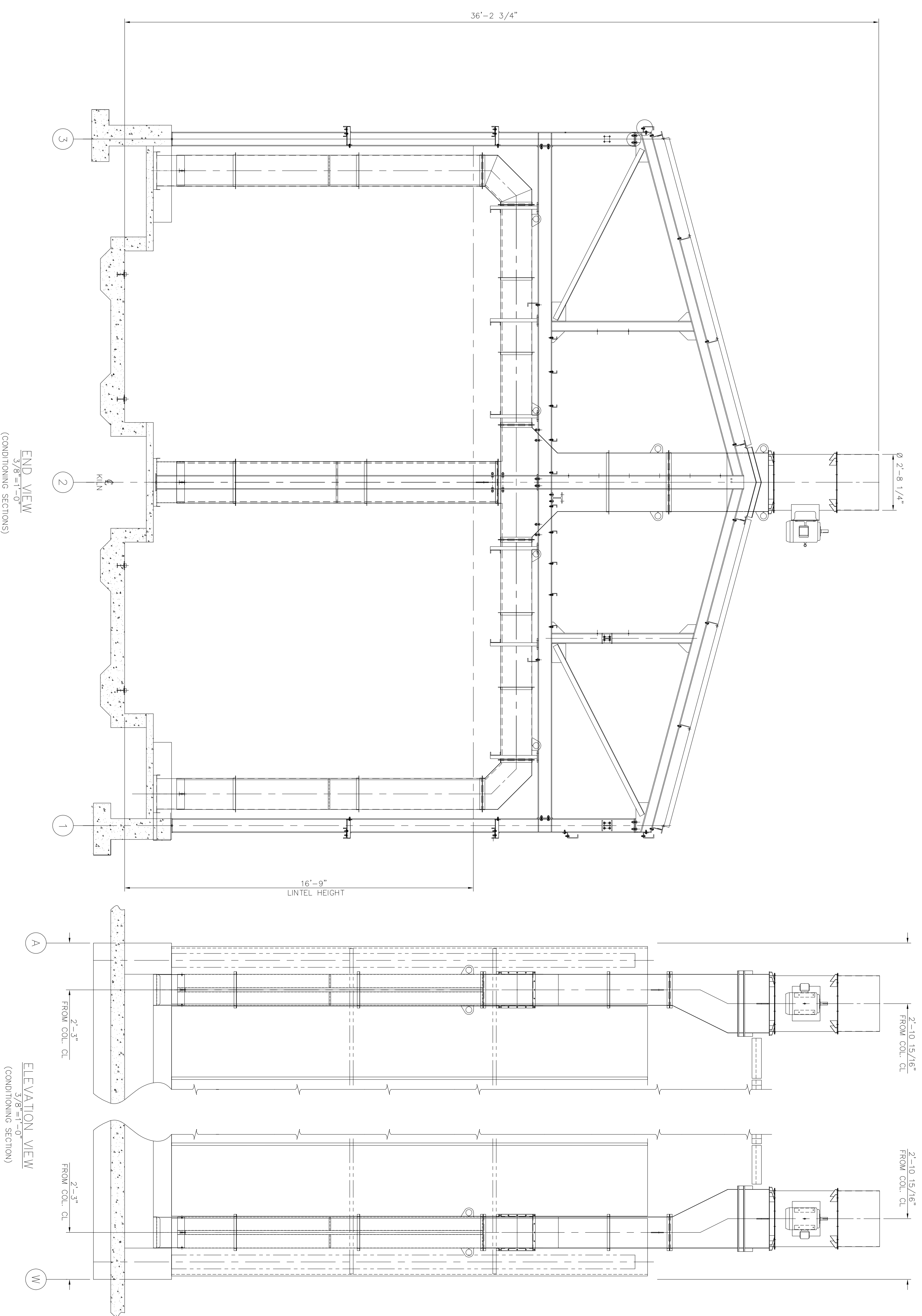


HARRIGAN LUMBER COMPANY
 MONROEVILLE, ALABAMA
 DUAL PATH KILNS
 GENERAL ARRANGEMENT
 KILN #2, SITE IMPLEMENTATION

PROJECT NO. 12369	SCALE: 1/8" = 1'-0"	DRWN: CHARLES LIN
DATE: JUN 12/19	CHKD: STEVEN ROY	REV
DRAWING NO. 12369-10-01-001		E

Figure 2-6

FOR INFORMATION



REV	DATE	BY	CHKD	REVISION DESCRIPTION	REV	DATE	BY	CHKD	REVISION DESCRIPTION
					A	AUG05/2019	SR	SR	ISSUED FOR INFORMATION

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GENERAL DIMENSIONS:
 DIMENSIONS IN FRACTIONS & DECIMALS
 UNLESS OTHERWISE NOTED
 1" = 1'-0" UNLESS OTHERWISE NOTED

PROJECT NO. 12369	SCALE: AS NOTED	DRWN: SROY
HARRIGAN LUMBER MONROEVILLE, AL	DATE: AUG05/2019	CHKD: SROY
DUAL PATH KILN EXTRACTION FAN DUCTING	PROJECT NO. 12369-55-12-001	REV: A
EXTRACTION DUCTING LAYOUT		

3 EMISSION CALCULATION METHODOLOGY

The project proposes installation of a continuous lumber drying kiln directly fired by a natural gas burner. Two natural gas fired evaporators will be installed to handle the condensate generated by the continuous kilns. Due to the PSD permitting review, emissions from Planer Mill Cyclone 1 and Cyclone 2B are evaluated as units that are affected but not modified by the project. The methods used to estimate emissions from each process modified or affected by this project are summarized here. Appendix B includes detailed potential to emit and PSD analysis calculations. Appendix C contains reference documentation to include historical data, emission factor references, and supporting documents.

3.1 Continuous Lumber Dry Kiln No. 2 (CDK-2) and Condensate Evaporators (CE-1 and CE-2)

Potential emissions of hazardous air pollutants (HAP) and criteria pollutants from the direct-fired continuous kiln are calculated from lumber drying and from natural gas combustion for each pollutant typically reviewed for lumber kilns. The maximum production capacity for dried lumber from the kiln in thousand board feet or MBf (MBf/hr and MBf/year) is multiplied by the appropriate emission factor (lb/MBf). Emissions of criteria and HAP pollutants from combustion of natural gas in the kiln and the condensate evaporators are estimated by the burner design capacity (MMBtu/hr and MMBtu/yr) assuming full year operation multiplied by the appropriate emission factor (lb/MMBtu) as published by the US EPA as AP-42, Chapter 1. The emissions of particulate reflect the sum of lumber drying emissions from steam heated kilns, using emission factors published by the North Carolina Department of Environmental Quality, and emissions from natural gas combustion. VOC as C emissions from lumber drying are estimated with an emission factor documented by the Arkansas Department of Environmental Quality and VOC (WPP1) is calculated by EPA's required Wood Products Protocol 1 to include methanol and formaldehyde contributions. VOC and particulate emissions from condensate evaporation are estimated with the total VOC concentration in kiln condensate obtained from a peer reviewed analytical report of kiln condensate from pine lumber and maximum total dissolved solids for particulate from an industry trade group presentation. Greenhouse gas emissions are estimated with EPA's GHG Mandatory Reporting Rule factors and permitted HAP emissions from lumber drying utilize factors in EPA's PCWP MACT memo dated June 30, 2017.

Example calculations follow.

PM₁₀ from CDK-2

$(0.022 \text{ lb PM}_{10}/\text{MBf lumber dried} * 110,000 \text{ MBf/yr} + 7.6 \text{ lb/MMscf natural gas burned} / 1,020 \text{ btu/scf} * 45 \text{ MMBtu/hr} * 8,760 \text{ hr/yr}) / 2,000 \text{ lb/ton} = 2.679 \text{ tpy}$

PM₁₀ from CE-1 (same as for CE-2)

$(1.68\text{E-}5 \text{ lb PM}_{10}/\text{gal of condensate evaporated} * 3,153,600 \text{ gal/yr} + 7.6 \text{ lb/MMscf natural gas burned} / 1,020 \text{ btu/scf} * 5.3 \text{ MMBtu/hr} * 8,760 \text{ hr/yr}) / 2,000 \text{ lb/ton} = 0.199 \text{ tpy}$

Total PM₁₀ from New Sources

$\text{PM}_{10} \text{ from CDK-2} + \text{PM}_{10} \text{ from CE-1} + \text{PM}_{10} \text{ from CE-2} = 2.679 \text{ tpy} + 0.199 \text{ tpy} + 0.199 \text{ tpy} = 3.078 \text{ tpy}$

VOC from CDK-2

$(4.78 \text{ lb VOC(WPP1)}/\text{MBf lumber dried} * 110,000 \text{ MBf/yr}) / 2,000 \text{ lb/ton} = 263.065 \text{ tpy}$

VOC from CE-1 (same as for CE-2)

$(72.1 \text{ mg VOC}/\text{m}^3 \text{ condensate} / 35.3147 \text{ ft}/\text{m}^3 / 453,592 \text{ mg}/\text{lb} / 7.48 \text{ gal}/\text{ft}^3 * 3,153,600 \text{ gal}/\text{yr} + 5.5 \text{ lb VOC}/\text{MMscf} / 1,020 \text{ btu}/\text{scf} * 5.3 \text{ MMBtu}/\text{hr} * 8,760 \text{ hr}/\text{yr})/2,000 = 0.126 \text{ tpy}$

Total VOC from New Sources

$\text{VOC from CDK-2} + \text{VOC from CE-1} + \text{VOC from CE-2} = 263.065 \text{ tpy} + 0.126 \text{ tpy} + 0.126 \text{ tpy} = 263.317 \text{ tpy}$

3.2 Planer Mill Cyclones (Cyclone 1 and Cyclone 2B)

Particulate emissions from Cyclone 1 and Cyclone 2B are reviewed as unmodified but affected, existing sources for the PSD review. Cyclone 1 has been in operation for many years and Cyclone 2B began operation in June of 2017 as the Department issued a Temporary Authorization to Operate on June 23, 2017. The evaluation of these emissions units' historic and projected emissions is required as part of the PSD analysis discussed in Section 4. Historic data for the cyclones is derived from past annual emission inventories submitted to the Department through the Air Emissions Electronic Reporting System (AEERS). Cyclone emissions in annual Title V reporting utilize emission factors available from EPA's WebFIRE database and operating hours. Copies of the historic emission estimates are included in Appendix C.

4 REGULATORY APPLICABILITY

This section of the application summarizes the air permitting requirements and key air regulations that apply to the project under both federal and state permitting programs. Applicability to New Source Review (NSR), New Source Performance Standards (NSPS), National Emissions Standards for Hazardous Air Pollutants (NESHAP), Title V, and Alabama air rules are addressed.

4.1 New Source Review Standards

As Harrigan is in Monroe County, which is currently classified as an attainment area for all criteria pollutants, consideration for New Source Review (NSR) pollutants are evaluated for Prevention of Significant Deterioration (PSD) in lieu of Nonattainment NSR. Lumber mills are not one of the 28 Major Source categories listed in ADEM Admin. Code r. 335-3-14-.014(2)(a)(1); therefore, the major source threshold of concern is 250 tpy for criteria pollutants.

Harrigan is a PSD major source due to facility-wide potential emissions and thus the emissions increases from the proposed project must be evaluated and compared to the major modification thresholds of regulated pollutants for NSR permitting applicability under the PSD program.

4.1.1 Project Description

Harrigan is proposing to construct and operate a new natural gas direct fired continuous drying kiln and two kiln condensate evaporators. The Continuous Drying Kiln (CDK-2) has a potential to dry 110 million board feet per year (MMBf/yr) using a 45 MMBtu/hr rated natural gas burner. The new kiln will replace the Batch Kiln 3 (K-3) as it was burned and is being removed from the site. The project will include two condensate evaporators (CE-1 and CE-2) to handle the condensate generated by the continuous kilns. The evaporators will be fired by natural gas burners rated at 5.3 MMBtu/hr each. The evaporators are redundant, but both are considered at full potential to emit in the application.

The proposed project will not modify any other sources at the mill. However, as CDK-2 has a greater drying capacity than the previous Batch Kiln 3, actual production through the planer mill could increase. While the planer mill will not be modified, actual emissions from Cyclone 1 (C-1) and Cyclone 2B (C-2B) could be affected by increased shavings throughput and sales, thus increased use of these sources is considered in this evaluation. Shavings to fuel Batch Kiln #3 routed through Cyclone 2A (C-2A) and 3 (C-3) is no longer required; any additional byproducts produced in the planer mill will be sold by routing through Cyclone 2B to trucks for shipping off-site. The use of shavings as a supplemental fuel in CDK-1 will not be impacted by this project, thus that process through Cyclones 2A, 3 and 5 (C-2A, C-3, and C-5 respectively) as well as CDK-1 are not considered in this PSD evaluation. The sawmill and associated sawdust handling sources, Cyclones 4A (C-4A) and 4B (C-4B), will not be modified and are not affected by this project as the sawmill currently limits the mill's production.

4.1.2 Significant Emission Increase

ADEM Admin Code 335-3-14-.04(1)(d), states that a project is a major modification for a regulated NSR pollutant only if it causes both:

- a significant emissions increase, as defined in subparagraph (2)(mm) of ADEM Admin Code 335-3-14-.04; and

- a significant net emissions increase, as defined in subparagraph (2)(c) and (2)(w) of ADEM Admin Code 335-3-14-.04.

As outlined in ADEM Admin Code R 335-3-14-.04(1)(e) – (i), as this project is a change to an existing facility involving new emissions units and affecting existing emissions units, the Hybrid Test is the relevant method for calculating the emissions increases associated with the project. The hybrid test allows an actual-to-projected-actual applicability test (ATPA) for existing sources (C-1 and C-2B) and actual-to-potential test (ATP) for new emissions units (CDK-2, CE-1, and CE-2). The emissions increases from the two tests are summed and compared to the significant emission rate (SER) as defined in ADEM Admin Code 335-3-14-.04(2)(w) to determine whether a significant emissions increase occurs from the project. The determination of existing versus new units is based on ADEM Admin Code 335-3-14-.04(2)(uu)(3) which indicates that units operating for at least two years are considered existing units. Cyclone 1 has been in operation for many years and Cyclone 2B began operation in June of 2017 per the Department’s Temporary Authorization to Operate issued on June 23, 2017.

4.1.3 Actual-to-Projected Actual Emissions Test (ATPA) for Existing Emissions Units

ADEM Admin Code R 335-3-14-.04(2)(nn) documents how to calculate projected actual emissions (PAE) within the Actual-to-Projected Actual Test (ATPA) for existing sources.

To calculate Projected Actual Emission (PAE), the facility is utilizing the method explained in U.S. EPA Region 3 letter regarding the Northampton Generating Company. The steps used to determine if a significant emissions increase will occur from Harrigan’s proposed project are itemized below. Detailed calculations and supporting production data can be found in Appendix B.

Step 1 – Calculate Baseline Actual Emissions (BAE) for all existing units affected by the project

The facility selected January 2017 – December 2018 as the consecutive 24-month period over the ten years preceding the date a complete permit application is received by the Department in determining the Baseline Actual Emission (BAE) for all NSR pollutants. For unmodified but affected existing sources, the emissions reported through the Department’s annual Air Emissions Report for 2017 and 2018 were used. The summary of those sources’ baseline data and BAE is in Table 4.1. Only particulate matter is emitted from these existing sources.

Table 4.1 Summary of BAE (tpy)

Baseline Actual Emissions (BAE)	PM	PM₁₀	PM_{2.5}	VOC	SO₂	CO	NO_x	CO_{2e}
Planer Cyclone (C-1)	3.599	3.272	1.963	-	-	-	-	-
Planer Shavings Hopper Cyclone (C-2B)	2.317	2.106	1.264	-	-	-	-	-
Total BAE, tpy	5.916	5.378	3.227	-	-	-	-	-

Step 2 – Calculate Projected Actual Emissions (PAE) for all existing units affected by the project

Projected Actual Emissions (PAE) is the maximum annual rate in tons per year at which an existing emissions unit is projected to emit a regulated NSR pollutant over any one of the five years following the change. HLC projects the highest annual dry lumber production at the mill after the project at 140,000 MBf/yr.

The summary of all unmodified but affected existing sources’ PAE can be found in Table 4.2 below.

Table 4.2 Summary of PAE (tpy)

Projected Actual Emissions (PAE)	PM	PM ₁₀	PM _{2.5}	VOC	SO ₂	CO	NO _x	CO ₂ e
Planer Cyclone (C-1)	5.658	5.143	3.086	-	-	-	-	-
Planer Shavings Hopper Cyclone (C-2B)	3.642	3.311	1.986	-	-	-	-	-
Total PAE, tpy	9.300	8.454	5.072	-	-	-	-	-

Step 3 – Calculate Adjusted PAE (APAE) removing Excludable Emissions (EE) for existing units

Post-change emissions are examined to determine if any such emissions above the baseline are not related to the project. The excludable projected actual emissions (EE) are determined if existing sources could-have-accommodated (CHA) operation and the resulting emissions during the baseline period without the CDK-2 project.

A sustained actual production of 10,656.806 MBf was processed through the planer mill in May 2018, which would indicate an achievable, sustainable production rate of 127,881.672 MBf/yr when annualized. This operation and resulting portion of PAE are clearly unrelated to the CDK-2 project as the monthly rate was achieved and could be achieved again without the project. Additionally, the emissions resulting from this level of operation are physically and legally possible; there is no permit violation resulting from these emissions.

Excludable emissions (EE) are determined from CHA emissions, Table 4.3, at the achievable production rate of 127,881 MBf/yr less BAE resulting from actual production rates during the baseline, documented in Table 4.1, as shown in Table 4.4.

Table 4.3 Summary of CHA Emissions (tpy)

Could Have Accommodated Emissions (CHA)	PM	PM ₁₀	PM _{2.5}	VOC	SO ₂	CO	NO _x	CO ₂ e
Planer Cyclone (C-1)	5.168	4.698	2.819	-	-	-	-	-
Planer Shavings Hopper Cyclone (C-2B)	3.327	3.024	1.814	-	-	-	-	-
Total CHA, tpy	8.495	7.722	4.633	-	-	-	-	-

Table 4.4 Summary of Excludable Emissions (tpy)

Excludable Emissions (EE)	PM	PM ₁₀	PM _{2.5}	VOC	SO ₂	CO	NO _x	CO ₂ e
Total CHA	8.495	7.722	4.633	-	-	-	-	-
Total BAE	5.916	5.378	3.227	-	-	-	-	-
Total EE (CHA - BAE), tpy	2.579	2.345	1.407	-	-	-	-	-

Table 4.5 reflects the resulting Adjusted PAE (APAE) as PAE from Step 2 less EE.

Table 4.5 Summary of Adjusted PAE (tpy)

Adjusted Projected Actual Emissions (APAE)	PM	PM ₁₀	PM _{2.5}	VOC	SO ₂	CO	NO _x	CO ₂ e
Total PAE	9.300	8.454	5.072	-	-	-	-	-
Total EE	2.579	2.345	1.407	-	-	-	-	-
Total APAE (PAE - EE), tpy	6.720	6.109	3.666	-	-	-	-	-

Step 4 – Complete the Actual to Adjusted Projected Actual Test (ATPA)

The BAE, Table 4.1, is subtracted from the Adjusted PAE derived in Step 3, Table 4.5, to indicate the Actual-to-Projected Actual Test (ATPA) portion of emission increases for use in the Hybrid Test. Table 4.6 provides the results of the ATPA for existing sources.

Table 4.6 Actual-to-Projected-Actual Test Emissions Increase (tpy)

Actual To Projected Actual (ATPA)	PM	PM ₁₀	PM _{2.5}	VOC	SO ₂	CO	NO _x	CO ₂ e
Total APAE	6.720	6.109	3.666	-	-	-	-	-
Total BAE	5.916	5.378	3.227	-	-	-	-	-
Total ATPA (APAE - BAE), tpy	0.805	0.732	0.439	-	-	-	-	-

Prior to Step 5, the Actual-to-Potential Test for new emissions units is documented as the other portion of the Hybrid Test,

4.1.4 Actual-to-Potential Test (ATP) for New Emissions Units

The actual-to-potential test as defined in ADEM Admin Code 335-3-14-.04(1)(g) is used to determine the project increase for the new sources from the CDK-2 project. New sources are CDK-2, CE-1, and CE-2. The detailed potential to emit (PTE) emission calculations can be found within Appendix B for each unit. The baseline actual emissions (BAE) for new units are equal to zero in accordance with ADEM Admin Code 335-3-14-.04(2)(uu)(3) since this is the initial construction and operation of the unit. The summary of the actual-to-potential test, which is PAE (at PTE) minus BAE (as zero) is shown in Table 4.7.

Table 4.7 Actual-to-Potential Test Emissions Increase (tpy)

Actual To Potential (ATP)	PM	PM ₁₀	PM _{2.5}	VOC	SO ₂	CO	NO _x	CO ₂ e
New Sources PAE = PTE	1.717	3.078	3.078	263.317	0.143	20.055	14.214	28,684
New Sources BAE = 0 tpy	0	0	0	0	0	0	0	0
Total ATP (PAE - BAE), tpy	1.717	3.078	3.078	263.317	0.143	20.055	14.214	28,684

4.1.5 Hybrid test for Total Emissions Increase from Project

The following completes the fifth step outlined in the Northampton letter.

Step 5 – Compare the emissions increase to the Significance Level for each pollutant

The emissions increase from existing units determined by the actual-to-projected-actual applicability test (ATPA) at Table 4.6 and the increase from new units via the actual-to-potential test (ATP) at Table 4.7 are summed. The total project emissions increases are compared to the Significant Emission Rate (SER) for each NSR pollutant. As shown in Table 4.8, the CDK-2 project results in a significant emission increase for VOC only.

Table 4.8 Summary of Hybrid Total Emissions Increase Test (tpy)

Total Emissions Increase from Project	PM	PM ₁₀	PM _{2.5}	VOC	SO ₂	CO	NO _x	CO ₂ e
Total ATPA Increase Existing Sources	0.805	0.732	0.439	-	-	-	-	-
Total ATP Increase New Sources	1.717	3.078	3.078	263.317	0.143	20.055	14.214	28,684
Hybrid Test Total Project Increase (ATPA + ATP), tpy	2.522	3.809	3.517	263.317	0.143	20.055	14.214	28,684
Significant Emission Rate (SER)	25	15	10	40	40	100	40	75,000
% of SER	10%	25%	35%	658%	0%	20%	36%	38%
PSD Review Required?	No	No	No	Yes	No	No	No	No

4.1.6 Significant Net Emissions Increase

If emissions decreases are available, emission netting can be performed to determine if the overall net emissions increase for an NSR pollutant is below its respective SER (considering both contemporaneous and creditable increases and decreases). Using the guidelines of ADEM Admin Code R 335-3-14-.04(2)(c), the emissions changes within the contemporaneous period do not negate

the PSD applicability to VOC. Further review and documentation of the netting analysis is not included.

As PSD permitting review is required for VOC due to this project, this application is proposed to satisfy the PSD requirements to allow construction. Emission limits are proposed based on the potential to emit calculations. The best available control technology (BACT) review has been completed and documented in Section 5. A demonstration that the project would not cause or contribute to a violation of the PSD increment or the National Ambient Air Quality Standard (NAAQS) is documented in Section 6 along with an additional analysis of the impairment to visibility, soils, and vegetation as the result of operation and growth associated with the project.

4.2 New Source Performance Standards (NSPS)

The proposed CDK-2 burner will provide direct heat to the kiln in which the combustion gases would contact the lumber being dried, thus the project is not subject to NSPS 40 CFR 60 Subpart Dc for Small Industrial-Commercial-Institutional Steam Generating Units. The proposed burners on the condensate evaporators, CE-1 and CE-2, provide direct heat and are smaller than 10 MMBtu/hr thus also are not subject to Subpart Dc. There are no other NSPS potentially applicable to the project.

4.3 National Emission Standards for Hazardous Air Pollutants (NESHAP)

National Emission Standards for Hazardous Air Pollutants: Plywood and Composite Wood Products (PCWP MACT) regulates HAP emissions from plywood and composite wood products (PCWP) manufacturing facilities that are major HAP sources. Lumber kilns and onsite wastewater treatment operations specifically associated with plywood and composite wood products manufacturing are “affected sources” under the PCWP MACT in accordance with §63.2232(b). The mill is currently regulated by the PCWP MACT due to the current kilns on site. The proposed CDK-2, CE-1, and CE-2 are new affected sources. Per §63.2252, they are not required to comply with the compliance options, work practice requirements, performance testing, monitoring, SSM plans, and recordkeeping or reporting requirements of this subpart, or any other requirements in Subpart A of this part, except for the initial notification requirements in §63.9(b) This application serves as the initial notification of the CDK-2 project.

National Emission Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial and Institutional Boilers and Process Heaters (Boiler MACT) regulates HAP emissions from solid, liquid, and gaseous fuel-fired boilers and process heaters at facilities that are a major source of HAP. As the combustion gases from the proposed natural gas burners directly contact the process material, the units are not considered process heaters, and Boiler MACT is not applicable.

There are no other NESHAP potentially applicable to the project.

4.4 Title V Applicability

Harrigan is currently a major source under the Title V operating permit program and a major source of hazardous air pollutants (HAP). Harrigan will be required to submit a modification to Major Source Operating Permit No. 106-S005 within 12 months of commencing operation of CDK-2.

4.5 Alabama State Rule Applicability

ADEM rules established at ADEM Admin. Code R. 335-3 are potentially applicable the proposed project.

4.5.1 Visible Emissions

CDK-2, CE-1, and CE-2 would be subject to the visible emission standards of ADEM Admin. Code r. 335-3-4-.01, which states that no air emission source may emit particulate of an opacity greater than 20%, as determined by a six-minute opacity average, except for one six-minute opacity average not greater than 40% during any 60-minute period.

4.5.2 Particulate Matter

Since CDK-2, CE-1, and CE-2 burners would supply heat directly to the kiln and evaporators, they are not considered "fuel burning equipment" per the regulatory definition, and not subject to ADEM Admin. Code r. 335-3-4-.03(1).

All proposed units would be subject to the State particulate matter emission standards for process industries at ADEM Admin. Code r. 334-3-4-.04(1). The allowable PM emission rate for the units, E, are determined using the following equation:

$$E = 3.59 P^{0.62} \quad P < 30 \text{ tons/hr}$$

The process weight rate, P, is the maximum amount of natural gas that could be burned in the burners in tons/hr. To avoid triggering PSD for particulate matter (PM) due to the State allowable rate based on process weight, Harrigan requests to limit the PM allowable emissions as identified in the calculations at Appendix B with emissions estimated from US EPA documented emission factors for natural gas combustion, the maximum burner design rating, and assuming year round operation in lieu of the Process Weight Rate allowance.

4.5.3 Sulfur Dioxide

The burners for CDK-2, CE-1, and CE-2 would be subject to ADEM Admin. Code R. 335-3-5-.01(1)(b) limit on emissions of 4.0 lb SO₂/MMBtu from fuel burning. The potential emissions from these units using AP-42 emission factors are well below this level.

5 PROPOSED COMPLIANCE

5.1 BACT Determination

As this project triggers PSD review for VOC, all new and modified sources must be assessed for Best Available Control Technology (BACT). BACT is an emissions limit based on the maximum pollutant reduction achievable after consideration of energy, economic, and environmental impacts. BACT is determined by unit by pollutant. For the proposed CDK-2 project, BACT must be determined for VOC emissions from direct-fired Continuous Lumber Dry Kiln No. 2 (CDK-2), Condensate Evaporator No. 1 (CE-1), and Condensate Evaporator No. 2 (CE-2). There will be no other new or modified sources requiring VOC analysis.

For this effort, Harrigan uses the "top-down" approach for the BACT analysis. This approach considers the most stringent control option available and a determination of its technical feasibility for the emissions unit in question. If the option is not rejected, the applicant must analyze the option based on economic, environmental, and energy considerations. Below are the five basic steps of a top-down BACT review procedure as identified by the US EPA in the March 15, 1990, Draft BACT Guidelines:

- Step 1 – Identify all control technologies
- Step 2 – Eliminate technically infeasible options
- Step 3 – Rank remaining control technologies by control effectiveness
- Step 4 – Evaluate most effective controls and document results
- Step 5 – Select BACT

Step 1 – Identify all control technologies

Potentially applicable emission control technologies are identified for the CDK-2 project by researching the US EPA control technology database, technical literature, state permitting authority files, and using process knowledge and experience. The US EPA's RACT/BACT/LAER Clearinghouse (RBLC) database contains case-specific information on the "Best Available" air pollution technologies that have been required to reduce the emission of air pollutants from stationary sources. A search was completed for continuous kilns and condensate evaporators to identify the emission control technologies and emission limits that were imposed by permitting authorities as BACT in the past for comparable emissions sources.

For CDK-2, a search was completed through August 2019 for Process Type 30.8 (Wood Products Industry, Wood Lumber Kilns) for VOC emissions. The search was further pared down to obtain a representative pool of natural gas fired continuous kilns. The results of this search provided emission limits ranging from 3.38 lb/MBf – 5.49 lb/MBf (with the 5.49 being indicated as VOC as WPP1). There were no add on controls indicated; if a control method was indicated, it mentioned proper kiln operation and maintenance and proper drying schedule.

For CE-1 and CE-2, a search was completed through August 2019 for Process Key Word "Evaporator" for VOC emissions. Few entries resulted and only one matched the kiln condensate evaporators proposed for Harrigan. The BACT determination for this facility (RBLCID AL-0310) is Proper Kiln Operation and Maintenance. As the burner exhaust from the evaporators will be returned to the kilns

and evaporative loss is fugitive in nature, the control of emissions generated from the evaporators are included in the kiln BACT review. The RBLC results are included in Appendix C.

As the RBLC review didn't indicate current add on controls for lumber drying kilns, additional VOC control technologies were evaluated:

- Regenerative Thermal Oxidation (RTO)
- Regenerative Catalytic Oxidation (RCO)
- Carbon Adsorption
- Condensation
- Biofiltration
- Wet Scrubbing
- Proper Maintenance & Operation

Regenerative Thermal Oxidation

According to EPA Air Pollution Control Technology, RTOs use a high-density media such as a ceramic-packed bed still hot from a previous cycle to preheat an incoming VOC-laden waste gas stream. The preheated, partially oxidized gases then pass into a combustion chamber where they are heated by auxiliary fuel (natural gas) combustion to a final oxidation temperature typically between 1400 - 1500°F and maintained at this temperature to achieve maximum VOC destruction. Purified hot gases exit this chamber and are directed to one or more different ceramic-packed beds cooled by an earlier cycle. Heat from the purified gases is absorbed by these beds before the gases are exhausted to the atmosphere. The reheated packed bed then begins a new cycle by heating a new incoming waste gas stream. Destruction efficiency of VOC depends upon the design criteria (i.e. chamber temperature, residence time, inlet VOC concentration, compound type, and degree of mixing). Typical VOC destructive efficiency range from 95% to 99% for RTO systems. Lower control efficiencies are generally associated with lower concentration flows.

Regenerative Catalytic Oxidation

An RCO operates in the same manner as an RTO but uses a catalyst material rather than ceramic material in the packed bed. This allows for destruction of VOC at a lower oxidation temperature. An RCO uses a precious metal catalyst in the packed bed, allowing oxidation to occur at approximately 800°F. The lower temperature requirement reduces the amount of natural gas needed to fuel the system and overall size of the incinerator. Destruction efficiencies range from 90 to 99% for RCO systems.

Carbon Adsorption

In adsorption, gaseous pollutants are removed from an air stream by transferring the pollutants to the solid surface of an adsorbent and the cleaned gas passes to the atmosphere. Activated carbon is the most commonly used adsorbent. When the limit to the mass of pollutants that can be collected by an adsorbent is reached, the adsorbent is no longer effective in removing pollutants. To recover the ability to capture gaseous pollutants, adsorbents typically are "regenerated", meaning, the pollutant is desorbed or removed from the adsorbent. This regeneration may occur off-site or on-site. VOC destructive efficiency range from 90% to 95% for carbon adsorption systems in proper operating capacity.

Condensation

Condensation employs a drop-in temperature and/or increase in pressure to cause the VOCs in the emission stream to condense. The cleaned air stream is separated from the condensate containing target pollutants. The removal efficiency of a condenser is dependent on the emission stream

characteristics including the nature of the VOC in question (vapor pressure/temperature relationship), VOC concentration, and the type of coolant used. Any component of any vapor mixture can be condensed if brought to a low enough temperature and allowed to come to equilibrium. A condenser cannot lower the inlet concentration to levels below the saturation concentration at the coolant temperature. In many cases, very large temperature drops are required to achieve effective condensation, requiring significant energy investment to accomplish cooling.

Biofiltration

In biofiltration, gases containing biodegradable organic compounds are vented through a biologically active material. The biofilm contains a population of microorganisms on a porous filter material. As gases pass through the biofilter, the organics partition from the gaseous phase to the liquid phase of the biofilm. From the liquid phase, the contaminants are available for the oxidation process through the microorganism on the biofilm. Control efficiency vary on several things to include water solubility of the VOC and can range from 10% - 90%.

Wet Scrubbing

Scrubbing of pollutants from a gas stream often use packed-bed scrubbers. The packing is held in place by wire mesh retainers and supported by a plate near the bottom of the scrubber. Scrubbing liquid is introduced above the packing and flows down through the bed. The liquid coats the packing and establishes a thin film. The pollutant, VOC, must be soluble in the absorbing liquid and even then, for any given absorbent liquid, only VOC that are soluble can be removed.

Proper Maintenance and Operation

Proper maintenance and operation of well-designed lumber drying kilns can effectively reduce VOC emissions. Prevention of the over drying lumber, which releases additional VOCs to the air, can be minimized. Proper drying through efficient unit operation and kiln temperature management based on lumber moisture content along with routine maintenance completed on manufacturer recommendations reduces VOC emissions.

Step 2 - Eliminate technically infeasible options

All add on control discussed in Step 1 requires collection of the kiln exhaust. The VOC emitted from combustion at the natural gas burner as well as the VOC emitted from lumber drying exhausts at the ends of the continuous kiln. The exhaust is vented through the openings and powered vents at the ends of the kilns. It is assumed that 80% of the kiln emissions released through the powered vent stack with 20% exhausting through the doorway openings. This exhaust has a relative humidity of 100% and exhausts at approximately 120 – 140°F. The primary constituent of the VOC in the kiln exhaust is terpenes.

Regenerative Thermal Oxidation

The use of an RTO is technically infeasible as the high moisture content and low exit temperature of the kiln exhaust gas stream. No known lumber kilns have successfully utilized this control.

Regenerative Catalytic Oxidation

An RCO can operate at a lower temperature than an RTO, however the temperature of the kiln exhaust remains below that for efficient function of an RCO. Catalyst poisoning from the particulate and other contaminants in the gas stream is possible requiring the contaminants to be removed from the incoming gas stream, adding to the cost of the control system. No such system has been applied to a lumber dry kiln. The system is technically infeasible for this process.

Carbon Adsorption

The high moisture content of the kiln exhaust indicates carbon adsorption is not practical. The water molecules compete with the hydrocarbon molecules for active adsorption sites reducing the capacity and efficiency of the adsorption system. There are no known lumber dry kilns equipped with a carbon adsorption system and it is deemed technically infeasible.

Condensation

Condensation is effective when the gas stream can be cooled to a temperature where VOC condense as a liquid out of the gas stream. To condense terpenes, the primary constituent of lumber kiln VOC emissions, the temperature would need to be reduced to -40°F. At this temperature, freezing of the water vapor would generate ice, causing plugging of the unit. This technology is technically infeasible.

Biofiltration

Temperature is an important variable affecting biofilter operations. The kiln exhaust temperature of approximately 120 – 140°F exceeds that at which microorganisms thrive. The terpenes in the exhaust stream, being highly viscous, would foul the biofilter. There are no known systems utilizing this application and leaves this option as technically infeasible.

Wet Scrubbing

The terpenes within the kiln exhaust are not highly soluble but are highly viscous. This would lead to plugging the absorption media of a wet scrubber and leaves the process technically infeasible.

Step 3 – Rank remaining control technologies by control effectiveness:

Proper Maintenance and Operation

The only technically feasible control technology for controlling VOC emissions from the proposed CDK is the use of proper maintenance and operating practices. Since this was the only remaining BACT control technology technically or economically feasible, ranking is not needed.

Step 4 – Evaluate most effective controls and document results

Proper Maintenance and Operation

Using the steps from the US EPA guidelines, only proper maintenance and operation remains technically feasible. Further, this is the only control identified in the RBLC database.

Step 5 – Select BACT

BACT is the most effective control technology remaining of the previous four steps. Proper kiln maintenance and operation is the only remaining technology for the control of VOC. The BACT limit on similar kilns are shown at 3.38 lb/MBf – 5.49 lb/MBf with the RBLC database.

Harrigan proposes BACT as proper kiln maintenance and operation at 4.78 lb/MBf as VOC (WPP1). The factor of 4.78 lb/MBf as VOC (WPP1) is consistent with other recent BACT determinations. To demonstrate compliance with this limit, Harrigan proposes to establish and follow a kiln maintenance and operating plan. Proper maintenance and operating practices will ensure optimal drying through production scheduling and kiln temperature set point reducing the potential for over drying lumber.

From this BACT review, Harrigan Lumber Company proposes the technology and limit presented in Table 5-1 as BACT for the continuous kiln and condensate evaporator emissions.

Table 5-1 Proposed BACT Limit Summary

Unit	Pollutant	BACT	Limit	Compliance Method
CDK-2 CE-1 CE-2	VOC	Proper Maintenance and Operating Practices	4.78 lb/MBf	Recordkeeping of Maintenance

5.2 Proposed Monitoring, Recordkeeping, and Reporting

Harrigan proposed the following compliance requirements for this proposed project within Table 5.2.

Table 5.2 Proposed Compliance

Emission Source Description	Emission Point ID	Proposed Compliance Requirements
Direct-Fired Continuous Lumber Dry Kiln No. 2	CDK-2	Maintain proper operating and maintenance practices and retain records of such practices
		Monthly records of lumber dried (110,000 MBf/yr on a 12-month rolling average basis)
Direct-Fired Continuous Lumber Dry Kiln No. 2 Condensate Evaporator No. 1 Condensate Evaporator No. 2	CDK-2 CE-1 CE-2	Calculate the 12-month rolling average emissions of NSR regulated pollutants in tpy

6 AIR QUALITY AND IMPACT ANALYSIS

A source that is subject to PSD is required to conduct an air quality analysis of the ambient air impacts associated with the project. The ambient air quality analysis is address in Section 6.1 utilizing the US EPA's Modeled Emission Rates for Precursors (MERPs) as Harrigan is subject to PSD permitting for VOC, which is a precursor to ozone. Section 6.2 addresses the additional impacts to document that impacts to the environment have been minimized.

6.1 Modeled Emission Rates for Precursors (MERPs)

As Harrigan's proposed project is subject to PSD permitting for VOC, as a precursor to ozone, it is necessary to conduct an air quality analysis of the ambient air impacts associated with the project. The analysis should demonstrate that the project emissions will neither cause nor contribute to a violation of the NAAQS or PSD increments.

EPA recommends a two-tiered approach for addressing single source impacts on ozone (O_3). Tier 1 involves use of appropriate and technically credible relationships between emissions and ambient impacts developed from existing modeling studies that are determined sufficient for evaluating the project impacts. Tier 2 involves chemical transport modeling. Tier 1 sufficiently demonstrates there will be no negative impact to the air quality as a result of this project.

Following the steps outlined in US EPA's *Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program* dated April 30, 2019, hereafter called "Guidance", the following section documents how the facility satisfies the compliance demonstration requirements for ozone under the PSD program. The steps required by the EPA are:

Step 1 – Identify representative hypothetical source. Start with lowest, most conservative, illustrative MERPs for selected Climate Zone (Table 4-1 of Guidance copied below).

Step 2 – Acquire source characteristics and associated source impact modeling results. Screen the closest hypothetical sources to the project facility and select the lowest, most conservative, MERPs.

Step 3 – Apply the source characteristics and photochemical modeling results from Step 2 to the MERP equation with the appropriate SIL value to assess the project source impacts.

In the context of the PSD program, precursors to O_3 include volatile organic compounds (VOC) and nitrogen oxides (NO_x) thus contribution of both from the project are evaluated.

Harrigan's project proposes an increase in emissions of 263.317 tpy of VOC (WPP1) and 14.214 tpy NO_x . Being located in Monroeville, AL, there are no unusual circumstances regarding complex terrain, proximity to very large sources of either NO_x or VOC, or meteorology. Thus, the climate zone is defined as the relevant geographic area such that the lowest MERPs from Guidance's Table 4-1, Figure 6-1, for the southeast region could be considered representative and chosen for comparison with the project emissions in lieu of selecting a particular hypothetical source from this same climate zone.

Figure 6.1 Guidance Table 4-1

Copied from Guidance

Table 4-1. Lowest, median, and highest illustrative MERP values (tons per year) by precursor, pollutant and climate zone.

Note: illustrative MERP values are derived based on EPA modeling and EPA recommended SILs from EPA’s final SILs guidance (U.S. Environmental Protection Agency, 2018).

Climate Zone	8-hr O ₃ from NO _x			8-hr O ₃ from VOC		
	Lowest	Median	Highest	Lowest	Median	Highest
Northeast	209	495	5,773	2,068	3,887	15,616
Southeast	170	272	659	1,936	7,896	42,964
Ohio Valley	126	340	1,346	1,159	3,802	13,595
Upper Midwest	125	362	4,775	1,560	2,153	30,857
Rockies/Plains	184	400	3,860	1,067	2,425	12,788
South	190	417	1,075	2,307	4,759	30,381
Southwest	204	422	1,179	1,097	10,030	144,744
West	218	429	936	1,094	1,681	17,086
Northwest	199	373	4,031	1,049	2,399	15,929

As EPA recommends that the NO_x and VOC precursor impacts on 8-hr daily maximum O₃ be considered together to determine if the project source’s air quality impact would exceed the O₃ SIL, the project emissions increase is expressed as a percent of the MERP for each precursor and then the percentages are summed. A value less than 100% verifies that the EPA recommended 8-hour O₃ SIL will not be exceeded when considering the combined impacts of these precursors on 8-hr daily maximum O₃.

The NO_x emissions of 14.214 tpy and VOC emissions of 263.317 tpy from the project are well below the lowest (most conservative) MERP values in the southeast region, NO_x at 170 tpy, and VOC at 1,936 tpy. Thus, air quality impacts from each O₃ precursor from this source are expected to be below the EPA recommended 8-hour O₃ SIL, 1.0 ppb as demonstrated below.

$$\begin{aligned}
 \text{Project Impact as \% of SIL} &= (\text{tpy NO}_x \text{ from source/south east climate zone NO}_x \text{ MERP} \\
 &\quad + \text{tpy VOC from source/ south east climate zone VOC MERP}) * 100 \\
 &= (14.214 \text{ tpy}/170 \text{ tpy} + 263.317/1,936 \text{ tpy}) * 100 \\
 &= (0.084 + 0.136) * 100 \\
 &= 0.220 * 100 = 22.0 \% \text{ of SIL}
 \end{aligned}$$

This project impact determination of 22.0% of the O₃ SIL from both NO_x and VOC precursor emissions together indicates no further analysis is required.

However, given the industry present in Monroe County and EPA’s ambiguity of “very large sources of either NO_x or VOC”, a hypothetical source is also utilized for compliance demonstration.

A comparable hypothetical source based on source characteristics and associated source impact modeling results is evaluated. The lowest MERP from nearby sources with similar stack heights is

used. EPA's excel spreadsheet available on SCRAM identifies one source with low level emission releases at 500 tpy modeled for VOC and NO_x in the southeast region located in Autauga County, Alabama as copied below, Figure 6-2.

(https://www3.epa.gov/ttn/scram/guidance/guide/illustrative_merps_epa_modeling_2018dec28version.xlsx).

Figure 6-2 US EPA Geographical MERPs

PRECUF	POLL	State	County	FIPS	EMISSI	STACKH	CONC	MERP	LATITU	LONGIT	CZ	CZNAV	terravg	urbmax	DOMAI	SOURC
VOC	OZONE	Alabama	Autauga	1001	500	10	0.064	7796	32.522	-86.5498		2 Southeast	96	25	12EUS2	4

METRIC	PRECUF	POLL	State	County	FIPS	EMISSI	STACKH	CONC	MERP	LATITU	LONGIT	CZ	CZNAV	terravg	urbmax	DOMAI	SOURC
MDA8	NOX	OZONE	Alabama	Autauga	1001	500	10	2.012	249	32.522	-86.5498		2 Southeast	96	25	12EUS2	4

The project stacks are 36 feet 9 inches (11.2 meters) indicating a stack height of 10 meters is more appropriate than 90 meters. Project emissions are 14.214 tpy NO_x and 263.317 tpy VOC. As such, the EPA modeled emission rates of 500 tpy for NO_x and VOC are the most representative. Given the close proximity of Harrigan to the hypothetical source (approximately 110 miles), the meteorology is adequately characterized. The facility is in the same region as the hypothetical source; thus, the background pollutant concentrations and emissions are reasonably similar.

To account for additive precursor impacts on 8-hr daily maximum O₃, the project impact as a % of SIL is calculated.

$$\begin{aligned}
 \text{Project Impact as \% of SIL} &= \text{tpy NO}_x \text{ from source/tpy hypothetical source NO}_x \text{ MERP} \\
 &\quad + \text{tpy VOC from source/tpy hypothetical source VOC MERP} * 100 \\
 &= (14.214 \text{ tpy}/249 \text{ tpy} + 263.317 \text{ tpy}/7796 \text{ tpy}) * 100 \\
 &= (0.057 + 0.034) * 100 \\
 &= 0.091 * 100 = 9.1 \% \text{ of SIL}
 \end{aligned}$$

Based on EPA modeling results for this representative hypothetical source, again, we demonstrate the project source emissions are expected to be well less than the EPA recommended SIL. Further compliance demonstration is not required.

6.2 Additional Impact Analysis

In addition to the BACT analysis and the Ambient Air Quality analysis, this PSD application documents that impacts to the environment have been minimized. Harrigan is in Monroe County, which is attainment for all criteria pollutants. The pollutants of concern for visibility and deposition are PM, SO₂, and NO_x. Because the project triggers PSD review for VOC only and would not cause a significant increase of PM, SO₂, or NO_x affecting visibility, no adverse impact to visibility is expected. The secondary impacts on soils and vegetation from the project have also been considered. The US EPA document *A Screening Procedure for the Impact of Air Pollution Sources on Plants, Soils, and Animals* provides methods to evaluate impacts of SO₂, NO₂, CO, and PM₁₀ to determine if there is a potential for vegetative stress. As the project does not have a significant emission increase of SO₂, NO₂, CO, and PM₁₀, no adverse impacts on soils and vegetation are anticipated. The project will not increase the workforce associated with the current mill; there will be no appreciable long-term growth in the area due to the project. Good management practices will be employed by the mill and contractor personnel to ensure minimal environmental impact from construction activities including minimizing fugitive dust and runoff.

APPENDIX A

ADEM REQUIRED FORMS

APPENDIX A-1

Form 103

ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT (AIR DIVISION)

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Facility Number

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CONSTRUCTION/OPERATING PERMIT APPLICATION
FACILITY IDENTIFICATION FORM

1. Name of Facility, Firm, or Institution: Harrigan Lumber Company, Inc.

Facility Physical Location Address

Street & Number: 1033 Hornady Road

City: Monroeville County: Monroe Zip: 36460

Facility Mailing Address (If different from above)

Address or PO Box: PO Drawer 926

City: Monroeville State: AL Zip: 36461

Owner's Business Mailing Address

2. Owner: Harrigan Lumber Company, Inc.

Street & Number: PO Drawer 926 City: Monroeville

State: AL Zip: 36461 Telephone: 251-575-4821

Responsible Official's Business Mailing Address

3. Responsible Official: Alan Morgan Title: Production Manager

Street & Number: PO Drawer 926

City: Monroeville State: AL Zip: 36461

Telephone Number: 251-362-1100 E-mail Address: amorgan@harriganlumber.com

Plant Contact Information

4. Plant Contact: Darrel McKinley Title: HR/EHS Manager

Telephone Number: 251-575-4821 E-mail Address: dmckinley@harriganlumber.com

5. Location Coordinates:

UTM	3,486,795	E-W	471,915	N-S
Latitude/Longitude	31.517532	LAT	-87.296258	LONG

6. Permit application is made for:

- Existing source (initial application)
- Modification
- New source (to be constructed)
- Change of ownership
- Change of location
- Other (specify) _____

Existing source (permit renewal)

If application is being made to construct or modify, please provide the name and address of installer or contractor

DelTech Manufacturing/BidGroup

930 Molly Pond Road

Augusta, GA 30901

Telephone 250-564-3585

Date construction/modification to begin upon approval (~Sept 2019) to be completed ~July 2020

7. Permit application is being made to obtain the following type permit:

- Air permit
- Major source operating permit
- Synthetic minor source operating permit
- General permit

8. Indicate the number of each of the following forms attached and made a part of this application: (if a form does not apply to your operation indicate "N/A" in the space opposite the form). Multiple forms may be used as required.

- NA ADEM 104 - INDIRECT HEATING EQUIPMENT
- 1 ADEM 105 - MANUFACTURING OR PROCESSING OPERATION
- NA ADEM 106 - REFUSE HANDLING, DISPOSAL, AND INCINERATION
- NA ADEM 107 - STATIONARY INTERNAL COMBUSTION ENGINES
- NA ADEM 108 - LOADING, STORAGE & DISPENSING LIQUID & GASEOUS ORGANIC COMPOUNDS
- NA ADEM 109 - VOLATILE ORGANIC COMPOUND SURFACE COATING EMISSION SOURCES
- NA ADEM 110 - AIR POLLUTION CONTROL DEVICE
- NA ADEM 112 - SOLVENT METAL CLEANING
- NA ADEM 438 - CONTINUOUS EMISSION MONITORS
- NA ADEM 437 - COMPLIANCE SCHEDULE

9. General nature of business: (describe and list appropriate standard industrial classification (SIC) and North American Industry Classification System (NAICS) (www.naics.com) code(s)):

PINE LUMBER MANUFACTURER

SIC CODE - 2421, NAICS CODE - 321113

10. For those making application for a synthetic minor or major source operating permit, please summarize each pollutant emitted and the emission rate for the pollutant. Indicate those pollutants for which the facility is major.

Regulated pollutant	Potential Emissions* (tons/year)	Major source? yes/no
Particulates	213.992	YES
Volatile Organic Compounds (WPP1)	513.005	YES
Carbon Monoxide	188.247	YES
Nitrogen Oxides	75.884	NO
Sulfur Oxides	7.151	NO
Methanol (HAP)	20.424	YES
Formaldehyde (HAP)	10.311	YES
Acetaldehyde (HAP)	4.161	NO
Greenhouse Gases (CO2e)	86,693	NO
PM10	45.713	NO
PM2.5	27.433	NO

*Potential emissions are either the maximum allowed by the regulations or by permit, or, if there is no regulatory limit, it is the emissions that occur from continuous operation at maximum capacity.

11. For those applying for a major source operating permit, indicate the compliance status by program for each emission unit or source and the method used to determine compliance. Also cite the specific applicable requirement.

CDK-2/CE-1/CE-2

Emission unit or source:

(description)

Emission Point No.	Pollutant ⁴	Standard	Program ¹	Method used to determine compliance	Compliance Status	
					IN ²	OUT ³
CDK-2/CE-1/CE-2	VOC	40 CFR 52	PSD	Proper Maintenance and Operation	Proposed	
CDK-2/CE-1/CE-2	HAP	40 CFR 63 PCWP MACT	NESHAP	Permit app provides notification of applicability	IN	

¹ PSD, non-attainment NSR, NSPS, NESHAP (40 CFR Part 61), NESHAP (40 CFR Part 63), accidental release (112(r)), SIP regulation, Title IV, Enhanced Monitoring, Title VI, Other (specify)

² Attach compliance plan

³ Attach compliance schedule (ADEM Form-437)

⁴ Fugitive emissions must be included as separate entries

13. List and explain any exemptions from applicable requirements the facility is claiming:

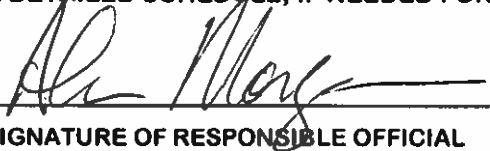
- a. _____
- b. _____
- c. _____
- d. _____
- e. _____
- f. _____
- g. _____
- h. _____
- i. _____

14. List below other attachments that are a part of this application(all supporting engineering calculations must be appended):

- a. ADEM Forms
- b. Project Description and Drawings
- c. Regulatory Applicability including PSD Analysis
- d. BACT Review and Proposed Compliance Demonstration
- e. Air Quality and Impact Analysis
- f. Emission Calculations
- g. Reference Documentation
- h. _____
- i. _____

I CERTIFY UNDER PENALTY OF LAW THAT, BASED ON INFORMATION AND BELIEF FORMED AFTER REASONABLE INQUIRY, THE STATEMENTS AND INFORMATION CONTAINED IN THIS APPLICATION ARE TRUE, ACCURATE AND COMPLETE.

I ALSO CERTIFY THAT THE SOURCE WILL CONTINUE TO COMPLY WITH APPLICABLE REQUIREMENTS FOR WHICH IT IS IN COMPLIANCE, AND THAT THE SOURCE WILL, IN A TIMELY MANNER, MEET ALL APPLICABLE REQUIREMENTS THAT WILL BECOME EFFECTIVE DURING THE PERMIT TERM AND SUBMIT A DETAILED SCHEDULE, IF NEEDED FOR MEETING THE REQUIREMENTS.

	Production Manager	8/13/2019
SIGNATURE OF RESPONSIBLE OFFICIAL	TITLE	DATE

APPENDIX A-2

Form 105

**PERMIT APPLICATION
FOR
MANUFACTURING OR PROCESSING OPERATION**

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Do not write in this space

1. Name of firm or organization: Harrigan Lumber Company

2. Briefly describe the operation of this unit or process in your facility: (separate forms are to be submitted for each type of process or for multiple units of one process type. If the unit or process receives input material from, or provides input material to, another operation, please indicate the relationship between the operations.) An application should be completed for each alternative operating scenario.

Operating scenario number ¹

After the green rough lumber exits the sawmill, it is sorted. The lumber is then staged and transferred to a lumber drying kiln for moisture removal. Continuous Dry Kiln #2 (CDK #2) is proposed as a 110 MMBf/yr unit heated by a 45 MMBtu/hr direct fired natural gas burner. Kiln condensate will be routed to a natural gas fired condensate evaporator (CE-1 and CE-2). Each evaporator will be equipped with a 5.3 MMBtu/hr burner.

3. Type of unit or process (e.g., calcining kiln, cupola furnace): Natural Gas Fired Continuous Dry Kiln #2 (CDK-2)

Kiln Condensate Evaporators (CE-2 and CE-1)

Make: DelTech **Model:**

Rated process capacity (manufacturer's or designer's guaranteed maximum) in pounds/hour: 110 MMBf

Manufactured date: 2019 **Proposed installation date:** 10/2019

Original installation date (if existing):

Reconstruction or Modification date (if applicable):

4. Normal operating schedule:

Hours per day: 24 **Days per week:** 7 **Weeks per year:** 52

Peak production season (if any):

5. Materials (feed input) used in unit or process (include solid fuel materials used, if any):

Material	Process Rate Average (lb/hr)	Maximum (lb/hr)	Quantity tons/year
Green Rough Lumber	12.6 MBf/hr	13.1 MBf/hr	110,000 MBf/yr
Natural Gas	34 MMBtu/hr	45 MMBtu/hr	394,200 MMBtu/yr
Condensate from Kiln, per kiln	300 gal/hr	360 gal/hr	3,153,600 gal/yr

6. Total heat input capacity of process heating equipment (exclude fuel used by indirect heating equipment previously described on Form ADEM-104): 45 & 5.3(CEs) MMBtu/hr

Fuel	Heat Content	Units	Max. % Sulfur	Max. % Ash	Grade No. [fuel oil only]	Supplier [used oil only]
Coal		Btu/lb				
Fuel Oil		Btu/gal				
Natural Gas	1,020	Btu/ft ³	<0.0005			
L. P. Gas		Btu/ft ³				
Wood		Btu/lb				
Other (specify)						

7. Products of process or unit:

Products	Quantity/year	Units of production
Dry Rough Lumber	110,000	MBf/yr

8. For each regulated pollutant, describe any limitations on source operation which affects emissions or any work practice standard (attach additional page if necessary):

CDK-2 will not dry more than 110 MMBf/yr. HAP - PCWP MACT compliance.

VOC - see the Best Available Control Technology section for summary of work practice standards

9. Is there any emission control equipment on this emission source?

Yes No (Where a control device exists, Form ADEM-110 must be completed and attached).

10. Air contaminant emission points: (Each point of emission should be listed separately and numbered so that it can be located on the attached flow diagram):

Emission Point	Stack		Diameter (Feet)	Gas Exit Velocity (Feet/Sec)	Volume of Gas Discharged (ACFM)	Exit Temperature (°F)
	Height Above Grade (Feet)	Base Elevation (Feet)				
CDK-2 East End	37	340	2.66	60	20,000	140
CDK-2 West End	37	340	2.66	60	20,000	140

* Std temperature is 68°F - Std pressure is 29.92" in Hg.

11. Air contaminants emitted: Basis of estimate (material balance, stack test, emission factor, etc.) must be clearly indicated on calculations appended to this form. Fugitive emissions must be included and calculations must be appended.

Emission Point	Pollutants	Potential Emissions			Regulatory Emission Limit	
		(lb/hr)	(Tons/yr)	Basis of Calculation	(lb/hr)	(units of standard)
CDK-2/CE-2/CE-1	Particulate (proposed limit)	0.404	1.717	Emission factor	NA	NA
	VOC as C VOC (WPP1)	49.838 62.715	209.252 263.317	Emission factor	NA	NA
	CO	4.579	20.055	Emission factor	NA	NA
	NOx	3.245	14.214	Emission factor	NA	NA
	SOx	0.033	0.143	Emission factor	NA	NA
	Methanol (HAP) Formaldehyde (HAP)	2.358 0.852	9.900 3.578	Emission factor	NA	NA
	Phenol (HAP) Propionaldehyde (HAP)	0.131 0.052	0.550 0.220	Emission factor	NA	NA
	Acetaldehyde (HAP) Acrolein (HAP)	0.524 0.052	2.200 0.220	Emission factor	NA	NA
	Greenhouse Gas Emissions (CO2e)	6,549	28,684	Emission factor	NA	NA

12. Using a flow diagram:

- (1) Illustrate input of raw materials,
- (2) Label production processes, process fuel combustion, process equipment and air pollution control equipment,
- (3) Illustrate locations of air contaminant release so that emission points under item 10 can be identified.

(Check box if extra pages are attached)
Process flow diagram

13. Is this unit or process in compliance with all applicable air pollution rules and regulations?

Yes No

(if "no", a compliance schedule, Form ADEM-437 must be completed and attached.)

14. Does the input material or product from this process or unit contain finely divided materials which could become airborne?

Yes No

15. If "yes", is this material stored in piles or in some other facility as to make possible the creation of fugitive dust problems?

Yes No

List storage piles or other facility (if any):

Type of material	Particle size (diameter or screen size)	Pile size or facility (average tons)	Methods utilized to control fugitive emissions (wetted, covered, etc.)

Name of person preparing application: Lisa M. Reed

Signature: *Lisa M. Reed* Date: 08/13/19

APPENDIX B

EMISSION CALCULATIONS

APPENDIX B-1

Potential to Emit for New Sources

POTENTIAL TO EMIT CALCULATIONS

Equipment Information

Continuous Drying Kiln No. 2 (CDK-2)					
Burner Rating	45	MMBtu/hr	394,200	MMBtu/yr	Burner design and full year operation
Dried Lumber Production	13.1	MBf/hr	110,000	MBf/yr	Kiln design (hourly) and production limit (annual)

Emission Calculations CDK-2

Pollutant	Emission Factors		Potential Emissions		Notes
	Lumber Drying lb/MBf	Fuel Combustion lb/MMscf	lb/hr	tpy	
PM (f)	0.022	1.9	0.37	1.577	NCDENR Lumber Kiln Emission Factor for Steam Heated Kiln (PM) and AP-42 Table 1.4-2 for NG Emissions (PM _{filterable})
PM ₁₀	0.022	7.6	0.62	2.679	NCDENR Lumber Kiln Emission Factor for Steam Heated Kiln (assumed PM ₁₀ = PM) and AP-42 Table 1.4-2 for NG Emissions
PM _{2.5}	0.022	7.6	0.62	2.679	NCDENR Lumber Kiln Emission Factor for Steam Heated Kiln (assumed PM _{2.5} = PM) and AP-42 Table 1.4-2 for NG Emissions
VOC as C	3.80	--	49.78	209.000	ADEQ Memo
VOC (WPP1)	4.78	--	62.66	263.065	WPP1 = (VOC as C * 1.225 + (1-0.65)*Methanol + Formaldehyde)
SO ₂	--	0.6	0.03	0.116	AP-42 Table 1.4-2
CO	--	84	3.71	16.232	AP-42 Table 1.4-1
NO _x	--	50.0	2.21	9.662	AP-42 Table 1.4-1
Lead	--	5.00E-04	2.21E-05	9.66E-05	AP-42 Table 1.4-2
CO ₂	--	120,020	5,295	23,192	EPA EF for GHG Inventories, Table 1
CH ₄	--	2.27	0.10	0.439	EPA EF for GHG Inventories, Table 1
N ₂ O	--	0.22	0.01	0.043	EPA EF for GHG Inventories, Table 1
GHG	--	120,022	5,295	23,192	Sum of individual GHGs
Total CO ₂ e	--	120,142	5,300	23,216	EPA EF for GHG Inventories, Table 10a
Acetaldehyde	0.04	--	0.52	2.200	PCWP Memo
Acrolein	0.004	--	0.05	0.220	PCWP Memo
Formaldehyde	0.07	--	0.85	3.575	PCWP Memo
Methanol	0.18	--	2.36	9.900	PCWP Memo
Phenol	0.01	--	0.13	0.550	PCWP Memo
Propionaldehyde	0.004	--	0.05	0.220	PCWP Memo

POTENTIAL TO EMIT CALCULATIONS

Equipment Information

Condensate Evaporator No. 1 (CE-1) and No. 2 (CE-2)					
Burner Rating	5.3	MMBtu/hr	46,428	MMBtu/yr	Burner design for each burner and full year operation
Kiln Condensate Production	360	gal/hr	3,153,600	gal/yr	Manufacturer estimate of max

Emission Calculations CE-1 and CE-2

Pollutant	Emission Factors		Potential Emissions per Evaporator		Notes
	Condensate Evaporation lb/gal	Fuel Combustion lb/MMscf	lb/hr	tpy	
PM (f)	1.68E-05	1.9	0.02	0.070	Maximum Total Dissolved Solids (mg/L) for southern yellow pine condensate per industry trade group presentation and AP-42 Table 1.4-2 for NG Emissions (PM _{filterable})
PM ₁₀	1.68E-05	7.6	0.05	0.199	Assumed PM ₁₀ = PM for evaporation and AP-42 Table 1.4-2 for NG Emissions
PM _{2.5}	1.68E-05	7.6	0.05	0.199	Assumed PM _{2.5} = PM for evaporation and AP-42 Table 1.4-2 for NG Emissions
VOC	6.02E-07	5.5	0.03	0.126	Converted from total volatile extract at 72.1 mg/m3 per bioresources.com "Analysis of the Chemical Constituent of Dry-Kiln Condensate and its Technological Recovery - Part 1: Volatile Extractives" and AP-42 Table 1.4-2
SO ₂	--	0.6	3.12E-03	0.014	AP-42 Table 1.4-2
CO	--	84	0.44	1.912	AP-42 Table 1.4-1
NO _x	--	100	0.52	2.276	AP-42 Table 1.4-1
Lead	--	5.00E-04	2.60E-06	1.14E-05	AP-42 Table 1.4-2
CO ₂	--	120,020	624	2,732	EPA EF for GHG Inventories, Table 1
CH ₄	--	2.27	0.01	0.052	EPA EF for GHG Inventories, Table 1
N ₂ O	--	0.22	1.15E-03	0.005	EPA EF for GHG Inventories, Table 1
GHG	--	120,022	624	2,732	Sum of individual GHGs
Total CO ₂ e	--	120,142	624	2,734	EPA EF for GHG Inventories, Table 10a
Formaldehyde	--	7.50E-02	3.90E-04	1.71E-03	AP-42 Table 1.4-3
Hexane	--	1.80E+00	0.01	0.041	AP-42 Table 1.4-3

Project Potential to Emit (PTE)	PM	PM ₁₀	PM _{2.5}	VOC (WPP1)	SO ₂	CO	NO _x	CO ₂ e
Continuous Drying Kiln No. 2 (CDK-2)	1.577	2.679	2.679	263.065	0.116	16.232	9.662	23,216
Condensate Evaporator No. 1 (CE-1)	0.070	0.199	0.199	0.126	0.014	1.912	2.276	2,734
Condensate Evaporator No. 2 (CE-2)	0.070	0.199	0.199	0.126	0.014	1.912	2.276	2,734
New Sources PAE (PTE)	1.717	3.078	3.078	263.317	0.143	20.055	14.214	28,684

Conversions
 Natural Gas Heating Value 1,020 btu/scf
 Volume 7.48 gal/ft3
 Volume 35,3147 ft3/m3
 Weight 453,592 mg/lb

POTENTIAL TO EMIT CALCULATIONS

Summary of PTE from CDK-2, CE-1, and CE-2

Pollutant	Potential Emissions for the Project	
	lb/hr	tpy
PM (f)	0.404	1.717
PM ₁₀	0.715	3.078
PM _{2.5}	0.715	3.078
VOC as C	49.838	209.252
VOC (WPP1)	62.715	263.317
SO ₂	0.033	0.143
CO	4.579	20.055
NO _x	3.245	14.214
Lead	0.000	0.000
CO ₂	6,542	28,655
CH ₄	0.124	0.542
N ₂ O	0.012	0.053
GHG	6,542	28,656
Total CO ₂ e	6,549	28,684
Acetaldehyde	0.524	2.200
Acrolein	0.052	0.220
Formaldehyde	0.852	3.578
Methanol	2.358	9.900
Phenol	0.131	0.550
Propionaldehyde	0.052	0.220
Hexane	0.019	0.082

APPENDIX B-2

Prevention of Significant Deterioration Analysis

PSD ANALYSIS BACKGROUND DATA
Baseline Evaluation

	2013	2014	2015	2016	Baseline	
					2017	2018
Green Lumber Produced (Bf)	74,344,232	80,995,550	80,288,083	81,284,906	83,157,512	101,528,203
Kiln 2 Dried (Bf)	26,673,153	28,021,312	25,480,365	23,967,680	21,897,920	0
Kiln 3 Dried (Bf)	18,651,776	20,896,128	25,630,246	25,462,586	26,634,496	14,020,613
Kiln 4 Dried (Bf)	29,019,303	28,418,597	29,177,472	31,854,640	30,418,368	22,905,976
CDK Dried (Bf)					1,634,227	65,997,288
Bark Sold (tons)	15,869	17,933	19,216	18,219	20,587	21,234
Sawdust Sold (tons)	4,713	5,775	6,232	4,986	6,404	198
Shavings Sold (tons)	8,212	8,751	6,955	8,610	9,790	22,477
Chips Sold (tons)	110,764	118,636	123,315	127,820	142,872	179,517
Planer Production (Bf)					77,965,719	100,141,579

		Baseline Emissions		
		2017	2018	Average
Planer Cyclone (C-1)	PM (f), tpy	2.583	4.615	3.599
	PM ₁₀ , tpy	2.348	4.195	3.272
	PM _{2.5} , tpy	1.409	2.517	1.963
Planer Shavings Hopper Cyclone (C-2B)	PM (f), tpy	1.171	3.462	2.317
	PM ₁₀ , tpy	1.065	3.147	2.106
	PM _{2.5} , tpy	0.639	1.888	1.264
Baseline Production	Planer Mill, Bf	77,965,719	100,141,579	89,053,649

**PSD ANALYSIS BACKGROUND DATA
Could Have Accommodated Evaluation**

	January	February	March	April	May	June	July	August	September	October	November	December	Total
2017													
Sawmill Production	6,444,038	6,258,387	8,243,758	6,264,372	8,586,817	7,115,355	6,268,600	7,965,143	5,930,827	6,084,352	6,797,299	7,198,564	83,157,512
Gross Hours (Sawmill)	207.5	210	260.5	209	299.5	240	219	281.5	222.5	235	229	252	2,865.50
Planer Production	5,481,044	6,296,608	8,083,771	5,750,091	8,511,233	6,968,403	5,834,399	8,143,444	5,188,830	5,890,857	5,521,572	6,295,467	77,965,719
Kiln Production	5,899,309	5,900,679	7,520,358	6,549,281	8,386,201	7,139,754	6,079,436	7,567,232	5,032,522	6,324,595	5,316,631	6,908,921	78,624,919
2018													
Sawmill Production	8,061,999	8,101,706	8,281,041	8,974,857	10,044,453	8,112,676	7,289,596	10,013,793	8,448,033	7,937,020	7,433,658	8,829,371	101,528,203
Gross Hours (Sawmill)	340.5	352.5	329	336	427.5	370	322.5	449	336.5	328.5	328	363.5	4,283.50
Planer Production	7,400,862	8,499,325	8,203,086	8,150,680	10,656,806	7,887,556	7,863,958	10,272,481	7,860,118	7,650,113	7,536,714	8,159,880	100,141,579
Kiln Production	7,428,314	8,109,968	8,748,711	8,441,091	10,353,112	7,743,861	7,607,686	9,746,598	8,141,962	7,532,696	8,114,132	7,332,718	99,300,849

Maximum planer production (Bf) 10,656,806 May 2018
 Annualized CHA production (Bf/yr) 127,881,672 Bf/yr

Projected Production through Planer Mill, Bf/yr 140,000,000
 % Increase Projected Production over Baseline Production 57.21%
 Could Have Accommodated Production through Planer Mill, Bf/yr 127,881,672
 % Increase CHA Production over Baseline Production 43.60%

PSD ANALYSIS

Baseline Actual Emissions (BAE)	PM	PM ₁₀	PM _{2.5}	VOC	SO ₂	CO	NO _x	CO _{2e}
Planer Cyclone (C-1)	3.599	3.272	1.963	-	-	-	-	-
Planer Shavings Hopper Cyclone (C-2B)	2.317	2.106	1.264	-	-	-	-	-
Total BAE, tpy	5.916	5.378	3.227	-	-	-	-	-
Projected Actual Emissions (PAE)	PM	PM ₁₀	PM _{2.5}	VOC	SO ₂	CO	NO _x	CO _{2e}
Planer Cyclone (C-1)	5.658	5.143	3.086	-	-	-	-	-
Planer Shavings Hopper Cyclone (C-2B)	3.642	3.311	1.986	-	-	-	-	-
Total PAE, tpy	9.300	8.454	5.072	-	-	-	-	-
Could Have Accommodated Emissions (CHA)	PM	PM ₁₀	PM _{2.5}	VOC	SO ₂	CO	NO _x	CO _{2e}
Planer Cyclone (C-1)	5.168	4.698	2.819	-	-	-	-	-
Planer Shavings Hopper Cyclone (C-2B)	3.327	3.024	1.814	-	-	-	-	-
Total CHA, tpy	8.495	7.722	4.633	-	-	-	-	-
Excludable Emissions (EE)	PM	PM ₁₀	PM _{2.5}	VOC	SO ₂	CO	NO _x	CO _{2e}
Total CHA	8.495	7.722	4.633	-	-	-	-	-
Total BAE	5.916	5.378	3.227	-	-	-	-	-
Total EE (CHA - BAE), tpy	2.579	2.345	1.407	-	-	-	-	-
Adjusted Projected Actual Emissions (APAE)	PM	PM ₁₀	PM _{2.5}	VOC	SO ₂	CO	NO _x	CO _{2e}
Total PAE	9.300	8.454	5.072	-	-	-	-	-
Total EE	2.579	2.345	1.407	-	-	-	-	-
Total APAE (PAE - EE), tpy	6.720	6.109	3.666	-	-	-	-	-
Actual To Projected Actual (ATPA)	PM	PM ₁₀	PM _{2.5}	VOC	SO ₂	CO	NO _x	CO _{2e}
Total APAE	6.720	6.109	3.666	-	-	-	-	-
Total BAE	5.916	5.378	3.227	-	-	-	-	-
Total ATPA (APAE - BAE), tpy	0.805	0.732	0.439	-	-	-	-	-
Actual To Potential (ATP)	PM	PM ₁₀	PM _{2.5}	VOC	SO ₂	CO	NO _x	CO _{2e}
New Sources PAE = PTE	1.717	3.078	3.078	263.317	0.143	20.055	14.214	28,684
New Sources BAE = 0 tpy	0	0	0	0	0	0	0	0
Total ATP (PAE - BAE), tpy	1.717	3.078	3.078	263.317	0.143	20.055	14.214	28,684
Total Emissions Increase from Project	PM	PM ₁₀	PM _{2.5}	VOC	SO ₂	CO	NO _x	CO _{2e}
Total ATPA Increase Existing Sources	0.805	0.732	0.439	-	-	-	-	-
Total ATP Increase New Sources	1.717	3.078	3.078	263.317	0.143	20.055	14.214	28,684
Hybrid Test Total Project Increase (ATPA + ATP), tpy	2.522	3.809	3.517	263.317	0.143	20.055	14.214	28,684
Significant Emission Rate (SER)	25	15	10	40	40	100	40	75,000
% of SER	10%	25%	35%	658%	0%	20%	36%	38%
PSD Review Required?	No	No	No	Yes	No	No	No	No

APPENDIX C

REFERENCE DOCUMENTS

APPENDIX C-1

Potential to Emit Emission Factor References

FACTORS:

Hardwood VOC factor changed from 0.34 to 0.409 to maintain 10% of softwood factor (REF: Kiln Factors per June 1999 DAQ letter to AFMA - posted on DAQ website)

North Carolina DENR Lumber Kiln Emission Factors

Hardwood toxics - there are no HAP/TAPS from hardwood kilns reported on this spreadsheet

Softwood: VOC, toxics, and PM from Wallace Pitts (DAQ-RCO) analysis of NCASI/EPA data summarized below (see full spreadsheet on DAQ website for factor documentation):

Note: NCASI data is based on shorter kiln cycles than for lumber kiln cycles at typical wood furniture manufacturing facilities. The emission factors may not be applicable.

Revised, references Southern Yellow Pine Emission Factors MBF is 1000 board feet			
emission factor, pounds per MBF			
	Steam heated	Suspension burner	Gasifier
PM	0.022 (1)	0.40 (2)	0.14 (3)
PM ₁₀	~	~	~
VOC			
as carbon	3.61 (4)	3.83 (5)	3.83 (5)
as VOC (pinene)	4.09	4.34	4.34
Methanol	0.199 (6)	0.161 (7)	0.161 (7)
Phenol	0.01(8)	0.01 (8)	0.01 (8)
Formaldehyde	0.0183 (9)	0.103 (10)	0.103 (10)
Acetaldehyde (11)	0.052	0.052	0.052
Acrolein (12)	0.0075	0.0075	0.0075
emission factor, pounds per MBF-hour			
	Steam heated	Suspension burner	Gasifier
Acetaldehyde	0.00377 (13)	0.00377	0.00377
Acrolein	0.00051 (14)	0.00051	0.00051
formaldehyde	0.0014 (15)	0.01185 (16)	0.01185 (16)
For TAPs, the emissions on an hourly basis are given by (Charge in 1000 board feet)* (emission factor) Example: 140,000 BF kiln charge = (140)*(0.00140) = 0.196 lb formaldehyde per hour			
Note: for hourly emissions of phenol, use emission factor in lb/MBF.			

REFERENCES

(1)	PRODUCT	FIRING TYPE	MILLS/UNITS/RUNS	RATIO OF NON-DETECTS	RANGE	MEDIAN	UNITS
	Southern Pine Lur	Steam Heated	3/3/16	0/16 nd	2.00E-03 to	1.70E-01	2.20E-02 lb/MBF
	Southern Pine Lur	Direct Fired	6/7/24	0/24 nd	2.30E-02 to	1.30E+00	3.70E-01 lb/MBF

(2) personal Communication, D Word, NCASI, May 31, 2005
Kiln 1K181

Suspension Burner	Run	M 5 lb/MBF	Production	Cycle time, hrs
1K181	1	0.4170	133	20.3
1K181	2	0.3480	133	20.3
1K181	1	0.4800	131	20
1K181	2	0.4100	131	20
1K181	3	0.3600	131	20
		0.40	131.80	20.12

(3) personal Communication, D Word, NCASI, May 31, 2005

Kiln 098 DF				
Gasifier	Run	M 5 lb/MBF	Production	Cycle time, hrs
1K098	1	0.2670	130	26.45
1K098	2	0.2010	130	26.45
1K098	3	0.2260	130	26.45
2K098	1	0.1520	128	17.52
2K098	2	0.1810	128	17.52
2K098	3	0.0980	128	17.52
2K098	1	0.0640	104.5	17.25
2K098	2	0.0548	104.5	17.25
2K098	3	0.0466	104.5	17.25
		0.143	120.83	20.41

(4) NCASI Technical Bulletin 845 Table 8.2 Steam heated average of all kilns

(5) NCASI Technical Bulletin 845 Table 8.1 Direct fired (gasifier) full scale kiln only

(6) NCASI Technical Bulletin 845 Table 9.6 Steam heated all kilns

(7) NCASI Technical Bulletin 845 Table 9.4 Direct fired (gasifier) full scale kiln

(8) Table 2A to Appendix B Emission factors for Plywood and Composite Wood Product MACT (Subpart DDDD)

(9) NCASI Technical Bulletin 845 Table 9.5 steam heated full scale kiln and OSU small scale runs. MSU not used. See spreadsheet tab for statistical test

(10) NCASI Technical Bulletin 845 Table 9.3 Direct fired full scale kiln only

(11) NCASI Technical Bulletin 845 Appendix BB6 FSK INDF3 and BB7 OSU INDF3

(12) NCASI Technical Bulletin 845 Appendix BB6 FSK INDF3 and BB7 OSU INDF3

(13) NCASI Technical Bulletin 845 Appendix BB6 FSK INDF3 run # 10 and BB7 OSU INDF3 Run # 2

(14) NCASI Technical Bulletin 845 Appendix BB6 FSK INDF3 run # 10 and BB7 OSU INDF3 Run # 2

(15) NCASI Technical Bulletin 845 Appendix Y7 FSK INDF1 run # 9, BB6 FSK INDF3 run # 10, App Y9 OSU INDF1 run # 4, BB7 OSU INDF3 run # 5

(16) NCASI Technical Bulletin 845 Appendix Y1 FSK DF2 run # 6, Y2 FSK DF5 run # 6

Table 1.4-1. EMISSION FACTORS FOR NITROGEN OXIDES (NO_x) AND CARBON MONOXIDE (CO)
FROM NATURAL GAS COMBUSTION^a

Combustor Type (MMBtu/hr Heat Input) [SCC]	NO _x ^b		CO	
	Emission Factor (lb/10 ⁶ scf)	Emission Factor Rating	Emission Factor (lb/10 ⁶ scf)	Emission Factor Rating
Large Wall-Fired Boilers (>100) [1-01-006-01, 1-02-006-01, 1-03-006-01]				
Uncontrolled (Pre-NSPS) ^c	280	A	84	B
Uncontrolled (Post-NSPS) ^c	190	A	84	B
Controlled - Low NO _x burners	140	A	84	B
Controlled - Flue gas recirculation	100	D	84	B
Small Boilers (<100) [1-01-006-02, 1-02-006-02, 1-03-006-02, 1-03-006-03]				
Uncontrolled	100	B	84	B
Controlled - Low NO _x burners	50	D	84	B
Controlled - Low NO _x burners/Flue gas recirculation	32	C	84	B
Tangential-Fired Boilers (All Sizes) [1-01-006-04]				
Uncontrolled	170	A	24	C
Controlled - Flue gas recirculation	76	D	98	D
Residential Furnaces (<0.3) [No SCC]				
Uncontrolled	94	B	40	B

^a Reference 11. Units are in pounds of pollutant per million standard cubic feet of natural gas fired. To convert from lb/10⁶ scf to kg/10⁶ m³, multiply by 16. Emission factors are based on an average natural gas higher heating value of 1,020 Btu/scf. To convert from lb/10⁶ scf to lb/MMBtu, divide by 1,020. The emission factors in this table may be converted to other natural gas heating values by multiplying the given emission factor by the ratio of the specified heating value to this average heating value. SCC = Source Classification Code. ND = no data. NA = not applicable.

^b Expressed as NO₂. For large and small wall fired boilers with SNCR control, apply a 24 percent reduction to the appropriate NO_x emission factor. For tangential-fired boilers with SNCR control, apply a 13 percent reduction to the appropriate NO_x emission factor.

^c NSPS=New Source Performance Standard as defined in 40 CFR 60 Subparts D and Db. Post-NSPS units are boilers with greater than 250 MMBtu/hr of heat input that commenced construction modification, or reconstruction after August 17, 1971, and units with heat input capacities between 100 and 250 MMBtu/hr that commenced construction modification, or reconstruction after June 19, 1984.

TABLE 1.4-2. EMISSION FACTORS FOR CRITERIA POLLUTANTS AND GREENHOUSE GASES FROM NATURAL GAS COMBUSTION^a

Pollutant	Emission Factor (lb/10 ⁶ scf)	Emission Factor Rating
CO ₂ ^b	120,000	A
Lead	0.0005	D
N ₂ O (Uncontrolled)	2.2	E
N ₂ O (Controlled-low-NO _x burner)	0.64	E
PM (Total) ^c	7.6	D
PM (Condensable) ^c	5.7	D
PM (Filterable) ^c	1.9	B
SO ₂ ^d	0.6	A
TOC	11	B
Methane	2.3	B
VOC	5.5	C

^a Reference 11. Units are in pounds of pollutant per million standard cubic feet of natural gas fired. Data are for all natural gas combustion sources. To convert from lb/10⁶ scf to kg/10⁶ m³, multiply by 16. To convert from lb/10⁶ scf to lb/MMBtu, divide by 1,020. The emission factors in this table may be converted to other natural gas heating values by multiplying the given emission factor by the ratio of the specified heating value to this average heating value. TOC = Total Organic Compounds.

VOC = Volatile Organic Compounds.

^b Based on approximately 100% conversion of fuel carbon to CO₂. CO₂[lb/10⁶ scf] = (3.67) (CON) (C)(D), where CON = fractional conversion of fuel carbon to CO₂, C = carbon content of fuel by weight (0.76), and D = density of fuel, 4.2x10⁴ lb/10⁶ scf.

^c All PM (total, condensable, and filterable) is assumed to be less than 1.0 micrometer in diameter. Therefore, the PM emission factors presented here may be used to estimate PM₁₀, PM_{2.5} or PM₁ emissions. Total PM is the sum of the filterable PM and condensable PM. Condensable PM is the particulate matter collected using EPA Method 202 (or equivalent). Filterable PM is the particulate matter collected on, or prior to, the filter of an EPA Method 5 (or equivalent) sampling train.

^d Based on 100% conversion of fuel sulfur to SO₂.

Assumes sulfur content is natural gas of 2,000 grains/10⁶ scf. The SO₂ emission factor in this table can be converted to other natural gas sulfur contents by multiplying the SO₂ emission factor by the ratio of the site-specific sulfur content (grains/10⁶ scf) to 2,000 grains/10⁶ scf.

TABLE 1.4-3. EMISSION FACTORS FOR SPECIATED ORGANIC COMPOUNDS FROM
NATURAL GAS COMBUSTION (Continued)

TABLE 1.4-3. EMISSION FACTORS FOR SPECIATED ORGANIC COMPOUNDS FROM
NATURAL GAS COMBUSTION^a

CAS No.	Pollutant	Emission Factor (lb/10 ⁶ scf)	Emission Factor Rating
91-57-6	2-Methylnaphthalene ^{b, c}	2.4E-05	D
56-49-5	3-Methylchloranthrene ^{b, c}	<1.8E-06	E
	7,12-Dimethylbenz(a)anthracene ^{b, c}	<1.6E-05	E
83-32-9	Acenaphthene ^{b, c}	<1.8E-06	E
203-96-8	Acenaphthylene ^{b, c}	<1.8E-06	E
120-12-7	Anthracene ^{b, c}	<2.4E-06	E
56-55-3	Benz(a)anthracene ^{b, c}	<1.8E-06	E
71-43-2	Benzene ^b	2.1E-03	B
50-32-8	Benzo(a)pyrene ^{b, c}	<1.2E-06	E
205-99-2	Benzo(b)fluoranthene ^{b, c}	<1.8E-06	E
191-24-2	Benzo(g,h,i)perylene ^{b, c}	<1.2E-06	E
207-08-9	Benzo(k)fluoranthene ^{b, c}	<1.8E-06	E
106-97-8	Butane	2.1E+00	E
218-01-9	Chrysene ^{b, c}	<1.8E-06	E
53-70-3	Dibenzo(a,h)anthracene ^{b, c}	<1.2E-06	E
25321-22-6	Dichlorobenzene ^b	1.2E-03	E
74-84-0	Ethane	3.1E+00	E
206-44-0	Fluoranthene ^{b, c}	3.0E-06	E
86-73-7	Fluorene ^{b, c}	2.8E-06	E
50-00-0	Formaldehyde ^b	7.5E-02	B
110-54-3	Hexane ^b	1.8E+00	E
193-39-5	Indeno(1,2,3-cd)pyrene ^{b, c}	<1.8E-06	E
91-20-3	Naphthalene ^b	6.1E-04	E
109-66-0	Pentane	2.6E+00	E
85-01-8	Phenanathrene ^{b, c}	1.7E-05	D
74-98-6	Propane	1.6E+00	E

TABLE 1.4-3. EMISSION FACTORS FOR SPECIATED ORGANIC COMPOUNDS FROM
NATURAL GAS COMBUSTION (Continued)

CAS No.	Pollutant	Emission Factor (lb/10 ⁶ scf)	Emission Factor Rating
129-00-0	Pyrene ^{b, c}	5.0E-06	E
108-88-3	Toluene ^b	3.4E-03	C

^a Reference 11. Units are in pounds of pollutant per million standard cubic feet of natural gas fired. Data are for all natural gas combustion sources. To convert from lb/10⁶ scf to kg/10⁶ m³, multiply by 16. To convert from lb/10⁶ scf to lb/MMBtu, divide by 1,020. Emission Factors preceded with a less-than symbol are based on method detection limits.

^b Hazardous Air Pollutant (HAP) as defined by Section 112(b) of the Clean Air Act.

^c HAP because it is Polycyclic Organic Matter (POM). POM is a HAP as defined by Section 112(b) of the Clean Air Act.

^d The sum of individual organic compounds may exceed the VOC and TOC emission factors due to differences in test methods and the availability of test data for each pollutant.

Memorandum

To: ADEQ Air Permit Engineers
From: Thomas Rheaume, Permit Branch Manager
Date: October 31, 2014
RE: VOC emissions from Lumber Drying Kilns

This guidance is to provide some consistency to the evaluation, limits and testing of VOC emissions from lumber kilns. It addresses VOC emissions only and not other emissions such those resulting from fuel use; except that VOC from fuel use is included in the case of direct fired kilns.

Summary

Since:

- The inherent design and function of kilns presents difficulty in testing accurately,
- VOC emissions are not subject to any control by the facility,
- NCASI and ADEQ data shows VOC emissions are consistently in the same emission factor range,
- No benefit is derived by requiring VOC testing on uncontrolled sources if acceptable values are used in permitting analysis, including
 - Emission Rates
 - BACT determinations
 - PSD Determinations/Netting

This memo establishes guidance that any permit that uses an uncontrolled emission factor of 3.5 and 3.8 lbVOC /MBF* average, for indirect and direct fired kilns respectively, is acceptable without additional testing conditions and extends this to PSD issues as listed above. This is a long term average (lb/batch or tons per rolling 12 month) and facilities may request higher short term (lb/hr) rates. Other values can be considered on a case by case basis with or without testing required.

This applies to the emission factor and is not a determination of BACT emission controls. A BACT determination is still required for applicable PSD permits (these factors can be used in the analysis) and if the final permit rates and limits are based on these factors without add on controls, then no testing is necessary.

*MBF is defined as 1000 board-feet of lumber

Discussion

Currently there are 4 types of lumber drying kilns found in Arkansas consisting of combinations of batch and continuous kilns and direct fired (wood or natural gas) and indirect (steam heated). These kilns primarily dry southern yellow pine, though on occasion hardwood may be dried.

Emissions result from the drying of the lumber and also in the combustion of the fuel in the case of direct fired kilns. These kilns do not employ any air pollution control equipment.

The kilns are constructed with multiple stacks or vents. For direct fired kilns, the combustion process contains a blower creating a flow of exhaust gasses. In an indirect kiln, there is no active fan or exhaust.

Stack testing of direct fired kilns has been done in the past by estimating total flow rates based on combustion gasses generated and testing of one vent for emissions, based on the assumption that all vents will have equal concentrations.

Emission data for VOC comes primarily from NCASI data and testing in Arkansas. These are summarized in the table below:

Type of Kiln	NCASI Factor lb/MBF	NCASI VOC Data ¹ lb/MBF	ADEQ VOC Factor lb/MBF ⁵	AR Test results
Batch Direct	3.8	3.38 lb/MBF mean ²	3.8 lb/MBF	2.05 lb/hr ⁶
Batch Indirect	3.5	5.16 lb/MBF max	3.5 lb/MBF	22.69 lb/hr ⁶
Continuous Direct	3.8	3.22 lb/MBF mean 4.59 lb/MBF max	3.8 lb/MBF	3.61 & 2.38 lb/MBF ³ 2.9 lb/MBF ⁴
Continuous Indirect	3.5	N/A	3.5 lb/MBF	None

¹Data from the latest NCASI data collection. NCASI cautions against setting limits based solely on the mean.

²Southern Yellow Pine Mix, less than 50% Hardwood – NCASI did not specify if they were DF or IDF, indicated factors are good for both types.

³ Anthony Forest Products

⁴ Bibler Brothers

⁵Value used in permits

⁶ Deltic, unknown lb/MBF conversion

BACT determinations for lumber kilns are attached, as of the date of this memorandum.. Many are not listed in lb/MBF but of those listed as such, limits range from 3.5 up to 7 lb/MBF. The most common limits are in the 3.5 to 5.2 range.

LUMBER KILN BACT DETERMINATIONS AS OF 10-31-2014

RBLCID	FACILITY_NAME	FACILITY_STATE	PROCESS_NAME	PRIMARY_FUEL	TESTMETHOD	EMISSION_LIMIT_1	EMISSION_LIMIT_1_UNIT	EMISSION_LIMIT_2	EMISSION_LIMIT_2_UNIT
AL-0235	ALBERTVILLE SAWMILL	AL	TWO 182.14 MBF, STEAM-HEADED LUMBER DRY KILNS (NORTH & SOUTH - K100/K101)		Unspecified	7	LB/MBF	0	
AL-0257	WEST FRASER-OPELIKA LUMBER MILL	AL	Two(2) 87.5 MMBF/YR Continuous kilns with a 35 MMBtu/hr direct-fired wood burner	Wood Shavings	Unspecified	3.76	LB/MBF	175	K/12 MONTHS
AL-0258	WEST FRASER, INC. - MAPLEWILE MILL	AL	Two(2) 100 MMBF/Y Continuous direct fired kiln	Wood Residuals	Unspecified	3.76	LB/MBF	0	
AL-0259	THE WESTERVELT COMPANY	AL	Three (3) 93 MMBF/Y Continous, Dual path, indirect fired kilns	Steam (Indirect heat)	Unspecified	4.57	LB/MMBF	0	
AL-0260	THE WESTERVELT COMPANY	AL	Two (2) 125 MMBtu/Hr. Wood-fired Boilers	Wood Residuals	Unspecified	0.5	LB/MMBTU	0.5	LB/MMBTU
AR-0080	WALDO	AR	STEAM HEATED LUMBER DRYING KILNS		Unspecified	3.5	LB/MBF	0	
AR-0083	POTLATCH CORPORATION - OZAN UNIT	AR	WOOD FIRED BOILER	WOOD CHIPS	Unspecified	0.034	LB/MMBTU	6	LB/H
AR-0083	POTLATCH CORPORATION - OZAN UNIT	AR	KILNS 1-4	STEAM HEATED	Unspecified	3.5	LB/MMBF	119	LB/H
AR-0084	POTLATCH CORPORATION - OZAN UNIT	AR	WOOD FIRED BOILER	WOOD CHIPS	Unspecified	0.034	LB/MMBTU	6	LB/H
AR-0084	POTLATCH CORPORATION - OZAN UNIT	AR	KILNS 1-4	STEAM HEATED	Unspecified	3.5	LB/MMBF	119	LB/H
AR-0101	BIBLER BROTHERS LUMBER COMPANY	AR	SN-07G AND SN-13G CONTINUOUS OPERATING KILNS	WOOD RESIDUE	Unspecified	3.8	LB/MBF VOC	46.5	LB VOC/H/KILN
*AR-0102	ANTHONY TIMBERLANDS, INC.	AR	KILN #3 INDIRECT-FIRED	NONE	Unspecified	3.5	LB/MBF	350	T/YR
*AR-0102	ANTHONY TIMBERLANDS, INC.	AR	KILN #4 INDIRECT-FIRED	NONE	Unspecified	3.5	LB/MBF	350	T/YR

RBLCID	FACILITY_NAME	FACILITY_STATE	PROCESS_NAME	PRIMARY_FUEL	TESTMETHOD	EMISSION_LIMIT_1	EMISSION_LIMIT_1_UNIT	EMISSION_LIMIT_2	EMISSION_LIMIT_2_UNIT
*AR-0102	ANTHONY TIMBERLANDS, INC.	AR	KILN #5 INDIRECT-FIRED	NONE	Unspecified	3.5	LB/MBF	350	T/YR
FL-0315	NORTH FLORIDA LUMBER/BRISTOL SAW MILL	FL	Wood lumber kiln	steam heated	Unspecified	116.93	T/YR	0	
GA-0146	SIMPSON LUMBER CO, LLC MELDRIM OPERATIONS	GA	KILN 3	WASTE WOOD	Unspecified	3.83	LB/MBF	0	
GA-0146	SIMPSON LUMBER CO, LLC MELDRIM OPERATIONS	GA	KILN 4	WASTE WOOD	Unspecified	3.93	LB/MBF	0	
LA-0180	JOYCE MILL	LA	WOOD LUMBER KILNS (INDIRECT FIRED)	N/A	Unspecified	367.77	LB/H	750	T/YR
LA-0181	COUSHATTA SAWMILL	LA	WOOD LUMBER KILNS (INDIRECT FIRED)	N/A	Unspecified	28	LB/H	122.6	T/YR
LA-0252	JOYCE MILL	LA	Kipper Boiler No. 1 and No. 2	wood residue	EPA/OAR Mthd 10	105.52	LB/H	0	
LA-0252	JOYCE MILL	LA	McBurney Boiler No. 4	wood residue	EPA/OAR Mthd 10	279.1	LB/H	0	
LA-0252	JOYCE MILL	LA	Lumber kilns		Unspecified	930	T/YR	0	
OK-0113	WRIGHT CITY COMPLEX	OK	PLANER MILL		Unspecified	0		0	
OK-0113	WRIGHT CITY COMPLEX	OK	LUMBER KILNS		Unspecified	4.8	LB/MBF	0	
OR-0049	GILCHRIST FACILITY	OR	LUMBER DRY KILNS		Unspecified	1.69	LB/MBF	0	
SC-0085	ELLIOT SAWMILLING COMPANY	SC	LUMBER DRYING KILN	WOOD WASTE	Unspecified	4.5	LB/1000 BF	0	
*SC-0135	NEW SOUTH COMPANIES, INC. - CONWAY PLANT	SC	LUMBER KILNS		None selected in SAE	799.18	T/YR	4.2	LB/MBF
SC-0136	SIMPSON LUMBER COMPANY, LLC	SC	DIRECT-FIRED LUMBER DRYING KILN NO. 4	DRY WOOD WASTE	Unspecified	104	T/YR	3.8	LB/MBF

RBLCID	FACILITY_NAME	FACILITY_STATE	PROCESS_NAME	PRIMARY_FUEL	TESTMETHOD	EMISSION_LIMIT_1	EMISSION_LIMIT_1_UNIT	EMISSION_LIMIT_2	EMISSION_LIMIT_2_UNIT
SC-0137	ELLIOTT SAWMILLING COMPANY	SC	DIRECT-FIRED LUMBER-DRYING KILN NO. 4	SAWDUST	Unspecified	122	T/YR	4.5	LB/MBF
SC-0138	ELLIOTT SAWMILLING COMPANY	SC	DIRECT FIRED LUMBER DRYING KILN NO.5	SAWDUST	Unspecified	119	T/YR	4.5	LB/MBF
SC-0149	KLAUSNER HOLDING USA, INC	SC	BIOMASS BOILER EU001	WET BARK, WOOD	Unspecified	0.017	LB/MMBTU	0	
SC-0149	KLAUSNER HOLDING USA, INC	SC	BIOMASS BOILER EU002	WET BARK, WOOD	Unspecified	0.017	LB/MMBTU	0	
SC-0149	KLAUSNER HOLDING USA, INC	SC	NATURAL GAS BOILER EU003	NATURAL GAS	Unspecified	0.003	LB/MMBTU	0	
SC-0149	KLAUSNER HOLDING USA, INC	SC	NATURAL GAS BOILER EU004	NATURAL GAS	Unspecified	0.003	LB/MMBTU	0	
SC-0149	KLAUSNER HOLDING USA, INC	SC	NATURAL GAS BOILER EU005	NATURAL GAS	Unspecified	0.003	LB/MMBTU	0	
SC-0149	KLAUSNER HOLDING USA, INC	SC	NATURAL GAS BOILER EU006	NATURAL GAS	Unspecified	0.003	LB/MMBTU	0	
SC-0149	KLAUSNER HOLDING USA, INC	SC	LUMBER DRYING KILNS EU007		Unspecified	3.5	LB/MBF	0	
SC-0149	KLAUSNER HOLDING USA, INC	SC	COLORS, INKS, LACQUERS EU013		Unspecified	0.03	LB/MBF	0	
*SC-0151	WEST FRASER - NEWBERRY LUMBER MILL	SC	TWO - 35 MMBTU/H DUAL PATH, DIRECT FIRED, CONTINUOUS LUMBER KILNS, 15 THOUSAND BF/H, EACH	SAWDUST	Unspecified	3.76	LB/MBF	376	T/YR
SC-0155	NEW SOUTH LUMBER, INC. - CAMDEN PLANT	SC	WOOD PRODUCTS INDUSTRIES	VIRGIN WOOD WASTE	Unspecified	0		0	
TX-0483	TEMPLE-INLAND DIBOLL OPERATIONS	TX	EAST LUMBER KILNS 1&2 (4)		Unspecified	30.6	LB/H	85.35	T/YR
TX-0483	TEMPLE-INLAND DIBOLL OPERATIONS	TX	WEST LUMBER KILNS 1&2 (4)		Unspecified	30.6	LB/H	85.35	T/YR

RBLCID	FACILITY_NAME	FACILITY_STATE	PROCESS_NAME	PRIMARY_FUEL	TESTMETHOD	EMISSION_LIMIT_1	EMISSION_LIMIT_1_UNIT	EMISSION_LIMIT_2	EMISSION_LIMIT_2_UNIT
TX-0584	TEMPLE INLAND PINELAND MANUFACTURING COMPLEX	TX	Dry studmill kilns 1 and 2	wood	EPA/OAR Mthd 25	2.49	LB VOC/1000 BOARDFEE	0	
WA-0327	SKAGIT COUNTY LUMBER MILL	WA	WOOD-FIRED COGENERATION UNIT	BARK & WASTE WOOD	Unspecified	0.019	LB/MMBTU	35.8	T/YR
WA-0327	SKAGIT COUNTY LUMBER MILL	WA	7. DRY KILNS		Unspecified	54	T/YR	0	
WA-0327	SKAGIT COUNTY LUMBER MILL	WA	ANTI-MOLD SPRAY SYSTEM		Unspecified	9	T/YR	0	

Emission Factors for Greenhouse Gas Inventories

Last Modified: 9 March 2018

Red text indicates an update from the 2015 version of this document.

Typically, greenhouse gas emissions are reported in units of carbon dioxide equivalent (CO₂e). Gases are converted to CO₂e by multiplying by their global warming potential (GWP). The emission factors listed in this document

Gas	100-Year GWP
CH ₄	25
N ₂ O	298

Source: Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment

Table 1 Stationary Combustion

Fuel Type	Heat Content (HHV) mmBtu per short ton	CO ₂ Factor kg CO ₂ per mmBtu	CH ₄ Factor g CH ₄ per mmBtu	N ₂ O Factor g N ₂ O per mmBtu	CO ₂ Factor kg CO ₂ per short ton	CH ₄ Factor g CH ₄ per short ton	N ₂ O Factor g N ₂ O per short ton
Coal and Coke							
Anthracite Coal	25.09	103.69	11	1.6	2,602	276	40
Bituminous Coal	24.93	93.28	11	1.6	2,325	274	40
Sub-bituminous Coal	17.25	97.17	11	1.6	1,676	190	28
Lignite Coal	14.21	97.72	11	1.6	1,389	156	23
Mixed (Commercial Sector)	21.39	94.27	11	1.6	2,016	235	34
Mixed (Electric Power Sector)	19.73	95.52	11	1.6	1,885	217	32
Mixed (Industrial Coking)	26.28	93.90	11	1.6	2,468	289	42
Mixed (Industrial Sector)	22.35	94.67	11	1.6	2,116	246	36
Coal Coke	24.80	113.67	11	1.6	2,819	273	40
Other Fuels - Solid							
Municipal Solid Waste	9.95	90.70	32	4.2	902	318	42
Petroleum Coke (Solid)	30.00	102.41	32	4.2	3,072	960	126
Plastics	38.00	75.00	32	4.2	2,850	1,216	160
Tires	28.00	85.97	32	4.2	2,407	896	118
Biomass Fuels - Solid							
Agricultural Byproducts	8.25	118.17	32	4.2	975	264	35
Peat	8.00	111.84	32	4.2	895	256	34
Solid Byproducts	10.39	105.51	32	4.2	1,096	332	44
Wood and Wood Residuals	17.48	93.80	7.2	3.6	1,640	126	63
Natural Gas							
Natural Gas	0.001026	53.06	1.0	0.10	0.05444	0.00103	0.00010
Other Fuels - Gaseous							
Blast Furnace Gas	0.000092	274.32	0.022	0.10	0.02524	0.000002	0.000009
Coke Oven Gas	0.000599	46.85	0.48	0.10	0.02806	0.000288	0.000060
Fuel Gas	0.001388	59.00	3.0	0.60	0.08189	0.004164	0.000833
Propane Gas	0.002516	61.46	3.0	0.60	0.15463	0.007548	0.001510
Biomass Fuels - Gaseous							
Landfill Gas	0.000485	52.07	3.2	0.63	0.025254	0.001552	0.000306
Other Biomass Gases	0.000655	52.07	3.2	0.63	0.034106	0.002096	0.000413
Petroleum Products							
Asphalt and Road Oil	0.158	75.36	3.0	0.60	11.91	0.47	0.09
Aviation Gasoline	0.120	69.25	3.0	0.60	8.31	0.36	0.07
Butane	0.103	64.77	3.0	0.60	6.67	0.31	0.06
Butylene	0.105	68.72	3.0	0.60	7.22	0.32	0.06
Crude Oil	0.138	74.54	3.0	0.60	10.29	0.41	0.08
Distillate Fuel Oil No. 1	0.139	73.25	3.0	0.60	10.18	0.42	0.08
Distillate Fuel Oil No. 2	0.138	73.96	3.0	0.60	10.21	0.41	0.08
Distillate Fuel Oil No. 4	0.146	75.04	3.0	0.60	10.96	0.44	0.09
Ethane	0.068	59.60	3.0	0.60	4.05	0.20	0.04
Ethylene	0.058	65.96	3.0	0.60	3.83	0.17	0.03
Heavy Gas Oils	0.148	74.92	3.0	0.60	11.09	0.44	0.09
Isobutane	0.099	64.94	3.0	0.60	6.43	0.30	0.06
Isobutylene	0.103	68.86	3.0	0.60	7.09	0.31	0.06
Kerosene	0.135	75.20	3.0	0.60	10.15	0.41	0.08
Kerosene-Type Jet Fuel	0.135	72.22	3.0	0.60	9.75	0.41	0.08
Liquefied Petroleum Gases (LPG)	0.092	61.71	3.0	0.60	5.68	0.28	0.06
Lubricants	0.144	74.27	3.0	0.60	10.69	0.43	0.09
Motor Gasoline	0.125	70.22	3.0	0.60	8.78	0.38	0.08
Naphtha (<401 deg F)	0.125	68.02	3.0	0.60	8.50	0.38	0.08
Natural Gasoline	0.110	66.88	3.0	0.60	7.36	0.33	0.07
Other Oil (>401 deg F)	0.139	76.22	3.0	0.60	10.59	0.42	0.08
Pentanes Plus	0.110	70.02	3.0	0.60	7.70	0.33	0.07
Petrochemical Feedstocks	0.125	71.02	3.0	0.60	8.88	0.38	0.08
Petroleum Coke	0.143	102.41	3.0	0.60	14.64	0.43	0.09
Propane	0.091	62.87	3.0	0.60	5.72	0.27	0.05
Propylene	0.091	67.77	3.0	0.60	6.17	0.27	0.05
Residual Fuel Oil No. 5	0.140	72.93	3.0	0.60	10.21	0.42	0.08
Residual Fuel Oil No. 6	0.150	75.10	3.0	0.60	11.27	0.45	0.09
Special Naphtha	0.125	72.34	3.0	0.60	9.04	0.38	0.08
Unfinished Oils	0.139	74.54	3.0	0.60	10.36	0.42	0.08
Used Oil	0.138	74.00	3.0	0.60	10.21	0.41	0.08
Biomass Fuels - Liquid							
Biodiesel (100%)	0.128	73.84	1.1	0.11	9.45	0.14	0.01
Ethanol (100%)	0.084	68.44	1.1	0.11	5.75	0.09	0.01
Rendered Animal Fat	0.125	71.06	1.1	0.11	8.88	0.14	0.01
Vegetable Oil	0.120	81.55	1.1	0.11	9.79	0.13	0.01
Biomass Fuels - Kraft Pulping Liquor, by Wood Furnish							
North American Softwood		94.4	1.9	0.42			
North American Hardwood		93.7	1.9	0.42			
Bagasse		95.5	1.9	0.42			
Bamboo		93.7	1.9	0.42			
Straw		95.1	1.9	0.42			

Source:

Federal Register EPA; 40 CFR Part 98; e-CFR, June 13, 2017 (see link below). Table C-1, Table C-2, Table AA-1.

https://www.ecfr.gov/cgi-bin/text-idx?SID=ae265d7d6f98ec86fcd8640b9793a3f6&mc=true&node=pt40.23.98&rgn=div5#ap40.23.98_19.1

Note: Emission factors are per unit of heat content using higher heating values (HHV). If heat content is available from the fuel supplier, it is preferable to use that value. If not, default heat contents are provided.

Table 2 Mobile Combustion CO₂

Fuel Type	kg CO ₂ per unit	Unit
Aviation Gasoline	8.31	gallon
Biodiesel (100%)	9.45	gallon
Compressed Natural Gas (CNG)	0.05444	scf
Diesel Fuel	10.21	gallon
Ethanol (100%)	5.75	gallon
Kerosene-Type Jet Fuel	9.75	gallon
Liquefied Natural Gas (LNG)	4.50	gallon
Liquefied Petroleum Gases (LPG)	5.68	gallon
Motor Gasoline	8.78	gallon
Residual Fuel Oil	11.27	gallon

Source:

Federal Register EPA; 40 CFR Part 98; e-CFR, June 13, 2017 (see link below). Table C-1, Table C-2, Table AA-1.

https://www.ecfr.gov/cgi-bin/text-idx?SID=ae265d7d6f98ec86fcd8640b9793a3f6&mc=true&node=pt40.23.98&rgn=div5#ap40.23.98_19.1

LNG: The factor was developed based on the CO₂ factor for Natural Gas factor and LNG fuel density from GREET1_2017.xlsx Model, Argonne National Laboratory. This represents a methodology change from previous versions.

Table 3 Mobile Combustion CH₄ and N₂O for On-Road Gasoline Vehicles

Vehicle Type	Year	CH ₄ Factor (g / mile)	N ₂ O Factor (g / mile)
Gasoline Passenger Cars	1973-74	0.1696	0.0197
	1975	0.1423	0.0443
	1976-77	0.1406	0.0458
	1978-79	0.1389	0.0473
	1980	0.1326	0.0499
	1981	0.0802	0.0626
	1982	0.0795	0.0627
	1983	0.0782	0.0630
	1984-93	0.0704	0.0647
	1994	0.0531	0.0560
	1995	0.0358	0.0473
	1996	0.0272	0.0426
	1997	0.0268	0.0422
	1998	0.0241	0.0379
	1999	0.0216	0.0337
	2000	0.0178	0.0273
	2001	0.0110	0.0158
	2002	0.0107	0.0153
	2003	0.0115	0.0133
	2004	0.0157	0.0063
2005	0.0164	0.0051	
2006	0.0161	0.0057	
2007	0.0170	0.0041	
2008	0.0172	0.0038	
2009-present	0.0173	0.0036	
Gasoline Light-Duty Trucks (Vans, Pickup Trucks, SUVs)	1973-74	0.1908	0.0218
	1975	0.1634	0.0513
	1976	0.1594	0.0555
	1977-78	0.1614	0.0534
	1979-80	0.1594	0.0555
	1981	0.1479	0.0660
	1982	0.1442	0.0681
	1983	0.1368	0.0722
	1984	0.1294	0.0764
	1985	0.1220	0.0806
	1986	0.1146	0.0848
	1987-93	0.0813	0.1035
	1994	0.0646	0.0982
	1995	0.0517	0.0908
	1996	0.0452	0.0871
	1997	0.0452	0.0871
	1998	0.0412	0.0778
	1999	0.0333	0.0593
	2000	0.0340	0.0607
	2001	0.0221	0.0328
2002	0.0242	0.0378	
2003	0.0225	0.0330	
2004	0.0162	0.0098	
2005	0.0160	0.0081	
2006	0.0159	0.0088	
2007	0.0161	0.0079	
2008-present	0.0163	0.0066	
Gasoline Heavy-Duty Vehicles	<1981	0.4604	0.0497
	1982-84	0.4492	0.0538
	1985-86	0.4090	0.0515
	1987	0.3675	0.0849
	1988-1989	0.3492	0.0933
	1990-1995	0.3246	0.1142
	1996	0.1278	0.1680
	1997	0.0924	0.1726
	1998	0.0655	0.1750
	1999	0.0648	0.1721
	2000	0.0630	0.1650
	2001	0.0578	0.1435
	2002	0.0634	0.1664
	2003	0.0603	0.1534
	2004	0.0323	0.0195
	2005	0.0329	0.0162
2006	0.0318	0.0227	
2007	0.0333	0.0134	
2008-present	0.0333	0.0134	
Gasoline Motorcycles	1960-1995	0.0899	0.0087
	1996-present	0.0672	0.0069

Source: EPA (2017) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2015. All values are calculated from Tables A-104 through A-110.

Table 4 Mobile Combustion CH₄ and N₂O for On-Road Diesel and Alternative Fuel Vehicles

Vehicle Type	Vehicle Year	CH ₄ Factor (g / mile)	N ₂ O Factor (g / mile)
Diesel Passenger Cars	1960-1982	0.0006	0.0012
	1983-1995	0.0005	0.0010
	1996-present	0.0005	0.0010
Diesel Light-Duty Trucks	1960-1982	0.0011	0.0017
	1983-1995	0.0009	0.0014
	1996-present	0.0010	0.0015
Diesel Medium- and Heavy-Duty Vehicles	1960-present	0.0051	0.0048
CNG Light-Duty Vehicles		0.737	0.050
CNG Medium- and Heavy-Duty Vehicles		1.966	0.175
CNG Buses		1.966	0.175
LPG Light-Duty Vehicles		0.037	0.067
LPG Medium- and Heavy-Duty Vehicles		0.066	0.175
LNG Medium- and Heavy-Duty Vehicles		1.966	0.175
Ethanol Light-Duty Vehicles		0.055	0.067
Ethanol Medium- and Heavy-Duty Vehicles		0.197	0.175
Ethanol Buses		0.197	0.175
Biodiesel Light-Duty Vehicles		0.0005	0.001
Biodiesel Medium- and Heavy-Duty Vehicles		0.005	0.005
Biodiesel Buses		0.005	0.005

Source: EPA (2017) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2015. All values are calculated from Tables A-104 through A-110.

Table 5 Mobile Combustion CH₄ and N₂O for Non-Road Vehicles

Vehicle Type	CH ₄ Factor (g / gallon)	N ₂ O Factor (g / gallon)
Residual Fuel Oil Ships and Boats	0.11	0.57
Gasoline Ships and Boats	0.64	0.22
Diesel Ships and Boats	0.06	0.45
Diesel Locomotives	0.80	0.26
Gasoline Agricultural Equip.	1.26	0.22
Diesel Agricultural Equip.	1.44	0.26
Gasoline Construction Equip.	0.50	0.22
Diesel Construction Equip.	0.57	0.26
Jet Fuel Aircraft	0.00	0.30
Aviation Gasoline Aircraft	7.06	0.11
Other Gasoline Non-Road Vehicles	0.50	0.22
Other Diesel Non-Road Vehicles	0.57	0.26
LPG Non-Road Vehicles	0.50	0.22
Biodiesel Non-Road Vehicles	0.57	0.26

Source: EPA (2017) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2015. All values are calculated from Table A-110.

Note: LPG non-road vehicles assumed equal to other gasoline sources. Biodiesel vehicles assumed equal to other diesel sources.

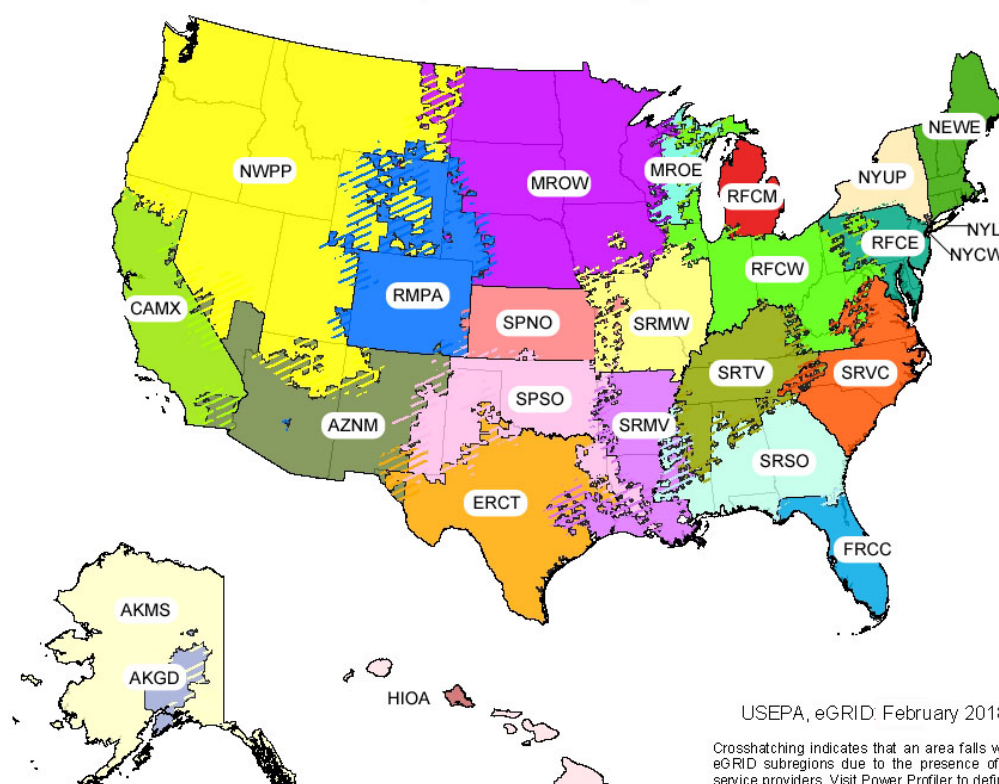
Table 6 Electricity

eGRID Subregion	Total Output Emission Factors			Non-Baseload Emission Factors		
	CO ₂ Factor (lb / MWh)	CH ₄ Factor (lb / MWh)	N ₂ O Factor (lb / MWh)	CO ₂ Factor (lb / MWh)	CH ₄ Factor (lb / MWh)	N ₂ O Factor (lb / MWh)
AKGD (ASCC Alaska Grid)	1,072.3	0.077	0.011	1,367.8	0.110	0.016
AKMS (ASCC Miscellaneous)	503.1	0.023	0.004	1,533.8	0.068	0.012
AZNM (WECC Southwest)	1,043.6	0.079	0.012	1,384.8	0.097	0.014
CAMX (WECC California)	527.9	0.033	0.004	942.9	0.045	0.006
ERCT (ERCOT All)	1,009.2	0.076	0.011	1,402.8	0.108	0.015
FRCC (FRCC All)	1,011.7	0.075	0.010	1,188.5	0.078	0.011
HIMS (HICC Miscellaneous)	1,152.0	0.095	0.015	1,530.0	0.147	0.023
HIOA (HICC Oahu)	1,662.9	0.181	0.028	1,637.5	0.153	0.024
MROE (MRO East)	1,668.2	0.156	0.026	1,740.1	0.156	0.025
MROW (MRO West)	1,238.8	0.115	0.020	1,822.0	0.154	0.029
NEWE (NPCC New England)	558.2	0.090	0.012	975.1	0.086	0.011
NWPP (WECC Northwest)	651.2	0.061	0.009	1,524.9	0.124	0.020
NYCW (NPCC NYC/Westchester)	635.8	0.022	0.003	1,061.7	0.022	0.002
NYLI (NPCC Long Island)	1,178.3	0.126	0.016	1,338.8	0.036	0.004
NYUP (NPCC Upstate NY)	294.7	0.021	0.003	1,018.2	0.061	0.008
RFCE (RFC East)	758.2	0.050	0.009	1,434.4	0.079	0.017
RFCM (RFC Michigan)	1,272.0	0.067	0.018	1,806.1	0.101	0.025
RFCW (RFC West)	1,243.4	0.108	0.019	1,934.4	0.172	0.029
RMPA (WECC Rockies)	1,367.8	0.137	0.020	1,688.3	0.147	0.021
SPNO (SPP North)	1,412.4	0.149	0.022	1,990.8	0.202	0.029
SPSO (SPP South)	1,248.3	0.095	0.015	1,662.5	0.121	0.019
SRMV (SERC Mississippi Valley)	838.9	0.050	0.007	1,186.0	0.071	0.010
SRMW (SERC Midwest)	1,612.6	0.082	0.026	1,955.2	0.084	0.031
SRSO (SERC South)	1,089.4	0.087	0.013	1,453.5	0.115	0.017
SRTV (SERC Tennessee Valley)	1,185.4	0.093	0.017	1,757.4	0.135	0.025
SRVC (SERC Virginia/Carolina)	805.3	0.067	0.011	1,422.2	0.111	0.019
US Average	998.4	0.080	0.013	1,501.0	0.111	0.018

Source: EPA eGRID2016, February 2018

Note: Total output emission factors can be used as default factors for estimating GHG emissions from electricity use when developing a carbon footprint or emissions inventory. Annual non-baseload output emission factors should not be used for those purposes, but can be used to estimate GHG emissions reductions from reductions in electricity use.

Map of eGRID Subregions



USEPA, eGRID February 2018
Crosshatching indicates that an area falls within overlapping eGRID subregions due to the presence of multiple electric service providers. Visit Power Profiler to definitively determine.



Table 7 Steam and Heat

	CO ₂ Factor (kg / mmBtu)	CH ₄ Factor (g / mmBtu)	N ₂ O Factor (g / mmBtu)
Steam and Heat	66.33	1.250	0.125

Note: Emission factors are per mmBtu of steam or heat purchased. These factors assume natural gas fuel is used to generate steam or heat at 80 percent thermal efficiency.

Table 8 Business Travel and Employee Commuting

Vehicle Type	CO ₂ Factor (kg / unit)	CH ₄ Factor (g / unit)	N ₂ O Factor (g / unit)	Units
Passenger Car ^A	0.343	0.019	0.011	vehicle-mile
Light-Duty Truck ^B	0.472	0.019	0.018	vehicle-mile
Motorcycle	0.189	0.070	0.007	vehicle-mile
Intercity Rail (i.e. Amtrak) ^C	0.140	0.0087	0.0031	passenger-mile
Commuter Rail ^D	0.161	0.0081	0.0032	passenger-mile
Transit Rail (i.e. Subway, Tram) ^E	0.119	0.0025	0.0017	passenger-mile
Bus	0.056	0.0013	0.0009	passenger-mile
Air Travel - Short Haul (< 300 miles)	0.225	0.0039	0.0072	passenger-mile
Air Travel - Medium Haul (>= 300 miles, < 2300 miles)	0.136	0.0006	0.0043	passenger-mile
Air Travel - Long Haul (>= 2300 miles)	0.166	0.0006	0.0053	passenger-mile

Source:

CO₂, CH₄, and N₂O emissions data for highway vehicles are from Table 2-13 of the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2015. Vehicle-miles and passenger-miles data for highway vehicles are from Table VM-1 of the Federal Highway Administration Highway Statistics 2015.

Fuel consumption data and passenger-miles data for rail are from Tables A.14 to A.16 and 9.10 to 9.12 of the Transportation Energy Data Book: Edition 35. Fuel consumption was converted to emissions by using fuel and electricity emission factors presented in the tables above.

Air Travel factors from 2017 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting. Version 1.0 August 2017.

Notes:

^A Passenger car: includes passenger cars, minivans, SUVs, and small pickup trucks (vehicles with wheelbase less than 121 inches).

^B Light-duty truck: includes full-size pickup trucks, full-size vans, and extended-length SUVs (vehicles with wheelbase greater than 121 inches).

^C Intercity rail: long-distance rail between major cities, such as Amtrak

^D Commuter rail: rail service between a central city and adjacent suburbs (also called regional rail or suburban rail)

^E Transit rail: rail typically within an urban center, such as subways, elevated railways, metropolitan railways (metro), streetcars, trolley cars, and tramways.

Table 9 Upstream Transportation and Distribution and Downstream Transportation and Distribution

Vehicle Type	CO ₂ Factor (kg / unit)	CH ₄ Factor (g / unit)	N ₂ O Factor (g / unit)	Units
Medium- and Heavy-Duty Truck	1.467	0.014	0.010	vehicle-mile
Passenger Car ^A	0.343	0.019	0.011	vehicle-mile
Light-Duty Truck ^B	0.472	0.019	0.018	vehicle-mile
Medium- and Heavy-Duty Truck ^C	0.202	0.0020	0.0015	ton-mile
Rail	0.023	0.0018	0.0006	ton-mile
Waterborne Craft	0.059	0.0005	0.0040	ton-mile
Aircraft	1.308	0.0000	0.0402	ton-mile

Source:

CO₂, CH₄, and N₂O emissions data for road vehicles are from Table 2-13 of the U.S. Greenhouse Gas Emissions and Sinks: 1990–2015 (April 15, 2017). Vehicle-miles and passenger-miles data for road vehicles are from Table VM-1 of the Federal Highway Administration Highway Statistics 2015.

CO₂e emissions data for non-road vehicles are based on Table A-117 of the U.S. Greenhouse Gas Emissions and Sinks: 1990–2015, which are distributed into CO₂, CH₄, and N₂O emissions based on fuel/vehicle emission factors. Freight ton-mile data for non-road vehicles are from Table 1-50 of the Bureau of Transportation Statistics, National Transportation Statistics for 2015 (Data based on 2014).

Notes:

Vehicle-mile factors are appropriate to use when the entire vehicle is dedicated to transporting the reporting organization's product. Ton-mile factors are appropriate when the vehicle is shared with products from other organizations.

^A Passenger car: includes passenger cars, minivans, SUVs, and small pickup trucks (vehicles with wheelbase less than 121 inches).

^B Light-duty truck: includes full-size pickup trucks, full-size vans, and extended-length SUVs (vehicles with wheelbase greater than 121 inches).

^C Medium- and Heavy-Duty Truck: updates due to a methodology change.

Table 10a Global Warming Potentials (GWPs)

Gas	100-Year GWP
CO ₂	1
CH ₄	25
N ₂ O	298
HFC-23	14,800
HFC-32	675
HFC-41	92
HFC-125	3,500
HFC-134	1,100
HFC-134a	1,430
HFC-143	353
HFC-143a	4,470
HFC-152	53
HFC-152a	124
HFC-161	12
HFC-227ea	3,220
HFC-236cb	1,340
HFC-236ea	1,370
HFC-236fa	9,810
HFC-245ca	693
HFC-245fa	1,030
HFC-365mfc	794
HFC-43-10mee	1,640
SF ₆	22,800
NF ₃	17,200
CF ₄	7,390
C ₂ F ₆	12,200
C ₃ F ₈	8,830
c-C ₄ F ₈	10,300
C ₄ F ₁₀	8,860
C ₅ F ₁₂	9,160
C ₆ F ₁₄	9,300
C ₁₀ F ₁₈	>7,500

Source:

100-year GWPs from IPCC Fourth Assessment Report (AR4), 2007. IPCC AR4 was published in 2007 and is among the most current and comprehensive peer-reviewed assessments of climate change. AR4 provides revised GWPs of several GHGs relative to the values provided in previous assessment reports, following advances in scientific knowledge on the radiative efficiencies and atmospheric lifetimes of these GHGs and of CO₂. Because the GWPs provided in AR4 reflect an improved scientific understanding of the radiative effects of these gases in the atmosphere, the values provided are more appropriate for supporting the overall goal of organizational GHG reporting than the Second Assessment Report (SAR) GWP values previously used in the Emission Factors Hub.

While EPA recognizes that Fifth Assessment Report (AR5) GWPs have been published, in an effort to ensure consistency and comparability of GHG data between EPA's voluntary and non-voluntary GHG reporting programs (e.g. GHG Reporting Program and National Inventory), EPA recommends the use of AR4 GWPs. The United States and other developed countries to the UNFCCC have agreed to submit annual inventories in 2015 and future years to the UNFCCC using GWP values from AR4, which will replace the current use of SAR GWP values. Utilizing AR4 GWPs improves EPA's ability to analyze corporate, national, and sub-national GHG data consistently, enhances communication of GHG information between programs, and gives outside stakeholders a consistent, predictable set of GWPs to avoid confusion and additional burden.

Table 10b Global Warming Potentials (GWPs) for Blended Refrigerants

ASHRAE #	100-year GWP	Blend Composition
R-401A	16	53% HCFC-22, 34% HCFC-124, 13% HFC-152a
R-401B	14	61% HCFC-22, 28% HCFC-124, 11% HFC-152a
R-401C	19	33% HCFC-22, 52% HCFC-124, 15% HFC-152a
R-402A	2,100	38% HCFC-22, 6% HFC-125, 2% propane
R-402B	1,330	6% HCFC-22, 38% HFC-125, 2% propane
R-403B	3,444	56% HCFC-22, 39% PFC-218, 5% propane
R-404A	3,922	44% HFC-125, 4% HFC-134a, 52% HFC 143a
R-406A	0	55% HCFC-22, 41% HCFC-142b, 4% isobutane
R-407A	2,107	20% HFC-32, 40% HFC-125, 40% HFC-134a
R-407B	2,804	10% HFC-32, 70% HFC-125, 20% HFC-134a
R-407C	1,774	23% HFC-32, 25% HFC-125, 52% HFC-134a
R-407D	1,627	15% HFC-32, 15% HFC-125, 70% HFC-134a
R-407E	1,552	25% HFC-32, 15% HFC-125, 60% HFC-134a
R-408A	2,301	47% HCFC-22, 7% HFC-125, 46% HFC 143a
R-409A	0	60% HCFC-22, 25% HCFC-124, 15% HCFC-142b
R-410A	2,088	50% HFC-32, 50% HFC-125
R-410B	2,229	45% HFC-32, 55% HFC-125
R-411A	14	87.5% HCFC-22, 11 HFC-152a, 1.5% propylene
R-411B	4	94% HCFC-22, 3% HFC-152a, 3% propylene
R-413A	2,053	88% HFC-134a, 9% PFC-218, 3% isobutane
R-414A	0	51% HCFC-22, 28.5% HCFC-124, 16.5% HCFC-142b
R-414B	0	5% HCFC-22, 39% HCFC-124, 9.5% HCFC-142b
R-417A	2,346	46.6% HFC-125, 5% HFC-134a, 3.4% butane
R-422A	3,143	85.1% HFC-125, 11.5% HFC-134a, 3.4% isobutane
R-422D	2,729	65.1% HFC-125, 31.5% HFC-134a, 3.4% isobutane
R-423A	2,280	47.5% HFC-227ea, 52.5% HFC-134a,
R-424A	2,440	50.5% HFC-125, 47% HFC-134a, 2.5% butane/pentane
R-426A	1,508	5.1% HFC-125, 93% HFC-134a, 1.9% butane/pentane
R-428A	3,607	77.5% HFC-125, 2% HFC-143a, 1.9% isobutane
R-434A	3,245	63.2% HFC-125, 16% HFC-134a, 18% HFC-143a, 2.8% isobutane
R-500	32	73.8% CFC-12, 26.2% HFC-152a, 48.8% HCFC-22
R-502	0	48.8% HCFC-22, 51.2% CFC-115
R-504	325	48.2% HFC-32, 51.8% CFC-115
R-507	3,985	5% HFC-125, 5% HFC143a
R-508A	13,214	39% HFC-23, 61% PFC-116
R-508B	13,396	46% HFC-23, 54% PFC-116

Source:

100-year GWPs from IPCC Fourth Assessment Report (AR4), 2007. See the source note to Table 13 for further explanation. GWPs of blended refrigerants are based on their HFC and PFC constituents, which are based on data from <http://www.epa.gov/ozone/snap/refrigerants/refblend.html>.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
SECTOR POLICIES AND PROGRAMS DIVISION
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
OFFICE OF AIR AND RADIATION

DATE: September 22, 2017

SUBJECT: Development of a Provisional Emissions Calculations Tool for Inclusion in the Final PCWP ICR

FROM: EPA/OAR/OAQPS/SPPD/NRG

TO: EPA-HQ-OAR-2016-0243

I. Introduction

The U.S. EPA is required under Clean Air Act sections 112(f)(2) and 112(d)(6) to perform a residual risk and technology review (RTR) of the Plywood and Composite Wood Products (PCWP) National Emission Standards for Hazardous Air Pollutants (NESHAP) codified in 40 CFR part 63, subpart DDDD. In order to conduct the data analyses required for the RTR, the EPA is conducting an Information Collection Request (ICR) to gather information from the PCWP industry. As part of the ICR, facilities are asked to compile a HAP emissions inventory that will be used in the EPA's residual risk modeling. The EPA will review the file for quality assurance (QA) and standardization. The EPA has included a Provisional Calculation Tool within the PCWP ICR spreadsheet in order to address stakeholder concerns regarding the level of effort (burden) required to develop the HAP emissions inventory as part of the ICR response. Some stakeholders have indicated that many facilities do not maintain HAP emissions inventories, and therefore, considerable effort will be required to develop the inventory required for the ICR. The goal of the developing the provisional calculations is to reduce respondent burden.

Instructions for use of the Provisional Calculation Tool are provided in the ICR instruction document accompanying the draft ICR spreadsheet (PCWP_survey.xlsx). The provisional calculations are built into the *HAP Emissions* tab of the ICR spreadsheet. Because use of the provisional calculations is optional, the columns and instructions pertaining to the Provisional Calculation Tool can be ignored by facilities not using the tool.

The purpose of this memorandum is to document the emission factors used in the Provisional Calculation Tool. Section II provides an overview of the PCWP Source Classification Codes (SCCs) and discusses the selection of emission factors for organic and metal HAP. Appendices to this memorandum list the SCCs and pollutants with emission factors included in the Provisional Calculation Tool.

II. Selection of Emission Factors

A. Source Classification Codes and Process Unit Types

The U.S. EPA uses SCCs to classify different types of activities that generate emissions. Each SCC represents a unique source category-specific process or function that emits air pollutants. The SCCs are used as a primary identifying data element in EPA's emission factor references (such as AP-42), the National Emissions Inventory (NEI), and other EPA databases. The SCCs are also used by many regional, state, local and tribal agency emissions data systems.

The list of SCCs applicable to the PCWP industry was updated in 2015, expanding the list to describe the relevant PCWP processes and to assign each process an SCC. A few additional revisions were made in 2016, and the lumber kiln SCCs were updated in 2017. The additional SCCs were added to assist various stakeholders in creation of emissions inventories for PCWP facilities. At present, there are 425 SCCs applicable to the PCWP industry. Many of the new SCCs do not yet appear in the most recent version (2014) version of the NEI.

In general, SCCs use a hierarchical system in which the classification of the emissions process becomes increasingly more specific with each of the four levels. The first level of description provides the most general information about the emissions process. The fourth level is the most detailed and describes specifics about emissions process. Over time the evolution of emissions activity and regulations where SCCs were needed, as well as other factors, have led to a concurrent evolution of the SCCs structure. Some SCCs have been retired, others have been created, and others have been modified or converted. Some SCCs may be extremely detailed in their representation of a process while others may not be as detailed. SCCs are not specific to a pollutant. Consequently, an SCC can describe a process that emits more than one pollutant.¹ Table 1 provides the SCC levels for the PCWP manufacturing industry.

¹Introduction to Source Classification Codes and their Use for EIS Submissions, <https://ofmpub.epa.gov/scsearch/docs/SCC-IntroToSCCs.pdf>

Table 1. SCC Levels for the PCWP Manufacturing Process Units

SCC Level	Description
Level 1	Industrial Processes
Level 2	Pulp and Paper and Wood Products
Level 3	<ul style="list-style-type: none"> • Plywood Operations • Particleboard Manufacture • Medium Density Fiberboard (MDF) Manufacture • Oriented Strandboard (OSB) Manufacture • Hardboard (HB) Manufacture • Fiberboard (FB) Manufacture • Glulam Manufacture • I-Joist Manufacture • Laminated Veneer Lumber (LVL) Manufacture • Laminated Strand Lumber (LSL) Manufacture • Parallel Strand Lumber (PSL) Manufacture • Sawmill Operations
Level 4	<i>Example:</i> Hardwood Veneer Dryer: Direct Natural Gas-fired: Cooling Section

Most of the PCWP SCCs are clearly or potentially applicable to PCWP process units covered under the ICR. Sixty (60) SCCs that are not applicable to the PCWP NESHAP source category were removed from the SCC list for the ICR, including:

- SCCs for “green-end” wood material handling sources not expected to emit HAP, but have SCCs because they are PM sources; and
- SCCs for lumber processing sources other than lumber kilns which are outside of the PCWP source category.

Appendix A lists the specific SCCs that were removed from the PCWP ICR.

Each facility responding to the ICR must select the applicable SCCs for their PCWP manufacturing operations. Stationary combustion sources (such as boilers) are not required to be included in the PCWP ICR unless the combustion unit provides direct heat to a dryer such that the combustion unit and dryer exhaust are comingled. To facilitate selection of appropriate SCCs for the PCWP ICR, the PCWP product types (coinciding with SCC Level 3) and the process unit types required to be included in the PCWP ICR were mapped to the SCCs. Occasionally, multiple SCCs apply for the same process unit (e.g., there are different SCCs for veneer dryer heated zones and cooling sections). An “other” process unit type was associated with SCCs that are generic in nature or are not necessarily related to process units that emit HAP.² **Appendix B** provides this mapping of SCCs with products and PCWP process units. A total of 365 SCCs are included for selection in the PCWP ICR.

² Facilities completing the ICR are not required to include “other” process units that do not emit HAP. Many of the “other” process units were included in the SCC-process unit type mapping for completeness but have no associated HAP emission factors.

B. Organic HAP Emission Factors

1. Use of AP-42

The number of PCWP SCCs now available greatly exceeds the number of SCCs appearing in AP-42, Chapter 10 (which covers the wood products industry). AP-42 Chapter 10 includes six sections with emission factors for the PCWP industry as shown in Table 2. The SCCs represented in AP-42 Chapter 10 were limited to the number of SCCs with available emission factors for criteria or hazardous air pollutants at that time. The PCWP AP-42 emission factors were last updated following collection of data for the PCWP NESHAP in 2002 and remain the largest single source of emission factors readily available to stakeholders and the public.³

Table 2. PCWP AP-42 Chapters

Section	Title	Date
10.5	Plywood Manufacturing	January 2002
10.6.2	Particleboard	June 2002
10.6.3	Medium Density Fiberboard	August 2002
10.6.4	Hardboard and Fiberboard	October 2002
10.9	Engineered Wood Products	November 2002

The AP-42 chapters are available at: <https://www3.epa.gov/ttn/chief/ap42/ch10/index.html>

It is acknowledged that the AP-42 emission factors are now somewhat dated in relation to developments in the PCWP industry. The AP-42 emission factors predate the 2007 PCWP NESHAP compliance date when many facilities installed controls on PCWP process units. However, the available uncontrolled AP-42 emission factors could be coupled with control efficiency estimates to estimate controlled emissions for facilities that do not have site-specific measurements or more representative data for certain HAP. The AP-42 emission factors also predate implementation of resin changes to reduce formaldehyde off-gassing from interior PCWP products. It is expected that use of the AP-42 factors would err on the side of overestimating emissions at facilities switching to low- or no-added formaldehyde resins.

In summary, AP-42 was selected as the reference for the organic HAP emission factors used in the Provisional Calculation Tool because:

- There is no other more-comprehensive, publicly-available information source,
- AP-42 is an EPA document that underwent a stakeholder review process prior to finalization, and
- The tradeoffs for using information dating back to 2002 in the tool seem to be a reasonable compromise for reducing the burden for facilities with no current HAP inventory and no other source of information to use for estimating emissions.

³ It is acknowledged that updated emission factors are maintained by and available to members of the National Council for Air and Stream Improvement (NCASI) and that member facilities will likely choose to use the NCASI emission factors in preparing their ICR emission inventories. The ICR instructs respondents to use the most-representative means of estimating emissions available to them, including site-specific emissions measurements or, if measurements are not available, emission estimates based on representative emission factors.

In order to use the AP-42 emission factors in the Provisional Calculation Tool, available “sets” of organic HAP emission factors representing uncontrolled emissions were paired with each SCC. As noted above, the number of SCCs exceeds the number of AP-42 emission factors. Therefore, it was necessary to extrapolate related emission factor sets to SCCs not having directly matched factors. A “set” of emission factors includes all the HAP for that SCC for which emission factors were not labeled below detection limit (BDL). The BDL labeling in AP-42 indicates that all of the measurement data used to derive the emission factor for a given pollutant was below the test method detection limit. The AP-42 indicates “BDL” instead of presenting a number in these cases. Emissions estimates based on BDL data are not necessary for the risk modeling inventory; the provisional calculations are designed to inform.

After comparing the pollutants with positive (non-BDL) emission factors in all of the “sets” available, a menu list of HAP compounds for inclusion in the ICR was developed that includes all the HAP for which provisional calculation formulas are available. If applicable, respondents would specify additional HAP compounds beyond those included in the list and provide their own site-specific estimate of HAP emissions. **Appendix C** lists the HAP compounds with provisional calculation formulas. Only a small number of these HAP compounds apply for most process units. For example, methanol and formaldehyde are the most commonly-emitted HAP compounds for PCWP process units, followed by acetaldehyde, acrolein, phenol and propionaldehyde. There is no data to show (and little reason to expect) that most of the other HAP compounds in the list are emitted in detectable amounts. The HAP compounds with positive (non-BDL) emission factors are listed in **Appendix B** for each SCC matched to an emission factor. Process unit types that heat wood (i.e., dryers and presses) have more associated HAP compounds than other wood processing units (e.g., saws, formers, chippers).

For many SCCs there was no HAP emission factor set available, either because no HAP data were available for emission factor development or because all of the available HAP factors were BDL. Many of the PCWP SCCs represent process units that are not known to emit HAP, so it follows that there would be no HAP emission factors for several of the SCCs. These SCCs are labeled with “No EF for SCC” in the EF source column of **Appendix B**. The “No EF for SCC” notation will display in the provisional calculation columns of the *HAP Emissions* tab in the PCWP ICR. Similarly, there are no HAP emission factors for many pollutants, either because no HAP data were available for emission factor development or because all of the available HAP factors were BDL. HAP compounds without emission factors are labeled “No EF for pollutant” in the provisional calculation columns of the *HAP Emissions* tab in the PCWP ICR. Respondents having additional information quantifying HAP emissions for a given process unit with an SCC labeled “No EF for SCC” or “No EF for pollutant” would be expected to enter their own site-specific estimates of HAP emissions, particularly if the HAP emissions are significant enough to have been included in a permit or existing HAP emissions inventory. Alternatively, if there is no reason to expect HAP compound emissions from the process unit with a SCC labeled “No EF for SCC” or “No EF for pollutant” then the respondent may choose not to enter any HAP emissions estimate for the process unit or HAP compound based on their engineering judgement. The most significant HAP emissions in the PCWP source category are associated with process units that heat wood (e.g., dryers, presses).

2. Matching the SCCs with Emission Factors

The AP-42 background documentation spreadsheets available at (<https://www3.epa.gov/ttn/chief/ap42/ch10/index.html>) were used as the first step in mapping relevant emission factors to the revised SCCs. Each emission factor set was matched based on the numeric SCC when possible, resulting in approximately 50 direct matches. This step is reflected in the “Emission Factor Grouping (AP-42) exact SCC match” column in **Appendix B**. In this column, N/A means additional effort was needed to identify an emission factor matching the SCC, either because the numeric SCC had changed with the recent SCC revisions or because no exactly-matching AP-42 emission factor was available.

Next, the SCC descriptions were reviewed in conjunction with the emission factor descriptions in the AP-42 background documentation spreadsheets and in the AP-42 chapters. Additional directly relevant matches were identified for SCCs and emission factors.

Finally, the remaining SCCs for which no directly matching emission factors were identified were reviewed to determine if a closely-related or slightly more-conservative emission factor might apply in the absence of any other more-representative, site-specific information. In this step, attempts were made to select the most representative emission factors available, erring on the conservative side to avoid the underestimation of emissions. Where a comparable factor was not available, a conservative approach was taken and the next higher emission factor was used. For example, if no direct-natural gas fired dryer emission factor was in AP-42, but there was a direct wood-fired emission factor for the dryer, the wood fired emission factor was applied. The following conservative substitution assumptions were used:

- Substitution of a softwood emission factors for units processing mixed or hardwood species.
- Substitution of a mixed-species emissions factors for units processing hardwoods.
- Substitution of a direct-wood fired emission factors for direct-gas fired process units.
- Substitution of a direct-wood or direct-gas fired emission factors for indirect-fired process units.
- Substitution of emission factors for formaldehyde-containing resin for process units using non-UF or non-PF resin.
- Substitution of emission factors for blowline blend for non-blowline blend.
- Substitution of emission factors for batch press for continuous presses.
- Substitution of emission factors for dry hardboard press for wet hardboard press.
- Substitution of emission factors for related products (e.g., OSB vs LSL; LVL vs PSL, SPW for LVL). When crossing product types, the presence of formaldehyde in the adhesive and dryer firing method was considered. It was presumed that:
 - Formaldehyde emissions were greater according to the hierarchy of: UF > PF > No HCHO (ex. MDI), and
 - Dryer emissions were greater according to the hierarchy of: direct wood fired > direct natural gas fired > indirect heat.

It is acknowledged that variability in emissions can mask the effects of any of the above variables. Also, given the combination of multiple process characteristics reflected in some of

the available emission factors, in many cases there is no clear way to distinguish which emission factors may be the most conservative (e.g., for hardboard dryers there are multiple competing process characteristics including blend method, softwood/hardwood, firing method, and resin type).

The “Related AP-42 EF to use in absence of more-representative data” column in **Appendix B** of this document includes a description of the most-closely related emission factor included in the provisional calculations. This column is provided in the provisional calculation columns of the *HAP Emissions* tab in the PCWP ICR in order for respondents to judge whether the provisional calculations are based on an emission factor sufficiency representative of their process unit in the absence of more-representative, site-specific information. Respondents are given the option to insert and substitute a more-representative emission factor into the provisional calculations if they have a better emission factor available to them.

Some of the related emission factors require conversions for the production units of measure (e.g., to convert from one panel thickness basis to another). A “scalar” column is included in the *HAP emissions* tab for this purpose. **Appendix D** provides a table showing the scalar factors included in the provisional calculations.

The PCWP ICR instructions document provides a lengthy description of how the provisional calculations work and presents the formulas used to calculate emissions. The calculations include the provisional emission factor, unit of measure scalar, process unit production rate, control efficiency (if applicable), a release point apportionment fraction (for process units with multiple release points), and a conversion from pounds to tons. **Appendix E** contains a table showing the numeric emission factors included in the provisional calculations.

3. Lumber kiln emission factors

No AP-42 emission factors are available for lumber kilns. Therefore, a comparison of lumber kiln emission factors from various references was conducted. Emission factors from NCASI were found to align with the various references and were included in the provisional calculations for the lumber kiln SCCs.

C. HAP Metal Emission Factors

Direct-fired dryers may have burners integral to the dryers (e.g., rotary dryers) or stand-alone combustion units that exhaust through the dryers. It is anticipated that there could be HAP metals emissions associated with combustion of fuels in direct-fired PCWP dryers. Fuel types used in the PCWP industry include:

- Resin free wood, sawdust or bark
- Trim/sawdust containing resin
- Natural gas
- Propane
- Residual/distillate oil
- Other materials used uncommonly such as waste water residuals, used oil, blender cleanings, spray booth solids

Of the fuels listed above, biomass fuels and natural gas are by far the most common. Coal is not used as a PCWP direct-fired dryer fuel. Of the PCWP fuels used, only biomass and fuel oil are expected to have measurable amounts of HAP metals emissions. Use of fuel oil in the PCWP industry is limited.

The EPA is not aware of any HAP metals emissions test data for PCWP direct-fired dryers. However, fuel analysis data for biomass combustion in boilers is available and, in the absence of better information, is reasonably transferable to combustion of these fuels in PCWP dryers for purposes of developing emission estimates for the EPA's residual risk analysis. However, boiler data would not be useful for setting metals emissions limits for dryers. Actual metals emissions data from dryers would be needed for this purpose or a PM-surrogate could be considered.

Fuel analysis data from the May 2012 Boiler MACT emission data base was queried based on NAICS 321 for the combustion unit types most relevant to direct-fired dryer combustion units burning forest biomass (stoker/sloped grate and suspension burner). The average standardized concentration in milligrams per gram of fuel (mg/g) and the standardized fuel-based emission factor in pounds per million Btu (lb/MMBtu) are summarized in Table 3 along with the non-detect rate. As a conservative measure (more likely to overestimate emissions), detection limit values available for non-detect samples were included in the averages presented in Table 3. The uncontrolled lb/MMBtu values in Table 3 can be coupled with facility-specific PM control efficiency (if known) to estimate HAP metals emissions from PCWP direct-fired dryers. Assuming a PM collection efficiency of 99 percent, the emission rates in Table 3 were found to compare reasonably with emission factors presented in NCASI Technical Bulletin 1013⁴ for HAP metals from biomass boilers of various designs and control devices. The emission factors derived from the boiler MACT data also compare favorably to those in AP-42 Chapter 1.6, though it is noted that the AP-42 factors represent a mixture of controlled and uncontrolled data.

The biomass emission factors in Table 3 were included in the provisional calculations to estimate direct wood-fired emissions for the following types of dryers: dry rotary dryers, green rotary dryers, primary tube dryers, softwood veneer dryers, and rotary strand dryers. If other types of dryers are direct-wood fired, facilities may use the emission factors in Table 3 to estimate emissions on a facility-specific basis.

For oil-fired PCWP dryers, uncontrolled emission factors from the AP-42 section 1.3⁵ for residual fuel oil combustion in boilers can be coupled with facility-specific PM control efficiency (if known) to estimate HAP metals emissions. These emission factors were converted to lb/MMBtu using an average heating value of 0.145 MMBtu per gallon as shown in Table 4. Facilities may use these emission factors for direct oil-fired dryers. The oil-fired emissions

⁴ National Council for Air and Stream Improvement. *A Comprehensive Compilation and Review of Wood-Fired Boiler Emissions*. Technical Bulletin 1013, March 2013.

⁵ AP 42, Fifth Edition, Volume I. Section 1.3: Fuel Oil Combustion, Supplement E September 1999, corrected May 2010. <https://www3.epa.gov/ttn/chief/ap42/ch01/final/c01s03.pdf>

factors were not programed into the provisional calculations because there are no PCWP SCC codes specific to oil firing.

In the absence of site-specific control efficiency information, suggested default control efficiencies for purposes of PCWP direct-fired process unit metal HAP estimates are as follows:

- Wet or dry electrostatic precipitator or baghouse – 99%
- Mechanical collector cyclone or multiclone – 90%
- Wet scrubber - 95%

These values are based on review of control technology fact sheets.⁶

The toxicity of chromium and mercury is largely dependent on the oxidation state of these compounds, and is an important factor in evaluating the health effects from exposure to chromium and mercury compounds. Chromium (Cr) exists in several different oxidation states, but the most stable and most commonly found are hexavalent chromium (Cr⁺⁶ valence state) (or Cr VI) and trivalent chromium (Cr⁺³ valence state) (or Cr III). The most common mercury species are divalent mercury (Hg⁺²) (including both particulate and gaseous forms) and elemental gaseous mercury (Hg⁰). In the absence of data on the specific oxidation state of chromium or mercury, emissions data reported can be speciated using the NEI default multipliers of 0.2 for particulate divalent mercury, 0.3 for gaseous divalent mercury, and 0.5 for elemental gaseous mercury. Only particulate divalent mercury would be coupled with a PM control device efficiency for purposes of estimating emissions. The default multipliers for PCWP SCC codes of 0.28 for hexavalent chromium (Cr IV) and 0.72 for trivalent chromium (Cr III) may be used. Emission factors adjusted with these multipliers are presented in Tables 3 and 4.

Table 3. Summary of HAP Metals Provided in the 2012 Boiler Fuel Analysis Data Set for Stoker/Sloped Grate Boilers and Suspension Burners for NAICS 321: Wood Products Manufacturing

HAP metal	Concentration		ND rate	lb/MMBtu (uncontrolled)	lb/MMBtu (99% control)
	mg/g	mg/kg			
Antimony (Sb)	0.000364	0.36	73%	4.21E-05	4.21E-07
Arsenic (As)	0.001053	1.1	47%	1.11E-04	1.11E-06
Beryllium (Be)	0.000225	0.22	54%	2.10E-05	2.10E-07
Cadmium (Cd)	0.000233	0.23	20%	2.44E-05	2.44E-07
Chromium (Cr)	0.001231	1.2	13%	1.66E-04	1.66E-06
Cr IV				4.66E-05 ¹	
Cr III				1.20E-04 ¹	
Cobalt (Co)	0.000235	0.23	32%	2.69E-05	2.69E-07
Lead (Pb)	0.000761	0.76	31%	8.29E-05	8.29E-07
Manganese (Mn)	0.347037	347	0.3%	3.97E-02	3.97E-04
Mercury (Hg)	0.001441	1.4	17%	1.66E-04	1.66E-06
Particulate Hg ⁺²				3.32E-05 ¹	

⁶ Air Pollution Control Technology Fact Sheets available at <https://www.epa.gov/catc/clean-air-technology-center-products#factsheets>

HAP metal	Concentration		ND rate	lb/MMBtu (uncontrolled)	lb/MMBtu (99% control)
	mg/g	mg/kg			
Gaseous Hg ⁺²				4.98E-05 ¹	
Elemental gaseous Hg				8.31E-05 ¹	
Nickel (Ni)	0.003777	3.8	16%	4.51E-04	4.51E-06
Selenium (Se)	0.017402	17	52%	2.01E-03	2.01E-05

1. Speciated based on the chromium and mercury emission factors using default multipliers as described above.

**Table 4. Summary of HAP Metals Provided in AP-42 Section 1.3
for Residual Oil Fired Boilers**

HAP metal	lb/1000 gal (uncontrolled)	lb/MMBtu ¹ (uncontrolled)
Antimony (Sb)	5.25E-03	3.62E-05
Arsenic (As)	1.32E-03	9.10E-06
Beryllium (Be)	2.75E-05	1.90E-07
Cadmium (Cd)	3.98E-04	2.74E-06
Chromium (Cr)	8.45E-04	5.83E-06
Cr IV	2.48E-04	1.71E-06
Cr III		4.12E-06 ²
Cobalt (Co)	6.02E-03	4.15E-05
Lead (Pb)	1.51E-03	1.04E-05
Manganese (Mn)	3.00E-03	2.07E-05
Mercury (Hg)	1.13E-04	7.79E-07
Particulate Hg ⁺²		1.56E-07 ³
Gaseous Hg ⁺²		1.17E-04 ³
Elemental gaseous Hg		9.42E-07 ³
Nickel (Ni)	8.45E-02	5.83E-04
Selenium (Se)	6.83E-04	4.71E-06

1. Converted to lb/MMBtu using a heating value of 0.145 MMBtu per gallon.

2. Calculated as the difference between the AP-42 emission factors for Cr and Cr VI.

3. Speciated based on the chromium and mercury emission factors using default multipliers as described above.

The PCWP ICR Instructions document describes the formulas used in the provisional calculations for metals. Because only biomass firing is included in the calculations, the dryer heat input (MMBtu/hr) associated with biomass is determined from elsewhere in the spreadsheet. Respondents are asked to provide a value for PM control efficiency. The heat input is multiplied by the emission factor (lb/MMBtu), control efficiency, and the process unit operating hours reported in the ICR. A release point apportionment fraction (for process units with multiple release points) is applied and emissions are converted to tons per year.

III. Summary

This memorandum explains the methods used to assign and apply available emission factors in a Provisional Calculation Tool included in the PCWP ICR. The tool is comprised of calculations within the *HAP Emissions* tab of the ICR. Use of the provisional calculations is

optional. The tool is intended to aid facilities that either do not maintain HAP emissions inventories or do not have site-specific or more-representative data.

Appendix E. Numeric Emission Factors Included in Provisional Calculations

PCWP	SCC	SCC Level Four	ICR Process Unit Type	Related AP-42 EF to use in absence of more representative data	EF source	EF units	Acetaldehyde	Acrolein	Formaldehyde	Methanol	Phenol	Propion aldehyde
plywood	30700784	Press: Non-Urea Formaldehyde Resin: Hardwood	Hardwood plywood press		No EF for SCC							
plywood	30700785	Press: Urea Formaldehyde Resin: Hardwood	Hardwood plywood press	Hardwood Plywood, press, UF resin	AP-42, Ch 10.5	lb/MSF 3/8			0.0047	0.032	0.011	
plywood	30700791	Hammermill/Chipper: Dry Wood Material	Panel trim chipper	SPW dry trim chipper (chips dry trim from SPW panel saws; process rate = finished board production)	AP-42, Ch 10.5	lb/MSF 3/8				0.0078		
plywood	30700794	Miscellaneous Coating Operations	Miscellaneous coating operation		No EF for SCC							
plywood	30700799	Other Not Classified	Other		No EF for SCC							
lumber	30700841	Lumber Kiln: Indirect-heated: Softwood: Pine Species	Lumber kiln		NCASI 2014	lb/MBF	0.04	0.004	0.016	0.18	0.01	0.004
lumber	30700842	Lumber Kiln: Indirect-heated: Softwood: Non-Pine Species	Lumber kiln		NCASI 2014	lb/MBF	0.04	0.004	0.016	0.18	0.01	0.004
lumber	30700843	Lumber Kiln: Indirect-heated: Hardwood	Lumber kiln		NCASI 2014	lb/MBF	0.04	0.004	0.016	0.18	0.01	0.004
lumber	30700844	Lumber Kiln: Direct-fired: Softwood: Pine Species	Lumber kiln		NCASI 2014	lb/MBF	0.04	0.004	0.065	0.18	0.01	0.004
lumber	30700845	Lumber Kiln: Direct-fired: Softwood: Non-Pine Species	Lumber kiln		NCASI 2014	lb/MBF	0.04	0.004	0.065	0.18	0.01	0.004
lumber	30700846	Lumber Kiln: Direct-fired: Hardwood	Lumber kiln		NCASI 2014	lb/MBF	0.04	0.004	0.065	0.18	0.01	0.004
MDF	30700909	Pressurized Refiner/Primary Tube Dryer: Direct Natural Gas-fired: Blowline Blend: Non-Urea Formaldehyde Resin:	Primary tube dryer	MDF, tube, direct wood-fired, blowline blend, UF, softwood	AP-42, Ch 10.6.3	lb/ODT			0.86			
MDF	30700910	Pressurized Refiner/Primary Tube Dryer: Direct Natural Gas-fired: Blowline Blend: Non-Urea Formaldehyde Resin:	Primary tube dryer	MDF, tube, direct wood-fired, blowline blend, UF, softwood	AP-42, Ch 10.6.3	lb/ODT			0.86			
MDF	30700911	Pressurized Refiner/Primary Tube Dryer: Direct Natural Gas-fired: Blowline Blend: Non-Urea Formaldehyde Resin: Mixed	Primary tube dryer	MDF, tube, direct wood-fired, blowline blend, UF, softwood	AP-42, Ch 10.6.3	lb/ODT			0.86			
MDF	30700912	Pressurized Refiner/Primary Tube Dryer: Direct Natural Gas-fired: Blowline Blend: Urea Formaldehyde Resin:	Primary tube dryer	MDF, tube, direct wood-fired, blowline blend, UF, softwood	AP-42, Ch 10.6.3	lb/ODT			0.86			

Analysis of the Chemical Constituents of Dry-Kiln Condensate and its Technological Recovery – Part 1: Volatile Extractives

Jörn Rathke ^a and Daniel Stratev ^{b,c,*}

In Central Europe the main species that are used for the production of sawn wood are spruce, pine, and European beech. After the sawing process, the sawn timber is technically dried to a certain moisture content by means of condensation drying. The water movement in the cellular structure, which is caused by the drying process, draws some of the extractives into solution. In the process of kiln drying, hot air evaporates the water and the dissolved extractives. Some of the water condenses on the floor and the walls of the kiln, while the rest is blown out with the steam. Therefore, condensate was taken from the bottom of the kiln as well as from the energy recovery system. A chemical analysis by means of purge-and-trap showed the presence of volatiles that could be classified as typical for the wood materials from which they originated under the conditions of high temperature and high moisture content.

Keywords: Condensate; Extractives utilization; Dissolved VOC; European Beech, VOC; Kiln drying; Pine; Spruce; Purge-and-trap

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INTRODUCTION

Several factors have an influence on the utilization of renewable biomass for material products, energy, and fine and polymeric chemicals. These factors include economic, environmental, and practical interests (Sattler *et al.* 2008). Economically, the forest products industry is in need of new products, as margins have been slashed in the last few years due to global competition and subsidized large-scale factories. From an environmental perspective, wood is a “green” source for solid materials, fuel, and chemical products. The practical interest involves the opportunity to replace petroleum-derived polymers with polymers produced from natural resources. Today, most of these bio-based polymers are produced from starch, leading to competition with food and animal feed markets (Schmidt and Padukone 1997; Parajo *et al.* 1996).

All over the world, governments are mandating stringent restraints on the emission of volatile organic compounds (Zwick *et al.* 1997). These emissions are produced, for example, during timber drying. One possibility for reducing emissions caused by timber drying is vacuum drying technology. Using this technology, the moisture as well as the volatile components can be condensed into liquid effluent (McDonald *et al.* 1999a). The drying process starts a complex reaction chain in the wood

structure. Volatilization, steam distillation, thermal degradation, and/or hydrolysis initiate the release of a combination of chemical compounds (Cronn *et al.* 1983; McDonald and Wastney 1995; Fraser and Swan 1972; Roffael 1987). The organic extractives emitted during the kiln drying process are said to include primarily terpenes, methanol, acetic acid, formaldehyde, resin acids, and fatty acids (McDonald *et al.* 1999b). The emitted water vapor mixture may be cause for environmental concern (Cronn *et al.* 1983). McDonald and Wastney conducted a study in 1995 to analyze kiln emissions from conventional kiln drying of Radiata pine, but they did not find hazardous emissions.

Extractives from wood originate mainly in the resin, which dissolves in organic solvents and various hydrocarbons (Kärki and Väätäinen 2004). In coniferous wood, resin of two kinds can be found: physiologic resin of healthy wood and pathologic resin as a consequence of damage or infection. While physiologic resin consists of fats, waxes, and alcohols, pathologic resin contains resin acids and terpenes (Voipo and Laasko 1992). The extractives of wood that dissolve in organic solvents are aliphatic hydrocarbons, alcohols, fatty acids, terpenes, resin acids, sterols, and waxes. Extractives that dissolve in water include phenols, mono- and dimeric sugar derivatives, pectin, and tannin. The proportion of extractives in wood most commonly ranges from 2 to 5% (Fengel and Wegener 2003). The extractives are located in specific morphological places in the wood structure. Resin, for instance, is located in resin canals, while waxes and fats are stored in parenchyma cells. Phenols are mainly found in heartwood and in the bark. All of these components are needed to enable the biological functions of the tree. Fats, for example, are a source of energy, while phenols, resins, and terpenes protect the tree from microbiological damage. All these components are washed out from the wood structure and are to some extent evaporated during the wood drying process. For this reason, the extractives are present in the air of the kiln (as well as in the condensed liquid collected in the kiln).

One way to reduce emissions is to condense their volatile parts and to use the liquid-bound extractives for technical purposes. A number of studies have been performed to investigate the composition of the condensates that accumulate during the process of vacuum kiln drying. Bucko *et al.* (1993) identified formic acid, acetic acid, levulinic acid, furfural, hydroxymethyl-furfural, formaldehyde, and acetaldehyde from the kiln-dried condensate of ash (*Fraxinus excelsior*), beech (*Fagus sylvatica*), and oak (*Quercus* spp.). A chemical analysis of the condensate of *Pinus radiata* generated from experimental vacuum kiln-drying was performed by Pervan and Draščić (2008). In their study, the condensate was sampled at regular time intervals throughout the total drying cycle. A chemical analysis of the green timber led to the conclusion that only 10% of the monoterpenes found in the wood structure could be recovered in the kiln condensate. In another study, Bicho *et al.* (1996) partially analyzed the condensates from Douglas fir (*Pseudotsuga menziesii*), Western red-cedar (*Thuja plicata*), and Western hemlock (*Tsuga heterophylla*). The condensates were obtained through radio-frequency-vacuum drying. Kärki and Väätäinen (2004) investigated the extractives from European aspen wood (*Populus tremula*) after high temperature drying. In their study, the extractive content in the wood mass depending on its position in the tree was examined, rather than the extractive content of the condensate. No significant differences between the extractive contents in different sample locations in the tree were found. However, a significant difference was found between the extractive contents of the heartwood and sapwood. The condensate from the steaming process of beech timber was analyzed by Ledig *et al.* (2003). In their study, only cumulative values of the components (*e.g.*, phenols and

saccharides) were determined, and these values reflected a higher degree of extractives for indirect steaming than for direct steaming.

Only one study was found that dealt with the condensate analysis of kiln-dried spruce wood (*Picea abies*) (Dejmal and Zejda 2008). This study was performed according to the accredited method SOA-16. However, only spruce wood was analyzed, and the chemical compounds were not investigated precisely. In the present study, the condensates from spruce, beech, and a mixture of spruce and pine (common for packaging material) were obtained and analyzed precisely by means of purge-and-trap followed by gas chromatography-mass spectroscopy (GC/MS) analysis. A technological solution for the recovery of condensate was given. In addition to the chemical compound analysis, the prices of these compounds were researched, and thus, a rough investment cost analysis for the technological recovery of the condensate was generated.

EXPERIMENTAL

Condensate Preparation and Storage

Condensate samples were selected from an Austrian softwood sawmill as well as from a German hardwood sawmill. They included samples of spruce (*Picea abies*), a pine/spruce mixture (*Picea abies* and *Pinus sylvestris*), and European beech (*Fagus sylvatica*). The samples were collected at the first stage of the kiln drying cycle from 3 dryer charges, which had a peak temperature of 77 °C for spruce, 72 °C for pine/spruce, and 65 °C for beech. From each of three dryer charges, two 500-mL samples were taken at the first stage of the kiln drying cycle. The condensates were stored in amber glass bottles at 4 °C and periodically examined for changes in pH value. No change in pH was noted in any of the condensates during storage.

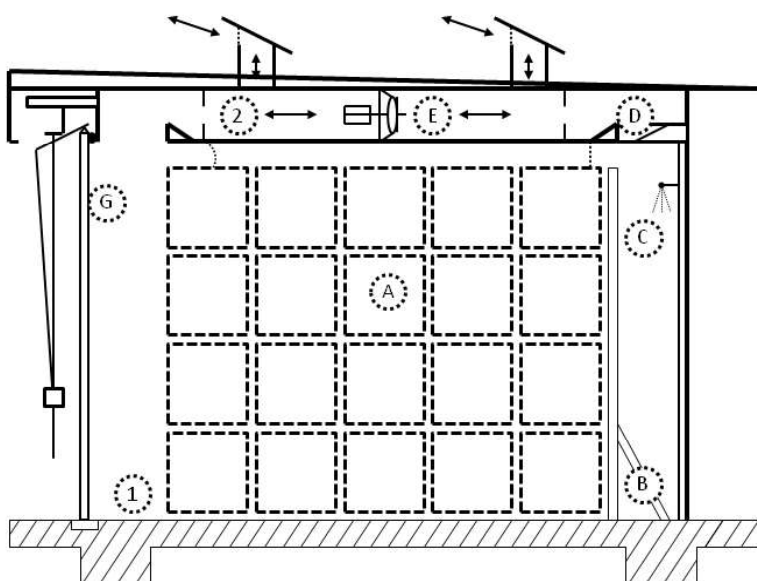


Fig. 1. Sectional drawing of a kiln with timber packages (A), stand (B), water spraying (C), damper register (D), and fan (E). Specimens were taken from the bottom (1) and from the intermediate ceiling (2).

The condensate samples were selected during the timber drying process from the bottom of the kiln (1) and from the intermediate ceiling (2), as can be seen in Fig. 1. The specimens were stored at 4 °C before the analysis process was begun.

Analysis of Condensate

Forty milliliters of each condensate was poured into a 40-mL clear glass screw vial (Sigma) and was subjected to purge-and-trap, by means of a homemade installation (Fig. 2) at 60 °C for 2 h, using technical air (hydrocarbon-free, Linde) as a purge gas and 200 mg of conditioned Tenax TA (60- to 80-mesh, Sigma) in TDAS 2000 glass tubes (Chromtech) as a sorbent. To reduce the temperature of the sorbent, the installation was put into a Binder KB 115 cooled chamber at 23 °C. After the sorption step had taken place, the Tenax tubes were spiked with 1 μL of a 0.373 $\mu\text{g}/\mu\text{L}$ methanol dilution of toluene- d_8 (Sigma) per tube as an internal standard (ISTD) and rinsed for 30 min at 23 °C with dry technical air (Linde gas) to reduce the water content in the sorbent. The air mass flow during the steps described above was set to 6 mL/min. The sorbent tubes were then thermally desorbed using a TDAS 2000 thermal desorption unit (Chromtech) coupled with a programmed temperature vaporizing (PTV) injector of an Agilent 7890A/5975C GC/MS. The analytes were desorbed at 250 °C for 5 min and cryo-focused in the PTV injector at -15 °C. The PTV injector was then heated to 280 °C at its maximum rate, and the analytes were separated on an HP-PONA methyl siloxane column (50 m x 0.2 mm x 0.5 mm, Agilent) using helium as the carrier gas in the velocity range of 25 to 30 cm s^{-1} and using the following oven temperature program: 3 min at 35 °C, then increased to 160 °C at 10 °C min^{-1} , and finally increased to 310 °C at 20 °C min^{-1} . The PTV injector was operated in split mode at a split of 30:1. The MS detector was set to scan over a m/z range of 12 to 400. The individual compounds were identified using a database with a spectra of wood-specific substances (Wood K plus). The concentrations of the identified volatile organic compounds (VOC) were then calculated in toluene equivalents.

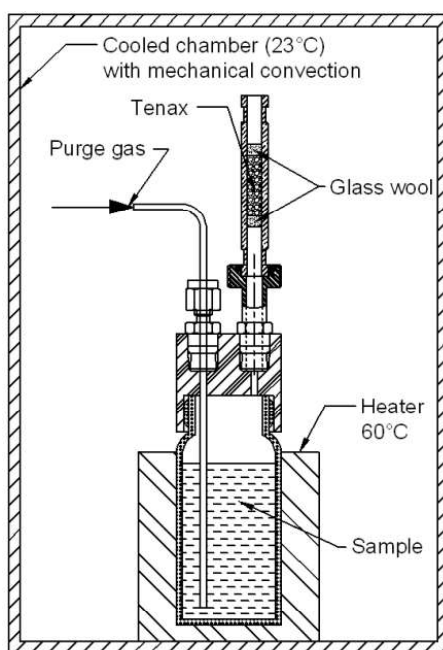


Fig. 2. Homemade purge and-trap installation

Purge-and-Trap Method Evaluation

To evaluate the average recovery rate and the quantification limit of the purge-and-trap method, a C6 to C14 alkane mixture was prepared by injecting 5 μL from each alkane in 955 μL of acetone. Twenty microliters of the solution were diluted with methanol in a ratio of 1:50, and 1 μL of the diluted solution was injected in 35 mL of deionized water. Finally, the mixture was analyzed according to the procedure described in the previous section (Analysis of Condensate). One microliter of the same methanol-acetone alkane mixture and 1 μL of ISTD were directly spiked in a Tenax tube and rinsed with dry technical air at 6 mL/min for 30 min. The areas of the GC/MS peaks of the alkanes, revealed by means of purge-and-trap as well as by direct injection, were divided by the corresponding area of the ISTD peak. These normalized areas were used for calculating the recovery rates in the alkane range of C6 to C14. It should be pointed out that the retention indices (RIs) of the C6 to C14 alkanes to a great extent covered the range of the RIs (not shown) of the detected substances in the condensate. The theoretical limits of quantization (LOQ) were calculated by dividing the known alkane concentrations in the deionized water solution by one tenth of the signal-to-noise ratios (S/N), determined from the Agilent MSD Chemstation software using “total ion concentration” as the signal (TIC).

Technological Implementation of Condensate Recovery

Conventional timber drying uses 60 to 95 $^{\circ}\text{C}$ warm air, which circulates through the timber packages. The timber packages are stacked with spacers to enable airflow. The kiln climate is controlled by venting the hot air and replacing it with ambient air. Thus, a drying program can be adapted according to the characteristics of the kiln load, *e.g.*, species, dimensions, and moisture content. In Fig. 3, a simplified transverse section of a kiln chamber with an energy recovery and dehumidification system is shown. The air, which is heated by the damper register (D) and circulated through the kiln by fans (E), heats the timber (A) and carries away the evaporated moisture and VOCs from the wood.

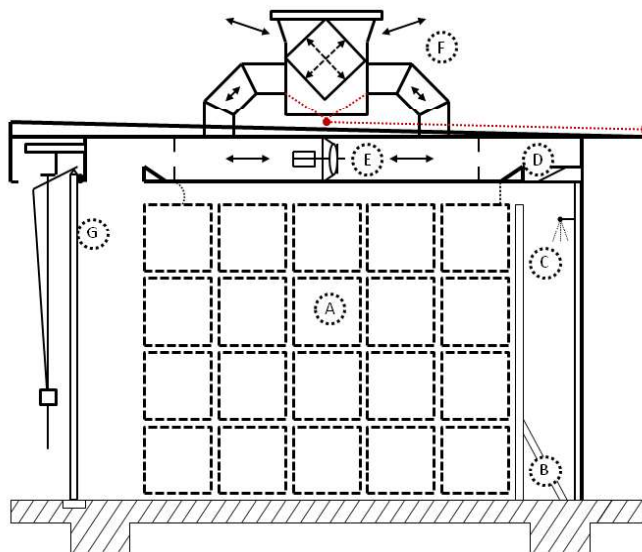


Fig. 3. Sectional drawing of a kiln chamber with timber packages (A), stand (B), water spraying (C), damper register (D), fan (E), and heat exchange device where condensate is ideally recovered (F); see red line.

The dehumidification unit of the kiln dries the wood in a closed system. This means that the dehumidification system condenses only as much moisture from the air as is necessary to generate the required relative humidity needed for the optimal drying process. The heat removed in the condensing procedure is returned to the kiln, with the fresh air coming in through a recuperator. The air flows over the lamella of the heat exchange unit, and the energy is transmitted into the incoming air while the condensed air moisture drops down and is collected at the bottom of the dehumidification unit, where it can be acquired for technical purposes.

The main disadvantages of the dehumidification unit are the high installation costs, as well as the higher operational and maintenance costs. The energy savings can compensate for part of these additional costs. However, in Millar's work (2006), the feasibility of using one dehumidification unit for the condensate recovery was examined. In that study, the VOC concentration in the kiln atmosphere was in the range of 10 ppm and was described as significantly lower than that of conventional kilns. This confirms the possibility of using dehumidification units for the recovery of chemical compounds released from wood during the drying process.

RESULTS AND DISCUSSION

Condensate Characteristics (Volatile Extractives)

Before analysis was performed, the condensate liquids were visually inspected. The condensates of softwood were of various shades of orange to orange-brown, while the beech condensates were brownish in color and contained suspended particles. The cumulative condensate characteristics of European beech, spruce, and the spruce/pine mixture are summarized in Table 1.

Feasibility of Using Condensate for Technological Purposes

In Table 2, the chemical components of the condensates are listed on the basis of Table 1. Here, the volatile extract value per m³ of condensate has been calculated depending on the amount and the price of the volatile organic components found in the liquid. The market prices were acquired from the catalog of one of the largest research chemical suppliers. For the extract value calculation, only 20% of the chemical prices were used due to the fact that processing costs, transportation costs, and sales costs must be included. The recovery rates (Table 4) were also considered when calculating the prices. The individual percentage contributions of the volatile compounds to the total extract value are also listed in Table 2.

The condensate that was collected during the industrial kiln drying processes contained the following volatile organic compounds: (i) terpenoids, (ii) ketones, (iii) alcohols, and (iv) traces of aldehydes and aromatic compounds. Small traces of benzene were found in the spruce condensate, but the concentrations were below the regulated limits. An interesting observation was that the fractions of alcohols and ketones were much higher than their usual fractions detected by direct emission determination of the corresponding dry wood materials (Hyttinen *et al.* 2010). This fact could be explained with the higher solubility of polar ketones and alcohols in water than terpenes which leads to their selective concentration in the condensate. High temperatures and moisture content during the drying process should also contribute for the oxidation of the monoterpenes.

Table 1. Characteristics of Condensates from Three European Species

Substances	Concentration [mg/m ³]		
	Beech	Spruce	Spruce/Pine
Total Volatile Extract	21.4	58.2	72.1
2-Butanone	4.6	1.6	9.9
Ethyl acetate	0.0	0.0	2.0
Butanol	0.0	1.1	0.4
Benzene	0.0	0.8	0.0
Isopropyl nitrate	0.0	2.4	0.0
2-Pentanone	1.9	0.9	5.9
1-Pentanol	0.0	4.7	6.6
Toluene	0.2	0.8	0.9
Hexanal	0.9	0.8	1.9
1-Hexanol	0.1	2.7	2.3
3-Heptanone	1.5	0.0	0.1
2-Heptanone	1.4	1.1	1.4
2-Heptanol	1.5	0.0	0.0
α -Pinene	0.3	11.3	0.3
3-Octanone	0.0	0.1	3.2
2-Octanone	2.3	0.1	1.2
2-Octanol	3.3	0.0	0.0
β -Pinene	0.0	7.7	0.6
2-Ethylhexanol	0.1	0.9	0.0
delta-3-Carene	1.3	6.8	0.4
Limonene	0.0	7.6	0.2
Fenchone	0.0	0.8	3.5
Fenchol	0.0	0.7	3.2
Camphor	0.3	0.4	7.5
Pinocamphone	0.0	0.0	2.1
Isopinocamphone	0.8	0.0	7.7
Terpinen-4-ol	0.1	0.7	2.9
α -Terpineol	0.4	1.9	4.6
Verbenone	0.0	0.1	2.6
Tridecane	0.3	0.2	0.3
Sesquiterpenoids	0.0	2.0	0.5

By using a different analytical technique (SPME) and much shorter condensate-gathering time (only four hours), Dejmal and Zejda (2008) also showed that the fraction of hydroxylated and oxidized terpenoids in condensate is much higher than that of the softwood characteristic monoterpenes like α - and β -Pinene, 3-Carene, and Limonene.

Table 1 shows that there were significant differences between the volatile contents of the three condensates. As expected, the concentrations of monoterpenes (such as α -pinene and 3-carene) in the spruce condensate were higher than those detected in the European beech condensate. Unexpectedly, the detected concentrations of monoterpenes in the spruce/pine condensate were much lower compared to spruce. It is possible that monoterpenes emitted during spruce/pine drying were oxidized/hydroxylated at higher rates to keto- and hydroxy- terpenoids such as fenchone, fenchol, camphor, pinocamphone, isopinocamphone, terpinen-4-ol, and verbenone. These terpenoids were detected in higher concentrations in the spruce/pine- condensate.

Table 2. Prices for Chemical Components

Substances	Substance contribution to the total extract value [%]		
	European Beech	Spruce	Spruce/ Pine
Extractives value [EUR/1000 m³]	0.59	2.13	3.61
2-Butanone	10.6%	1.1%	3.8%
Ethyl acetate	0.0%	0.0%	0.6%
Butanol	0.0%	0.8%	0.2%
Benzene	0.0%	0.8%	0.0%
Isopropyl nitrate	0.0%	3.4%	0.0%
2-Pentanone	4.7%	0.6%	2.4%
1-Pentanol	0.0%	6.0%	5.0%
Toluene	0.4%	0.5%	0.3%
Hexanal	2.7%	0.6%	0.9%
1-Hexanol	0.1%	0.9%	0.5%
3-Heptanone	16.2%	0.0%	0.2%
2-Heptanone	3.4%	0.8%	0.6%
2-Heptanol	10.8%	0.0%	0.0%
α-Pinene	3.2%	30.6%	0.5%
3-Octanone	0.0%	0.2%	3.3%
2-Octanone	5.0%	0.1%	0.4%
2-Octanol	5.1%	0.0%	0.0%
β -Pinene	0.0%	4.1%	0.2%
2-Ethylhexanol	0.2%	0.4%	0.0%
delta-3-Carene	8.1%	11.7%	0.4%
Limonene	0.0%	9.5%	0.2%
Fenchone	0.0%	0.9%	2.3%
Fenchol	0.0%	0.9%	2.4%
Camphor	1.9%	0.6%	7.3%
Pinocamphone	0.0%	0.0%	2.8%
Isopinocampnone	6.1%	0.0%	9.9%
Terpinen-4-ol	9.0%	15.8%	41.6%
α -Terpineol	1.2%	1.3%	2.0%
Verbenone	0.0%	0.4%	10.0%
Tridecane	11.2%	1.5%	1.5%
Sesquiterpenoids	0.0%	6.5%	0.9%

According to Table 2, a maximum value of 0.59 € per 1000 m³ of condensate could be gained from the beech condensate. For spruce, 2.13 € per 1000 m³ could be gained, while the mixture of spruce and pine was revealed to have the highest potential gains, at 3.61 € per 1000 m³, which is in all likelihood due to the high terpene content in pine. The calculation of the technological feasibility was based on the raw material revenue for each kiln drying cycle. The additional costs for the dehumidification unit were calculated, estimating 10,000 € for each kiln chamber.

The condensate that is generated is typically transported to waste, as no toxicity has been detected. In this study, the profitability of using the condensate as a chemical resource was analyzed.

Table 3 shows a number of parameters needed for the cost calculation, including density, moist weight, water content, and the revenue that would be generated per drying cycle and per year using the chemical compounds in the condensate.

Table 3. Physiological Parameters and Revenue Calculation

Parameter	European Beech	Spruce	Spruce/Pine
Dry density [kg/m ³]	740	430	475*
Moist density [kg/m ³]	1340	774	855
Water content [kg/m ³]	600	344	380
Kiln dry capacity [m ³]	180	300	300
Peak dryer temperature [°C]	65	77	72
Condensate pH Value	5	7	7
Total water content [t]	108	103	114
Number of cycles [p.a]	13	70	70
Revenue per cycle [€]	0.06	0.22	0.41
Revenue per year [€]	1	15	29
* Average			

Green timber has an average wood moisture content (calculated based on dry weight) of 80%, which indicates a corresponding water content of approximately 45%. In Central Europe, hardwood is most often dried unedged, while softwood is edged or already sawn into dimensions. In addition to the shape of the boards, the drying time is also quite varied. Normally, it takes about five days to dry softwood timber, while hardwood requires at least four weeks. Assuming 350 production days for the kiln, 13 drying cycles can be accomplished with hardwood timber, and 70 with softwood, due to the longer drying cycles of hardwood (European beech). The two sawmills from which the condensate was obtained operated with kiln capacities of approximately 300 m³ for the softwood kiln and 180 m³ for the hardwood kiln. According to the calculations that were made, the revenue that could be generated from the volatile extractives by drying hardwood is 0.06 € per drying cycle.

Method Evaluation

The theoretical limits of the quantification (Table 4) were higher than the detection limits reported by Rosell *et al.* (2003), but taking into account the potential for further reductions in the split ratio, the overall sensitivity of the current P&T method should be slightly higher.

Table 4. C6 to C14 Recovery Rates and Theoretical Limits of Quantification

Alcane	Concentration [µg/L]	Recovery rate	LOQ by split 30:1 [ng/L]	S/N (TIC)
C6	1.87	73%	319	59
C7	1.94	102%	203	96
C8	2.01	94%	98	205
C9	2.05	87%	73	280
C10	2.09	86%	56	371
C11	2.11	76%	60	352
C12	2.23	67%	47	476
C13	2.16	48%	107	202
C14	2.16	54%	296	73
Average	2.07	76%	140	235

However, the substances used for the LOQ detection were not identical to those used by Rosell *et al.* (2003). The recovery rates in the range of C7 to C14 decreased, as expected, due to the decrease in the VOC volatility. The recovery rate of hexane was unexpectedly lower than that of heptane, but this could be explained by its loss (due to higher volatility) during the preparation steps before trapping took place.

CONCLUSIONS

According to the findings presented, the recovery of the volatile fraction (of dry-kiln condensate) alone with the help of dehumidification unit is not economically reasonable. Only the combination of extractive recovery combined with energy recovery systems seem to be economically viable. It is of further interest whether the inclusion of nonvolatile condensate extractives in the equation could contribute for making recovery more profitable.

ACKNOWLEDGMENTS

The support from the sawmills Schaffer in Eppenstein, Austria and B. Keck GmbH in Ehningen, Germany as well as the language support by Cornelia Riegler are gratefully acknowledged by the authors.

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APPENDIX C-2

Prevention of Significant Deterioration Background Data

**Harrigan Lumber Company
Monroeville, AL
Actual Emissions Calculations
Reporting Year: 2017**

Particulate Emissions

Emission Point Description	ID #	Emission Factor	Emission Factor Units	Operating Units	Actual Operating Levels	Actual Emissions (tons/yr)	Condensable Emissions (tons/yr)*
98 MBF Kiln #2 w/ 15 MMBtu/hr Burner	002C	0.592	lbs/ton	tons burned	4,986	1.476	0.755
98 MBF Kiln #3 w/ 15 MMBtu/hr Burner	K-3	0.592	lbs/ton	tons burned	6,064	1.795	0.918
147 MBF Kiln #4 w/ 32 MMBtu/hr Burner	K-4	0.321	lbs/ton	tons burned	12,767	2.050	1.492
82.2 MMBF/yr Continuous Dry Kiln East End	CDK-1E	0.321	lbs/ton	tons burned	343	0.055	0.022
82.2 MMBF/yr Continuous Dry Kiln West End	CDK-1W	0.321	lbs/ton	tons burned	343	0.055	0.022
Planer Cyclone Exhaust	005 C-1	2.0	lbs/hr	hours	2,583	2.583	
Planer Shavings Silo Cyclone Exhaust	005 C-2A	2.0	lbs/hr	hours	737	0.737	
Planer Shavings Hopper Cyclone Exhaust	C-2B	2.0	lbs/hr	hours	1,171	1.171	
Powder Silo Cyclone Exhaust	005 C-3	5.0	lbs/hr	hours	737	1.842	
Green Sawdust Fuel Cyclone Exhaust	006 C-4A	2.0	lbs/hr	hours	2,772	2.772	
CDK Green Sawdust Fuel Cyclone Exhaust	C-4B	2.0	lbs/hr	hours	163	0.163	
Powder Blend Box Cyclone Exhaust	C-5	0.75	lbs/hr	hours	-	0.000	
Facility Totals (tons/yr)						14.699	3.209

- Kiln emission factors were calculated using the Kiln #4 test result of 0.037 lbs/MMBtu converted to lbs/ton using fuel heat values.
- Cyclone emission factors for Cyclones #1, 2, 3 and 4 are from FIRE. Emission factor for Cyclone #5 is based on cyclone manufacturer information.
- Cyclones 1, 2 & 3 are restricted to 5200 hours per year.
- Condensable emissions calculated using AP-42 factor of 0.017 lb/MMBtu at max burner firing rate.

Volatile Organic Compounds (As Terpenes) (Includes HAP-VOCs)

Emission Point Description	ID #	Emission Factor	Emission Factor Units	Operating Units	Actual Operating Levels	Actual Emissions (tons/yr)
98 MBF Kiln #2 w/ 15 MMBtu/hr Burner	002C	4.29	lb/MBF	MBF dried	21,898	46.971
98 MBF Kiln #3 w/ 15 MMBtu/hr Burner	K-3	4.29	lb/MBF	MBF dried	26,634	57.131
147 MBF Kiln #4 w/ 32 MMBtu/hr Burner	K-4	4.29	lb/MBF	MBF dried	30,418	65.247
82.2 MMBF/yr Continuous Dry Kiln East End	CDK-1E	4.29	lb/MBF	MBF dried	817	1.753
82.2 MMBF/yr Continuous Dry Kiln West End	CDK-1W	4.29	lb/MBF	MBF dried	817	1.753
Facility Totals (tons/yr)						172.855

- NCASI Technical Bulletin 845 Factor of 3.8 lbs VOC as C/Mbf converted to lbs VOC as terpenes/Mbf

Emission Unit 005 C-1: Planer Cyclone Exhaust

<u>Tons Emitted</u>	<u>Pollutant</u>
2.348	PM10
1.409	PM2.5
2.583	PM

Emission Unit 005 C-2A: Planer Shavings Silo Cyclone Exhaust

<u>Tons Emitted</u>	<u>Pollutant</u>
0.670	PM10
0.402	PM2.5
0.737	PM

Emission Unit C-2B: Planer Shavings Hopper Cyclone Exhaust

<u>Tons Emitted</u>	<u>Pollutant</u>
1.065	PM10
0.639	PM2.5
1.171	PM

Emission Unit 005 C-3: Powder Silo Cyclone Exhaust

<u>Tons Emitted</u>	<u>Pollutant</u>
1.674	PM10
1.005	PM2.5
1.842	PM

Emission Unit 006 C-4A: Green Sawdust Fuel Cyclone Exhaust

<u>Tons Emitted</u>	<u>Pollutant</u>
2.520	PM10
1.512	PM2.5
2.772	PM

Emission Unit C-4B: CDK Green Sawdust Fuel Cyclone Exhaust

<u>Tons Emitted</u>	<u>Pollutant</u>
0.149	PM10
0.089	PM2.5
0.163	PM

Emission Unit C-5: CDK Powder Blend Box Cyclone Exhaust

<u>Tons Emitted</u>	<u>Pollutant</u>
0.000	PM10
0.000	PM2.5
0.000	PM

**Harrigan Lumber Company
Monroeville, AL
Actual Emissions Calculations
Reporting Year: 2018**

Particulate Emissions

Emission Point Description	ID #	Emission Factor	Emission Factor Units	Operating Units	Actual Operating Levels	Actual Emissions (tons/yr)	Condensable Emissions (tons/yr)*
98 MBF Kiln #3 w/ 15 MMBtu/hr Burner	Stack K-3	0.592	lbs/ton	tons burned	6,170	1.826	0.839
147 MBF Kiln #4 w/ 32 MMBtu/hr Burner	Stack K-4	0.321	lbs/ton	tons burned	24,702	3.967	1.823
82.2 MMBF/yr Continuous Dry Kiln East End	Stack CDK-1E	0.335	lbs/ton	tons burned	13,014	2.178	1.001
82.2 MMBF/yr Continuous Dry Kiln West End	Stack CDK-1W	0.335	lbs/ton	tons burned	13,014	2.178	1.001
Planer Cyclone Exhaust	Stack C-1	2.0	lbs/hr	hours	4,615	4.615	
Planer Shavings Silo Cyclone Exhaust	Stack C-2A	2.0	lbs/hr	hours	1,153	1.153	
Planer Shavings Hopper Cyclone Exhaust	Stack C-2B	2.0	lbs/hr	hours	3,462	3.462	
Powder Silo Cyclone Exhaust	Stack C-3	5.0	lbs/hr	hours	1,153	2.883	
Green Sawdust Fuel Cyclone Exhaust	Stack C-4A	2.0	lbs/hr	hours	2,142	2.142	
CDK Green Sawdust Fuel Cyclone Exhaust	Stack C-4B	2.0	lbs/hr	hours	2,142	2.142	
Powder Blend Box Cyclone Exhaust	Stack C-5	0.75	lbs/hr	hours	2,603	0.976	
Facility Totals (tons/yr)						27.521	4.663

- Kiln emission factors were calculated using the Kiln #4 test result of 0.037 lbs/MMBtu converted to lbs/ton using fuel heat values.
- Cyclone emission factors for Cyclones #1, 2, 3 and 4 are from FIRE. Emission factor for Cyclone #5 is based on cyclone manufacturer information.
- Cyclones 1, 2 & 3 are restricted to 6240 hours per year.
- Condensable emissions calculated using AP-42 factor of 0.017 lb/MMBtu at max burner firing rate.

Volatile Organic Compounds (As Terpenes) (Includes HAP-VOCs)

Emission Point Description	ID #	Emission Factor	Emission Factor Units	Operating Units	Actual Operating Levels	Actual Emissions (tons/yr)
98 MBF Kiln #3 w/ 15 MMBtu/hr Burner	Stack K-3	4.29	lb/MBF	MBF dried	14,021	30.074
147 MBF Kiln #4 w/ 32 MMBtu/hr Burner	Stack K-4	4.29	lb/MBF	MBF dried	22,906	49.133
82.2 MMBF/yr Continuous Dry Kiln East End	Stack CDK-1E	4.29	lb/MBF	MBF dried	32,999	70.782
82.2 MMBF/yr Continuous Dry Kiln West End	Stack CDK-1W	4.29	lb/MBF	MBF dried	32,999	70.782
Facility Totals (tons/yr)						220.772

- NCASI Technical Bulletin 845 Factor of 3.8 lbs VOC as C/Mbf converted to lbs VOC as terpenes/Mbf

Emission Unit 005 C-1: Planer Cyclone Exhaust

<u>Tons Emitted</u>	<u>Pollutant</u>
4.195	PM10
2.517	PM2.5
4.615	PM

Emission Unit 005 C-2A: Planer Shavings Silo Cyclone Exhaust

<u>Tons Emitted</u>	<u>Pollutant</u>
1.048	PM10
0.629	PM2.5
1.153	PM

Emission Unit C-2B: Planer Shavings Hopper Cyclone Exhaust

<u>Tons Emitted</u>	<u>Pollutant</u>
3.147	PM10
1.888	PM2.5
3.462	PM

Emission Unit 005 C-3: Powder Silo Cyclone Exhaust

<u>Tons Emitted</u>	<u>Pollutant</u>
2.620	PM10
1.573	PM2.5
2.883	PM

Emission Unit 006 C-4A: Green Sawdust Fuel Cyclone Exhaust

<u>Tons Emitted</u>	<u>Pollutant</u>
1.947	PM10
1.168	PM2.5
2.142	PM

Emission Unit C-4B: CDK Green Sawdust Fuel Cyclone Exhaust

<u>Tons Emitted</u>	<u>Pollutant</u>
1.947	PM10
1.168	PM2.5
2.142	PM

Emission Unit C-5: CDK Powder Blend Box Cyclone Exhaust

<u>Tons Emitted</u>	<u>Pollutant</u>
0.887	PM10
0.532	PM2.5
0.976	PM

APPENDIX C-3

Best Available Control Technology Data

Harrigan Lumber Company
PSD Permit Application

RBL Database Results for Natural Gas Fired Continuous Lumber Drying Kilns

RBLCID	FACILITY_NAME	PROCESS_NAME	PROCESS_TYPE	PRIMARY_FUEL	CONTROL_METHOD_DESCRIPTION	EMISSION_LIMIT_1_UNIT	EMISSION_LIMIT_1_AVG_TIME_CONDITION
AL-0308	TWO RIVERS LUMBER CO., LLC	15.4 MBF/HR CDK (DPK-1) W/ 38.8 MMBTU/HR NATURAL GAS BURNER	30.8	NATURAL GAS		3.8 LB/MBF	MEASURED AS CARBON
AL-0308	TWO RIVERS LUMBER CO., LLC	15.4 MBF/HR CDK (DPK-2) W/ 38.8 MMBTU/HR NATURAL GAS BURNER	30.8	NATURAL GAS		3.8 LB/MBF	MEASURED AS CARBON
AL-0310	FULTON SAWMILL	11.4 MBF/HR CONTINUOUS DIRECT-FIRED LUMBER DRY KILN, 40 MMBTU/HR NATURAL GAS BURNER, & 4 MMBTU/HR NATURAL GAS CONDENSATE EVAPORATOR	30.8	NATURAL GAS	BACT DETERMINED AS PROPER KILN OPERATION AND MAINTENANCE PRACTICES	4 LB/MBF	MBF
*AL-0318	TALLADEGA SAWMILL	Dry Kiln 1	30.8	natural gas		5.49 LB/MBF AS WPP1 VOC	
*AL-0318	TALLADEGA SAWMILL	Dry Kiln 2	30.8	Natural Gas		5.49 LB/MBF AS WPP1 VOC	
*AL-0318	TALLADEGA SAWMILL	Dry Kiln 3	30.8	Natural Gas		5.49 LB/MBF AS WPP1 VOC	
AR-0122	GEORGIA-PACIFIC WOOD PRODUCTS SOUTH LLC (GURDON PLYWOOD AND	SN-09 #4 LUMBER KILN	30.8	NATURAL GAS		3.8 LB/ 1000 BOARD FEET	
AR-0124	EL DORADO SAWMILL	LUMBER DRYING KILN SN-01	30.8	NATURAL GAS	PROPER MAINTENANCE AND OPERATION	3.8 LB/MBF	
AR-0124	EL DORADO SAWMILL	LUMBER DRYING KILN SN-02	30.8	NATURAL GAS		3.8 LB/MBF	
AR-0124	EL DORADO SAWMILL	LUMBER DRYING KILN SN-03	30.8	NATURAL GAS		3.8 LB/MBF	
SC-0184	NSLC - DARLINGTON	Lumber Drying Kiln 7	30.8	Natural Gas	Volatile Organic Compounds (VOC) best available control technology for the continuous lumber drying kiln, KLN7, is work practice standards. VOC emissions are based on an emissions factor of 4.2 lb VOC/1000 bd-ft (as terpene +methanol + formaldehyde).	4.2 LB VOC/1000 BD-FT	VOC AS TERPENE + METHANOL + FORMALDEHYDE

Harrigan Lumber Company
PSD Permit Application

RBLCID	FACILITY_NAME	PROCESS_NAME	RBLC Database Results for Natural Gas Fired Condensate Evaporators		CONTROL_METHOD_DESCR	EMISSION_LIMIT_1_UNIT
			PROCESS_PRIMARY_FUEL			
AL-0267	GEORGIA PACIFIC BRETON LLC	No. 4 Multiple Effect Evaporator System		30.219 BL	INCINERATE in No. 4 REC or No.3 Lime Kiln	0
AL-0267	GEORGIA PACIFIC BRETON LLC	50% BLS Tank - No.4 Multiple Effect Evaporator System		30.219		0.113 LB/H
AL-0267	GEORGIA PACIFIC BRETON LLC	73% BLS Tank - No.4 Multiple Effect Evaporator System		30.219		0.113 LB/H
AL-0267	GEORGIA PACIFIC BRETON LLC	Weak BLS Tank - No.4 Multiples Effect Evaporator System		30.219		4.84 LB/H
AL-0267	GEORGIA PACIFIC BRETON LLC	Stripped Condensate - No.4 Multiple Effect Evaporator System		30.219		0.187 LB/H
AL-0267	GEORGIA PACIFIC BRETON LLC	Condensate A Tank - No.4 Multiple Effect Evaporator System		30.219		0.187 LB/H
AL-0267	GEORGIA PACIFIC BRETON LLC	Condensate B Tank - No.4 Multiple Effect Evaporator System		30.219		0.485 LB/H
AL-0310	FULTON SAWMILL	11.4 MBF/HR CONTINUOUS DIRECT-FIRED LUMBER DRY KILN, 40 MMBTU/HR NATURAL GAS BURNER, & 4 MMBTU/HR NATURAL GAS CONDENSATE EVAPORATOR		30.8 NATURAL GAS	BACT DETERMINED AS PROPER KILN OPERATION AND MAINTENANCE PRACTICES	4 LB/MBF
OK-0156	NORTHSTAR AGRI IND ENID	Wastewater Evaporator		22.9	Evaporator routed to Mineral Oil Scrubber	0

September 4, 2019

Mr. Lester Meredith
Air Division
Alabama Department of Environmental Management
1400 Coliseum Blvd
Montgomery, AL 36110
vlm@adem.alabama.gov

Re: Harrigan Lumber Company
Prevention of Significant Deterioration (PSD) Application UDPATE

Mr. Meredith:

Attached, we are providing an update to the PSD Application provided on August 13, 2019. The update reflects a request to increase the CDK-2 project Best Available Control Technology limit from 4.78 lb VOC/MBf to 4.8 lb VOC/MBf; compliance will still be demonstrated by completing and recording proper operating and maintenance practices and recording lumber dried in CDK-2. The purpose of this request is to ensure that the possible emissions from the condensate evaporators are considered in the VOC emissions allowed from the kiln.

The pages provided are Page Nos. 5-4 and 5-5 for update within Section 5.1 BACT Determination and a new Form 103 as certification by the Responsible Official. We are providing this change by email in the interest of Harrigan obtaining the authorization to construct the replacement kiln as quickly as possible. The documents with Alan Morgan's original signature by mail.

We appreciate the Department's consideration of this matter. If you have any questions, please do not hesitate to contact me at (334) 568-9749 or lreed@acesconsult.com or Alan Morgan at amorgan@harriganlumber.com.

Sincerely,
ACES Consulting Group


Lisa M. Reed
Principal Owner

Attachment

Continuous Dry Kiln No. 2 Construction Permit Application

Harrigan Lumber Company

1033 Hornady Road
Monroeville, AL 36460

Updated Pages September 2019
Page # 5-4 and 5-5 and Form 103

Prepared by:

ACES

ACES Consulting Group
307 High Pointe Ridge
Prattville, AL 36066
Telephone (334)568-9749
www.acesconsult.com

Carbon Adsorption

The high moisture content of the kiln exhaust indicates carbon adsorption is not practical. The water molecules compete with the hydrocarbon molecules for active adsorption sites reducing the capacity and efficiency of the adsorption system. There are no known lumber dry kilns equipped with a carbon adsorption system and it is deemed technically infeasible.

Condensation

Condensation is effective when the gas stream can be cooled to a temperature where VOC condense as a liquid out of the gas stream. To condense terpenes, the primary constituent of lumber kiln VOC emissions, the temperature would need to be reduced to -40°F. At this temperature, freezing of the water vapor would generate ice, causing plugging of the unit. This technology is technically infeasible.

Biofiltration

Temperature is an important variable affecting biofilter operations. The kiln exhaust temperature of approximately 120 – 140°F exceeds that at which microorganisms thrive. The terpenes in the exhaust stream, being highly viscous, would foul the biofilter. There are no known systems utilizing this application and leaves this option as technically infeasible.

Wet Scrubbing

The terpenes within the kiln exhaust are not highly soluble but are highly viscous. This would lead to plugging the absorption media of a wet scrubber and leaves the process technically infeasible.

Step 3 – Rank remaining control technologies by control effectiveness:

Proper Maintenance and Operation

The only technically feasible control technology for controlling VOC emissions from the proposed CDK is the use of proper maintenance and operating practices. Since this was the only remaining BACT control technology technically or economically feasible, ranking is not needed.

Step 4 – Evaluate most effective controls and document results

Proper Maintenance and Operation

Using the steps from the US EPA guidelines, only proper maintenance and operation remains technically feasible. Further, this is the only control identified in the RBLC database.

Step 5 – Select BACT

BACT is the most effective control technology remaining of the previous four steps. Proper kiln maintenance and operation is the only remaining technology for the control of VOC. The BACT limit on similar kilns are shown at 3.38 lb/MBf – 5.49 lb/MBf with the RBLC database.

Harrigan proposes BACT as proper kiln maintenance and operation at 4.8 lb/MBf as VOC (WPP1). The factor of 4.8 lb/MBf as VOC (WPP1) is consistent with other recent BACT determinations and includes the minimal emissions possible from kiln condensate evaporation released through the kiln. To demonstrate compliance with this limit, Harrigan proposes to establish and follow a kiln maintenance and operating plan. Proper maintenance and operating practices will ensure optimal drying through production scheduling and kiln temperature set point reducing the potential for over drying lumber.

From this BACT review, Harrigan Lumber Company proposes the technology and limit presented in Table 5-1 as BACT for the continuous kiln and condensate evaporator emissions.

Table 5-1 Proposed BACT Limit Summary

Unit	Pollutant	BACT	Limit	Compliance Method
CDK-2 CE-1 CE-2	VOC	Proper Maintenance and Operating Practices	4.8 lb/MBf	Recordkeeping of Maintenance

5.2 Proposed Monitoring, Recordkeeping, and Reporting

Harrigan proposed the following compliance requirements for this proposed project within Table 5.2.

Table 5.2 Proposed Compliance

Emission Source Description	Emission Point ID	Proposed Compliance Requirements
Direct-Fired Continuous Lumber Dry Kiln No. 2	CDK-2	Maintain proper operating and maintenance practices and retain records of such practices Monthly records of lumber dried (110,000 MBf/yr on a 12-month rolling average basis)
Direct-Fired Continuous Lumber Dry Kiln No. 2 Condensate Evaporator No. 1 Condensate Evaporator No. 2	CDK-2 CE-1 CE-2	Calculate the 12-month rolling average emissions of NSR regulated pollutants in tpy

ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT (AIR DIVISION)

Do not Write in This Space

Facility Number

			-				
--	--	--	---	--	--	--	--

CONSTRUCTION/OPERATING PERMIT APPLICATION
FACILITY IDENTIFICATION FORM

1. Name of Facility, Firm, or Institution:		Harrigan Lumber Company, Inc.	
Facility Physical Location Address			
Street & Number:		1033 Hornady Road	
City:	County:	Zip:	
Monroeville	Monroe	36460	
Facility Mailing Address (If different from above)			
Address or PO Box:		PO Drawer 926	
City:	State:	Zip:	
Monroeville	AL	36461	
Owner's Business Mailing Address			
2. Owner:		Harrigan Lumber Company, Inc.	
Street & Number:		PO Drawer 926	
		City:	
		Monroeville	
State:	Zip:	Telephone:	
AL	36461	251-575-4821	
Responsible Official's Business Mailing Address			
3. Responsible Official:		Alan Morgan	
		Title:	
		Production Manager	
Street & Number:		PO Drawer 926	
City:	State:	Zip:	
Monroeville	AL	36461	
Telephone Number:		E-mail Address:	
251-362-1100		amorgan@harriganlumber.com	
Plant Contact Information			
4. Plant Contact:		Darrel McKinley	
		Title:	
		HR/EHS Manager	
Telephone Number:		E-mail Address:	
251-575-4821		dmckinley@harriganlumber.com	

5. Location Coordinates:

UTM	3,486,795	E-W	471.915	N-S
Latitude/Longitude	31.517532	LAT	-87.296258	LONG

6. Permit application is made for:

- Existing source (initial application)
- Modification
- New source (to be constructed)
- Change of ownership
- Change of location
- Other (specify) _____

Existing source (permit renewal)

If application is being made to construct or modify, please provide the name and address of installer or contractor

DelTech Manufacturing/BidGroup

930 Molly Pond Road

Augusta, GA 30901

Telephone 250-564-3585

Date construction/modification to begin upon approval (~Sept 2019) to be completed ~July 2020

7. Permit application is being made to obtain the following type permit:

- Air permit
- Major source operating permit
- Synthetic minor source operating permit
- General permit

8. Indicate the number of each of the following forms attached and made a part of this application: (if a form does not apply to your operation indicate "N/A" in the space opposite the form). Multiple forms may be used as required.

- NA ADEM 104 - INDIRECT HEATING EQUIPMENT
- 1 ADEM 105 - MANUFACTURING OR PROCESSING OPERATION
- NA ADEM 106 - REFUSE HANDLING, DISPOSAL, AND INCINERATION
- NA ADEM 107 - STATIONARY INTERNAL COMBUSTION ENGINES
- NA ADEM 108 - LOADING, STORAGE & DISPENSING LIQUID & GASEOUS ORGANIC COMPOUNDS
- NA ADEM 109 - VOLATILE ORGANIC COMPOUND SURFACE COATING EMISSION SOURCES
- NA ADEM 110 - AIR POLLUTION CONTROL DEVICE
- NA ADEM 112 - SOLVENT METAL CLEANING
- NA ADEM 438 - CONTINUOUS EMISSION MONITORS
- NA ADEM 437 - COMPLIANCE SCHEDULE

9. General nature of business: (describe and list appropriate standard industrial classification (SIC) and North American Industry Classification System (NAICS) (www.naics.com) code(s)):

PINE LUMBER MANUFACTURER

SIC CODE - 2421, NAICS CODE - 321113

10. For those making application for a synthetic minor or major source operating permit, please summarize each pollutant emitted and the emission rate for the pollutant. Indicate those pollutants for which the facility is major.

Regulated pollutant	Potential Emissions* (tons/year)	Major source? yes/no
Particulates	213.992	YES
Volatile Organic Compounds (WPP1)	513.005	YES
Carbon Monoxide	188.247	YES
Nitrogen Oxides	75.884	NO
Sulfur Oxides	7.151	NO
Methanol (HAP)	20.424	YES
Formaldehyde (HAP)	10.311	YES
Acetaldehyde (HAP)	4.161	NO
Greenhouse Gases (CO2e)	86,693	NO
PM10	45.713	NO
PM2.5	27.433	NO

*Potential emissions are either the maximum allowed by the regulations or by permit, or, if there is no regulatory limit, it is the emissions that occur from continuous operation at maximum capacity.

11. For those applying for a major source operating permit, indicate the compliance status by program for each emission unit or source and the method used to determine compliance. Also cite the specific applicable requirement.

Emission unit or source: CDK-2/CE-1/CE-2

(description)

Emission Point No.	Pollutant ⁴	Standard	Program ¹	Method used to determine compliance	Compliance Status	
					IN ²	OUT ³
CDK-2/CE-1/CE-2	VOC	40 CFR 52	PSD	Proper Maintenance and Operation	Proposed	
CDK-2/CE-1/CE-2	HAP	40 CFR 63 PCWP MACT	NESHAP	Permit app provides notification of applicability	IN	

¹PSD, non-attainment NSR, NSPS, NESHAP (40 CFR Part 61), NESHAP (40 CFR Part 63), accidental release (112(r)), SIP regulation, Title IV, Enhanced Monitoring, Title VI, Other (specify)

²Attach compliance plan

³Attach compliance schedule (ADEM Form-437)

⁴Fugitive emissions must be included as separate entries

13. List and explain any exemptions from applicable requirements the facility is claiming:

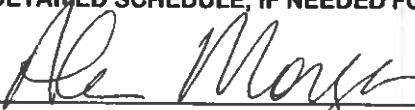
- a. _____
- b. _____
- c. _____
- d. _____
- e. _____
- f. _____
- g. _____
- h. _____
- i. _____

14. List below other attachments that are a part of this application(all supporting engineering calculations must be appended):

- a. ADEM Forms
- b. Project Description and Drawings
- c. Regulatory Applicability including PSD Analysis
- d. UPDATED BACT Review and Proposed Compliance Demonstration **PAGE 5-4 and 5-5 PROVIDED AS UPDATE
- e. Air Quality and Impact Analysis
- f. Emission Calculations
- g. Reference Documentation
- h. _____
- i. _____

I CERTIFY UNDER PENALTY OF LAW THAT, BASED ON INFORMATION AND BELIEF FORMED AFTER REASONABLE INQUIRY, THE STATEMENTS AND INFORMATION CONTAINED IN THIS APPLICATION ARE TRUE, ACCURATE AND COMPLETE.

I ALSO CERTIFY THAT THE SOURCE WILL CONTINUE TO COMPLY WITH APPLICABLE REQUIREMENTS FOR WHICH IT IS IN COMPLIANCE, AND THAT THE SOURCE WILL, IN A TIMELY MANNER, MEET ALL APPLICABLE REQUIREMENTS THAT WILL BECOME EFFECTIVE DURING THE PERMIT TERM AND SUBMIT A DETAILED SCHEDULE, IF NEEDED FOR MEETING THE REQUIREMENTS.


SIGNATURE OF RESPONSIBLE OFFICIAL

Production Manager
TITLE

9/4/2019
DATE