



Air Pollution Control Division

Small Business Assistance Program

An Overview of Colorado Air Regulations for: Coffee Roasting

The roasting of coffee beans is a common activity that occurs throughout Colorado at a wide variety of facilities ranging from small gourmet coffee shops to larger commercial operations. The associated coffee roasting equipment ranges from small 25 pound per hour batch roasters located at gourmet coffee shops to industrial, four ton per hour, re-circulating, continuous roasters at larger facilities. The air pollutant emissions resulting from coffee roasting operations include particulate matter (PM), volatile organic compounds (VOCs), organic acids, and natural gas combustion byproducts such as NO_x, CO, and CO₂. The odorous and visible emissions (smoke) resulting from the roasting process have the most obvious and direct impact on the public.

This fact sheet provides an overview of the coffee roasting process and the air quality requirements affecting coffee roasting operations in Colorado. The Air Pollution Control Division (APCD or the Division) at the Colorado Department of Public Health and Environment (CDPHE) administers and enforces these requirements. For more information on air quality requirements, contact the APCD at 303-692-3100 or visit the Division's website at www.colorado.gov/pacific/cdphe/apcd

➤ *Coffee Roasting Processes and Emissions*

The roasting of coffee beans typically consists of the following processes.

A. Roasting

After screening to remove dirt and other debris, green coffee beans are transferred to feed hoppers that charge beans to the roaster. The roaster may operate on a batch or continuous basis. Roasting temperature typically ranges from 700°F to 1000°F with roasting times ranging from 5 to 20 minutes depending on the desired coffee bean color and flavor. Roasters are typically horizontal rotating drums that tumble the green coffee beans in a current of hot combustion gases; the roasters can be indirect- or direct-fired. Indirect-fired roasters are roasters in which the burner flame does not contact the coffee, although combustion gases from the burner do contact the beans. Direct-fired roasters contact the beans with the burner flame and the combustion gases.

Gaseous and particulate matter (PM) emissions occur during the roasting process. The gaseous emissions result from the breakdown of the sugars and oils present in the green coffee beans. These gaseous emissions include aldehydes (e.g., formaldehyde, acetaldehyde), organic acids, phenols, and other hydrocarbons. In addition, nitrogen oxides and carbon monoxide emissions occur as a result of the combustion of natural gas, which is

typically used to fuel the roaster. Air emissions from the combustion of natural gas used to fuel the roaster are only taken into account if they exceed reporting requirements outlined in Colorado Regulation No. 3, Part A, Section II.D.1.k. Fuel burning equipment that uses gaseous fuel is exempt from reporting under this regulation if it has a design rate (input capacity) less than or equal to five million British thermal units (BTU) per hour.

Particulate emissions are composed primarily of coffee chaff (the outer skin of the coffee cherry) that is released when the coffee beans swell during roasting. Most of the chaff released during roasting is light enough to be carried off with the roaster exhaust. The emission factors for roasting operations are listed in Table 1. The Division generally assumes that all PM is equal to PM₁₀ in particulate emissions calculations. Emissions information from the manufacturer should be utilized if available.

B. Quenching

When the beans reach the desired color, they are immediately quenched with a water spray to halt the roasting process. Due to the elevated temperature of the roaster, the water applied is emitted as steam. The primary emission from the quenching process is steam. The steam contains primarily particulate matter and may contain trace amounts of the pollutants emitted during the roasting process. Air emissions from this process are considered to be minimal.

C. Cooling

The beans are then transferred to an enclosed cooler, where ambient air is blown over and/or through the beans as they are stirred or agitated to facilitate the cooling process. In the case of small batch-type roasters, this step is carried out in an open bin (referred to as a cooler car) equipped with a rotating stirring arm and blower to facilitate the cooling process. Some chaff is emitted during the cooling process, although the majority of chaff emissions occur at the roaster. Particulate emission factors for the cooling process are listed in Table 1.

D. Destoning

The cooled beans are then transferred to a destoner, which is essentially an air classifier that separates the beans from heavier material such as stones, metal fragments, and other waste materials that were not removed during the initial cleaning process. In the case of small batch-type roasting operations, operators typically rely on the initial cleaning process and do not mechanically destone the beans after roasting. The primary pollutant emitted during the cooling and destoning processes is particulate matter as coffee chaff. The majority of chaff is composed of large flaky particles exceeding 100 microns in diameter. Cyclone collectors used to control cooling or destoning emissions typically achieve a particulate matter collection efficiency ranging from 70% to 90% by weight. Particulate emission factors for a separate, independently operated cooler and/or destoner are listed in Table 1.

E. Green Bean Handling

Green Bean handling includes unloading, pneumatic conveying, cleaning/screening, blending, and loading operations. These processes result in the emission of large particulate matter (>100 microns) that are composed of coffee chaff, dirt, fibers, and other debris associated

with the green bean harvesting, packing, and shipping processes. Particulate emission factors for these processes are listed in Table 1.

F. Grinding

Roasted beans are typically pneumatically conveyed to hoppers that feed multi-stage grinders. Ground coffee and whole coffee beans are packaged into various sizes for consumer and commercial distribution. Because the particulate emissions resulting from grinding and packaging operations are not typically vented to the atmosphere, they are assumed to be negligible.

G. Decaffeination

Decaffeination is the process of extracting caffeine from green coffee beans prior to roasting. Several methods of decaffeination are used in Colorado including supercritical carbon dioxide (CO₂) extraction, water extraction, and solvent extraction using oil (extracted from roasted coffee), methylene chloride, or ethyl acetate as a solvent. Not all coffee roasting operations have decaffeination operations. Decaffeinated green coffee beans are purchased by many facilities that produce decaffeinated coffee. For facilities that have decaffeination operations, air emissions would vary depending upon the extraction process. There may be reportable emissions of VOC or hazardous air pollutants (HAPs) from a solvent extraction process. Guidance is available on calculating air emissions for VOCs and HAPs on the Division's website at www.colorado.gov/pacific/cdphe/apen-and-permitting-guidance.

H. Control Equipment

Typically particulate matter emissions from the roaster, cooler, destoner, and green bean handling equipment are controlled by high-efficiency cyclones. Because the majority of particulate matter emitted is larger than 100 microns in diameter, these cyclones are very effective in capturing the particulate matter emitted. Collection efficiencies range from 70% to 90% by weight.

Catalytic or thermal oxidizers that are downstream of cyclones typically control gaseous emissions from coffee roasters. Re-circulating roasters have reduced air emissions since they redirect a portion of the roaster exhaust back through the burners, resulting in the oxidation of some of the pollutants. The Division typically uses 95% control efficiency for oxidizers.

The following table (Table 1) lists the emission factors used by the Division for coffee roasting operations.

Table 1				
Emission Factors for Coffee Roasters				
Source	PM (lb/ton)	VOC (lb/ton)	NOx (lb/ton)	Formaldehyde (lb/ton)^d
Batch Roaster	4.2 ^c	0.86 ^b	0.1 ^c	0.054
Batch Roaster abated by Thermal Oxidizer	0.12 ^b	0.047 ^b	0.1 ^c	N/D ^a
Continuous Roaster	0.66 ^b	1.4 ^b	0.1 ^c	0.088
Continuous Roaster abated by Thermal Oxidizer	0.092 ^b	0.16 ^b	0.1 ^c	N/D ^a
Continuous cooler with cyclone	0.028 ^b	--	--	--
Independent Cooler/Destoner	1.4 ^e	--	--	--
Screening, handling, and storage system with fabric filter	0.059 ^b	--	--	--

^a Factor will vary depending upon destruction efficiency of abatement device. Assume destruction efficiency of 90% by weight unless otherwise specified by the manufacturer. N/D means no data is available.

^b Factor taken from EPA AP-42, Chapter 9.13, 9/95. Emission factors are based on green coffee bean feed e.g. tons per year of coffee bean feed x emission factor divided by 2000 pounds per ton = tons of pollutant emitted per year controlled or uncontrolled (depends upon the emission factor).

^c Factor taken from EPA AP-42, Chapter 6.2-1, 2/72. Other byproducts of combustion from the roasting process are not listed as emissions from these pollutants are negligible e.g., Sulfur dioxide, Carbon monoxide.

^d Factor taken from the Toxic Air Contaminant Emission Inventory, San Francisco Bay, April 1990. Emissions of the toxic compounds acrolein, acetaldehyde, and organic acids may be present in coffee roaster exhaust streams; however, the amounts of these emissions have not been substantiated enough to include in this guidance.

^e Factor taken from the Bay Area Air Quality Management District Permit Handbook, Coffee Roasting Operations, San Francisco Bay, May 15, 1998.

➤ **Air Pollutant Emission Notices (APENs)**

An APEN is a form used to report a facility's emissions. Coffee Roasting operations are required to submit an APEN to the Air Pollution Control Division if air emissions exceed the Reporting thresholds presented in Table 1. The form titled, "General Air Pollutant Emission Notice" is available from the Division and downloadable at: www.colorado.gov/pacific/cdphe/general-apen. Use the APEN form to report information about your facility, the process, fuel information, and air emissions. APENs are valid for five years.

**Table 1
APEN Reporting Thresholds**

	Attainment (Ton per year)	Nonattainment (Ton per year)
Criteria Pollutants (NOx, Ozone)	2	1
Other Criteria Pollutants (CO, SOx, PM, PM-10, etc.)	2	1
Non-Criteria Pollutant (HAPs & other reportable pollutants)	≥ 250 pounds per year of any individual non-criteria reportable pollutant	

The form titled, "Air Pollution Control Division Construction Permit Application" must be submitted with the General APEN form. This form provides general information about the coffee roasting company, potential start up date, and transfer of ownership information, if applicable. Only one application form is necessary for each facility.

To expedite the application process, it is recommended that you submit a narrative description of the facility operations, a map of the facility indicating sources, conveyor systems, control devices, and emission stacks within the facility property lines.

➤ **Air Permits**

The APCD will use the information provided on your APEN to determine if you need an air permit and/or to prepare or update your air permit. Air permits will be issued for the level of production requested on the APEN form. Please consider this when completing your application and allow room for future growth. Air permit reporting thresholds are listed in Table 3. If you meet or exceed these thresholds, you will be required to obtain an air permit for that source(s) of air emissions.

If your coffee roasting operations require an air permit, the APCD will use the information provided in your APEN to determine the specific terms and conditions for your permit.

**Table 3
AIR PERMIT Reporting Thresholds**

Pollutant	Uncontrolled Actual Emissions (tons per year)	
	Attainment Area	Non-attainment Area
VOC	5	2
PM 10, PM 2.5	5	1
TSP, CO, SO _x , NO _x	10	5
Non-Criteria Pollutant (HAP)	10 per each pollutant	

In Colorado, Construction Permits are issued in two phases: “Issuance 1” and “Final Approval to Operate”.

- Issuance 1 of a permit allows the plant to be constructed and begin operation. The source must self-certify to Issuance 1 of the permit once in operation within 180 days of receiving the first issued permit.
- After the owner certifies that the operation is in compliance with the conditions of Issuance 1 of the permit, the Division issues a “Final Approval to Operate” letter to operate under the conditions of Construction Permit Issuance 1. This letter confirms the completion of the self-certification requirements of that permit. The source is issued an invoice for processing time for this letter, and must pay the invoice within 30 days of receipt. Please note that if the permit processing fee is not paid within 30 days of receipt, you will be in violation of your permit conditions and may result in revocation of the permit.
- If the source modifies an existing permit, the source will be issued Construction Permit Issuance 2 (Issuance number determined by modification sequence). The source may have to self-certify to the new Issuance if required by the permit.

A permit describes key areas that an operator needs to address. The permit defines the type of air pollution control measures to be used, limits the annual production at the site, provides guidelines for opacity (how dense the visible emissions are allowed to be), and includes recordkeeping requirements.

Coffee roasting operations may require a 30-day public comment period (where a public notice is published in a local newspaper and written comments from the public are requested) prior to issuance of the Initial Approval air permit due to the potential for violation of Colorado Regulation No. 2 (odor emissions) if controls are not properly operated. This determination is made during the preliminary analysis of all application materials.

More information on air emissions reporting and air permitting requirements can be found in the guidance document, “Reporting Your Air Emissions and Applying for Air Permits Step-by-Step for Colorado Small Businesses.” This document is available on the Division’s website at www.colorado.gov/pacific/cdphe/apen-and-permitting-guidance.

Specific air permit conditions are listed in your air permit. These conditions may include an emission limit for coffee bean production (pounds or tons per year) and annual air emission limits for specific pollutants. You should routinely compare your actual production rate and/or air pollutant emission calculations to your air permit limit(s) and maintain records as required to show compliance with these conditions. If you need to increase an air permit limit, you can do so by submitting a new APEN to the Division.

Other requirements may be listed in your air permit. You should be able to show compliance with these conditions upon request by the Division. The following are other typical permit requirements for coffee roasting operations:

- Visible emissions or opacity (smoke) from coffee roasting operations must not exceed 20% during normal operation of the source. This means that during roasting operations, a certified opacity observer can see at least 80% of the background (sky) through the stack emissions (according to EPA Method 9). There may be other opacity provisions for start up or maintenance of roasting equipment.
- Coffee roasters are subject to the odor requirements of Regulation No. 2. Detectable odors, which can be a problem during roasting operations, are not allowed to emanate from a property and cause a potential nuisance to neighbors.
- Each roaster must be equipped with a cyclone capable of reducing uncontrolled emissions of particulate matter by at least 70%.
- Each roaster must be equipped with an afterburner capable of reducing uncontrolled emissions of VOC by at least 95%.
- Cyclones and afterburners must be operated and maintained according to the manufacturer's recommendations.
- The permit number must be marked on the subject equipment for ease of identification.

➤ *Applicable Fees*

Filing Fee: A filing fee is required for each APEN submitted. This includes APENs submitted for administrative changes (e.g., change in ownership, change in location). Fees are subject to change by the legislature on an annual basis.

Annual Fee: All sources required to file APENs must pay annual fees. The Division bills each source subject to an APEN filing fee per ton of criteria pollutants emitted and per ton of non-criteria (hazardous air pollutants) emitted. The Division mails invoices for these fees in May or June of each year (these fees account for the emissions from the previous year's operation). Fees are subject to change by the legislature on an annual basis.

Permit Processing Fee: In addition to the APEN filing fee, permit-processing fees will be assessed at an hourly rate. If the total processing time is anticipated to be more than 30

hours the Division will contact the applicant in writing and provide an estimate of the projected processing time. The applicant can waive this notice by submitting a letter making this request when the application is submitted.

Current fee information is available online at:

<https://www.colorado.gov/pacific/cdphe/emissions-and-permitting-fees>

➤ *Air Inspections and Enforcement*

The APCD enforcement staff conducts routine inspections of coffee roasting operations to ensure that reported emission controls are in place and operational, and that the facility is in compliance with their air permit. The APCD also reviews annual VOC emission reports to ensure compliance with the air permit requirements. When a permit violation or noncompliance issue leads to enforcement proceedings, corrective action is required and fines up to \$15,000 per day can be assessed.

➤ *Additional Resources and Information*

Specialty Coffee Association

www.scaa.org

Small Business Development Center (SBDC)

Assistance in Starting a Small Business

Small Business Hotline

(303) 592-5920

www.coloradosbdc.org

Occupational Health & Safety Association (OSHA) Consultation Program

(970) 491-6151

www.bernardino.colostate.edu/public

➤ *Help is Available*

The Small Business Assistance Program (SBAP) is available to answer questions you may have regarding environmental issues at your facility. The SBAP can help you understand regulations, fill out required forms, calculate your emissions, or provide information by presenting a workshop for your company or for your industry. We are here to help, and our services are always free.

- ❖ **Air Pollution Control Division (APCD): (303) 692-3100**
- ❖ **Small Business Assistance Program: (303) 692-3175 or 3148**
- ❖ **Small Business Ombudsman: (303) 692-2135**