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CONTROLLED AND UNCONTROLLED EMISSION RATES AND APPLICABLE LIMITATIONS FOR EIGHTY PROCESSES

by

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Task Order No. 12

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Division of Stationary Source Enforcement

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Division of Stationary Source Enforcement
Research Triangle Park, North Carolina 27711

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After forming, those cores that achieve a primary or complete set while in the core machine require no special handling, while those requiring an oven bake or gasing are placed on a flat core plate or formed core dryer providing rigid support.

Oil sand cores requiring baking are transferred to gas or oil-fired ovens. Light oil fractions and moisture in the sand are evaporated, followed by oxidation and polymerization of the core oil. Baking makes the cores strong enough so that they can be handled while the mold is being made and will resist erosion and deformation by metal when the mold is being filled.

There are several types of core ovens in use depending on the size, shape, and type of core that is needed. The five types of core ovens that find the most widespread use are:

1. shelf ovens,
2. drawer ovens,
3. portable-rack ovens,
4. car ovens, and
5. conveyor ovens.

Most ovens are operated at temperatures between 300° and 400°F (149° and 204°C) for baking periods ranging from less than an hour to overnight. The weight of cores baked at any one time may range from less than one hundred pounds to more than a ton.

D. Emission Rates:

The air contaminants discharged from core ovens consist of organic acids, aldehydes, hydrocarbon vapors, and particulate matter. The vapors are the result of the evaporation of hydrocarbon solvents and the light ends usually present in core oils. The organic acids and aldehydes are the result of partial oxidation of the various organic material in the cores.

In general, emission rates are low, especially from small- and medium-sized ovens operating at 400°F (204°C) or less. Large amounts of emissions can generally be expected from ovens operated at higher temperatures and from which the cores baked contain larger than normal amounts of core oils. Table VII-5 summarizes the particulate and hydrocarbon emissions from core ovens.[4] (2)314Core Ovens,Iron Fndry

TABLE VII-5

PARTICULATE AND HYDROCARBON EMISSIONS FROM CORE OVENS IN CAST IRON FOUNDRIES

Type of Operation & Control	% Control	Particulate Emissions+				Hydrocarbon Emissions+			
		lb/ton*	kg/MT	lb/hr	kg/hr	lb/ton*	kg/MT	lb/hr	kg/hr
Core Ovens, Uncontrolled	0	3.48	1.74	0.20	0.10	16.9	8.45	1.0	0.5
Core Ovens, With Afterburner	90	.35	.17	.02	.01	1.69	0.85	0.05	0.02

* Ton of Cores Baked
+ Based on Actual Emission Data

E. Control Equipment:

Most core ovens are vented directly to the atmosphere through a stack, as they usually do not require air pollution control equipment. Excessive emissions from core ovens have been reduced by modifying the composition of the core binders, and lowering the baking temperatures. When neither of these approaches is feasible, afterburners are the only control devices that have proved effective. Afterburners that have been used for controlling emissions from core ovens are predominantly of the direct flame type. Both controlled and uncontrolled particulate and hydrocarbon emissions from core ovens are shown in Table VII-5.

F. New Source Performance Standards and Regulation Limitations:

New Source Performance Standards (NSPS): No New Source Performance Standards have been promulgated for core making in cast iron foundries.

State Regulations for Existing Sources: Particulate emission regulations for varying process weight rates are expressed differently from state to state. There are four types of regulations that are applicable to core making processes. The four types of regulations are based on:

1. concentration,
2. control efficiency,
3. gas volume, and
4. process weight.

Concentration Basis: Alaska, Delaware, Pennsylvania, Washington and New Jersey are representative of states that express particulate emission limitations in terms of grains/standard cubic foot and grains/dry standard cubic foot for general processes. The limitations for these five states are:

Alaska	-	0.05 grains/standard cubic foot
Delaware	-	0.20 grains/standard cubic foot
Pennsylvania	-	0.04 grains/dry standard cubic foot, when gas volume is less than 150,000 dscfm
Pennsylvania	-	0.02 grains/dry standard cubic foot, when gas volumes exceed 300,000 dscfm
Washington	-	0.20 grains/dry standard cubic foot
Washington	-	0.10 grains/dry standard cubic foot (new)
New Jersey	-	0.02 grains/standard cubic foot

Control Efficiency Basis: Utah requires general process industries to maintain 85% control efficiency over the uncontrolled emissions.

Gas Volume Basis: Texas expresses particulate emission limitations in terms of pounds/hour for specific stack flow rates expressed in actual cubic feet per minute. The Texas limitations for particulates are as follows:

1	-	10,000 acfm	-	9.11 lbs/hr
10,000	-	100,000 acfm	-	38.00 lbs/hr
10^5	-	10^6 acfm	-	158.6 lbs/hr

Process Weight Rate Basis for New Sources: Several states have adopted process limitations in terms of pounds per hour as a function of a specific process weight rate. For the core oven process described in Section D, an average process weight of 115 lbs/hour was used. For a process weight rate of this size, Massachusetts is representative of a most restrictive limitation, 0.3 lbs/hr (0.14 kg/hr) and New Hampshire is representative of a least restrictive limitation, 1.2 lbs/hr (.60 kg/hr).

Process Weight Rate Basis for Existing Sources: The majority of states express general process limitations for particulate emissions in lbs/hr for a wide range of process weight rates. For a process weight rate of 115 lbs/hr, New York is representative of a most restrictive limitation, 0.54 lbs/hr (0.24 kg/hr) and Georgia is representative of a least restrictive limitation, 0.6 lbs/hr (0.27 kg/hr).

State Regulations for New and Existing Sources for Hydrocarbons: Currently, hydrocarbon emission regulations are patterned after Los Angeles Rule 66 and Appendix B type legislation. Organic solvent useage is categorized by three basic types. These are, (1) heating of articles by direct flame or baking with any organic solvent, (2) discharge into the atmosphere of photochemically reactive solvents by devices that employ or apply the solvent, (also includes air or heated drying of articles for the first twelve hours after removal from #1 type device) and (3) discharge into the atmosphere of non-photochemically reactive solvents. For the purposes of Rule 66, reactive solvents are defined as solvents of more than 20% by volume of the following:

1. A combination of hydrocarbons, alcohols, aldehydes, esters, ethers or ketones having an olefinic or cyclo-olefinic type of unsaturation: 5 per cent
2. A combination of aromatic compounds with eight or more carbon atoms to the molecule except ethylbenzene: 8 per cent
3. A combination of ethylbenzene, ketones having branched hydrocarbon structures, trichloroethylene or tolune: 20 per cent

Rule 66 limits emissions of hydrocarbons according to the three process types. These limitations are as follows:

	Process	lbs/day &	lbs/hour
1.	heated process	15	3
2.	unheated photochemically reactive	40	8
3.	non-photochemically reactive	3000	450

Appendix B (Federal Register, Vol. 36, No. 158 - Saturday, August 14, 1971) limits the emission of photochemically reactive hydrocarbons to 15 lbs/day and 3 lbs/hr. Reactive solvents can be exempted from the regulation if the solvent is less than 20% of the total volume of a water based solvent. Solvents which have shown to be virtually unreactive are, saturated halogenated hydrocarbons, perchloroethylene, benzene, acetone and c_1-c_5n-paraffins.

For both Appendix B and Rule 66 type legislation, if 85% control has been demonstrated the regulation has been met by the source even if the lbs/day and lbs/hour values have been exceeded. Most states have regulations that limit the emissions from handling and use of organic solvents. Alabama, Connecticut and Ohio have regulations patterned after Los Angeles Rule 66. Indiana and Louisiana have regulations patterned after Appendix B. Some states such as North Carolina have an organic solvent regulation which is patterned after both types of regulations.

Table VII-6 presents controlled and uncontrolled particulate and hydrocarbon emissions and limitations from core ovens.

TABLE VII-6

PARTICULATE AND HYDROCARBON EMISSIONS AND LIMITATIONS FROM CORE OVENS

Type of Operation & Control	% Control	Particulate Emissions (Based on 503 tons/yr)		Hydrocarbon Emissions (Based on 503 tons/yr)		Limitations lb/hr / kg/hr				
						General Processes				
						Particulate			Hydrocarbon	
		lbs/hr	kg/hr	lbs/hr	kg/hr	MA	Georgia	UT 85% Control	Heated	
Core Ovens, Uncontrolled	0	.20	.10	1.0	0.5	0.3/1.4	0.6/0.27	.03/.01	3	1.4
Core Ovens, with Afterburner	90	.02	.01	.05	0.02	0.3/1.4	0.6/0.27	.03/.01	3	1.4

Potential Source Compliance and Emission Limitations: Most core ovens are vented directly to the atmosphere through a stack and do not require air pollution control equipment. From Table VII-6, it can be seen that even the most restrictive limitations can be met without control equipment.

The Environment Reporter was used to update emission regulations.

G. References:

The following literature was used to develop the information on core ovens:

(1) Systems Analysis of Emissions and Emissions Control in the Iron Foundry Industry, Volume I, Text, A. T. Kearney & Company, Inc., EPA, Contract No. CPA 22-69-106, February 1971.

(2) Systems Analysis of Emissions and Emission Control in the Iron Foundry Industry, Volume II, Exhibits, A. T. Kearney & Company, Inc., EPA, Contract No. CPA 22-69-106, February 1971.

(3) Danielson, J. A., Air Pollution Engineering Manual, Second Edition, AP-40, Research Triangle Park, North Carolina, EPA, May 1973.

(4) Hopper, T. G., Impact of New Source Performance Standards on 1985 National Emissions from Stationary Sources, Volume II, (Final Report), TRC - The Research Corporation of New England, EPA, Contract No. 68-02-1382, Task #3, October 1975.

(5) Analysis of Final State Implementation Plans, Rules, and Regulations, EPA, Contract No. 68-02-0248, July 1972, Mitre Corporation.

(6) Priorization of Air Pollution from Industrial Surface Coating Operations, Monsanto Research Corporation, Contract No. 68-02-0320, February 1975.

Two other references were consulted but not directly used to develop this section on core ovens.

(7) Particulate Pollutant System Study, Volume III - Handbook of Emission Properties, Midwest Research Institute, EPA, Contract No. CPA 22-69-104, May 1, 1971.

(8) Background Information for Establishment of National Standards of Performance for New Sources, Gray Iron Foundries, (Draft), Environmental Engineering, Inc. and PEDCO Environmental Specialists, Inc., EPA, Contract No. CPA 70-142, Task Order No. 2, March 15, 1971.

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U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT
OFFICE OF GENERAL ENFORCEMENT
WASHINGTON, D.C. 20460

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Research Triangle Park, North Carolina 27711

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A. Source Category: VI Food and Agricultural Industry

B. Sub Category: Beer Processing

C. Source Description:

The manufacture of beer from grain is a multiple-step process. From the time the grain is harvested until the beer manufacturing process is complete the following events take place at the brewery:

1. melting of barley (softening of barley by soaking in water followed by kiln drying),
2. addition of corn, grit, rice,
3. conversion of starch to maltose by enzymatic processes,
4. separation of wort (liquid to be fermented) from grain,
5. hopping (addition of cones of the hop plant) and boiling of wort,
6. cooling of wort,
7. addition of yeast,
8. fermentation,
9. removal of settled yeast,
10. filtration,
11. carbonation,
12. aging, and
13. packaging. (2)6.5-1

This process is graphically detailed below:

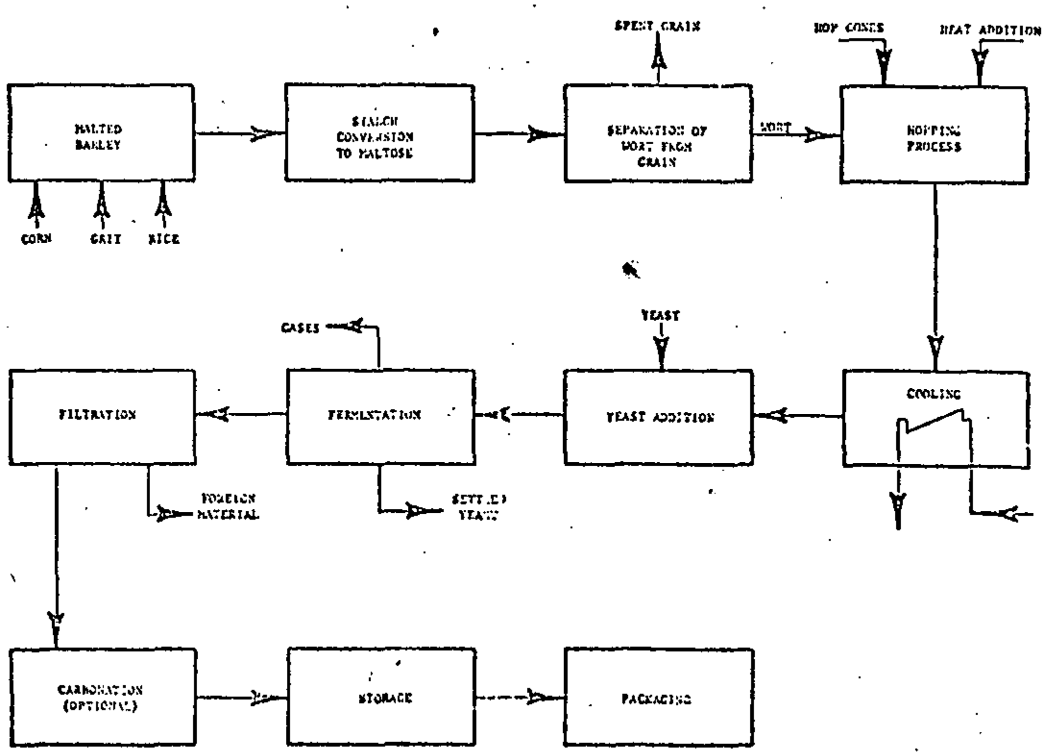

Figure VI-1: Beer Processing

Most of the beer manufacturing process takes place with the raw or processed materials in liquid form.

D. Emission Rate:

The manufacture of beer causes carbon dioxide, hydrogen, oxygen, and water vapor to be discharged into the atmosphere. The hydrocarbon emission rate may be approximated by assuming that 1 percent by weight of spent grain is emitted as hydrocarbon. Assuming the grain loses 20 percent of its weight during the manufacturing process, for every pound of spent grain, 1.25 pounds of raw grain are required. Therefore, each 1.25 pounds of input discharges 0.01 pounds of hydrocarbons. Based on the above, hydrocarbon emissions from beer processing are detailed below:

TABLE VI-1

HYDROCARBON EMISSIONS FROM BEER PROCESSING

Type of Operation and Control	% Control	Hydrocarbon Emissions[3]			
		lb/ton	kg/ton	(16.1 tons/hour) lb/hr	kg/hr
Beer Processing, Uncontrolled	0	2.63	1.32	42.3	19.2
Beer Processing, Incineration	99	0.0263	0.0132	.42	.19

E. Control Equipment:

The major hydrocarbon emission is ethyl alcohol and is controlled by incineration or absorption.

There is a limited quantity of ethyl alcohol from a typical processing plant. Incineration is accomplished by introducing ethyl alcohol fumes into a boiler air supply or by passing the fumes through an afterburner.[(2)171-183]

F. New Source Performance Standards and Regulation Limitations:

New Source Performance Standards (NSPS): No new source performance standards have been promulgated for the beer processing industry.

State Regulations for New and Existing Sources: Currently, hydrocarbon emission regulations are patterned after Los Angeles Rule 66 and Appendix B type legislation. Organic solvent useage is categorized by three basic types. These are, (1) heating of articles by direct flame or baking with any organic solvent, (2) discharge into the atmosphere of photochemically reactive solvents by devices that employ or apply the solvent, (also includes air or heated drying of articles for the first twelve hours after removal from #1 type device) and (3) discharge into the atmosphere of non-photochemically reactive solvents. For the purposes of Rule 66, reactive solvents are defined as solvents of more than 20% by volume of the following:

1. A combination of hydrocarbons, alcohols, aldehydes, esters, ethers or ketones having an olefinic or cyclo-olefinic type of unsaturation: 5 per cent
2. A combination of aromatic compounds with eight or more carbon atoms to the molecule except ethylbenzene: 8 per cent
3. A combination of ethylbenzene, ketones having branched hydrocarbon structures, trichloroethylene or tolune: 20 per cent

Rule 66 limits emissions of hydrocarbons according to the three process types. These limitations are as follows:

	Process	lbs/day &	lbs/hour
1.	heated process	15	3
2.	unheated photochemically reactive	40	8
3.	non-photochemically reactive	3000	450

Appendix B (Federal Register, Vol. 36, No. 158 - Saturday, August 14, 1971) limits the emission of photochemically reactive hydrocarbons to 15 lbs/day and 3 lbs/hr. Reactive solvents can be exempted from the regulation if the solvent is less than 20% of the total volume of a water based solvent. Solvents which have shown to be virtually unreactive are, saturated halogenated hydrocarbons, perchloroethylene, benzene, acetone and c_1-c_5n-paraffins.

For both Appendix B and Rule 66 type legislation, if 85% control has been demonstrated the regulation has been met by the source even if the lbs/day and lbs/hour values have been exceeded. Most states have regulations that limit the emissions from handling and use of organic solvents. Alabama, Connecticut and Ohio have regulations patterned after Los Angeles Rule 66. Indiana and Louisiana have regulations patterned after Appendix B. Some states such as North Carolina have an organic solvent regulation which is patterned after both types of regulations.

Table VI-2 presents uncontrolled and controlled emissions and limitations for beer processing.

TABLE VI-2

HYDROCARBON EMISSIONS FROM BEER PROCESSING

Type of Operation and Control	% Control	Hydrocarbon Emissions (based on 16.1 tons/hour)		Hydrocarbon Limitations	
				lbs/hr	kg/hr
		lbs/hr	kg/hr	Heated	Unheated
Beer Processing, Uncontrolled	0	42.3	19.2	3/1.4	8/3.6
Beer Processing, Incineration	97	.42	.19	3/1.4	8/3.6

Potential Source Compliance and Emission Limitations: Hydrocarbon emission limitations are not based on process weight, but large processes such as beer processing can be controlled with incineration to meet emission limitations as described in Section D. For beer processing manufacture to meet the 3 lb/hour limitation, 81% control efficiency must be maintained. Existing control technology is adequate for beer processing manufacture to be in compliance with state regulations.

The Environment Reporter was used to update emission limitations.

G. References:

Literature used to develop the preceding discussion on beer processing include the following:

1. Danielson, J. A., Air Pollution Engineering Manual, Second Edition, AP-40, Research Triangle Park, North Carolina, EPA, May 1973.

2. Compilation of Air Pollutant Emission Factors (Second Edition), EPA, Publication No. AP-42, April 1973.

3. Impact of New Source Performance Standards on 1985 National Emissions from Stationary Sources, Volume II, Beer Processing, pp. 4, 6, 7.

4. Analysis of Final State Implementation Plans - Rules and Regulations, EPA, Contract 68-02-0248, July 1972, Mitre Corporation.

Assuming the grain loses 20 percent of its weight during the manufacturing process, for every pound of spent grain, 1.25 pounds of raw grain are required. Therefore, each 1.25 pounds of input discharges 0.01 pounds of hydrocarbons. Based on the above, hydrocarbon emissions from beer processing are detailed below:

1.25(.01) = .01

TABLE OF VOC EMISSIONS FROM BEER PROCESSING

Type of Operation and Control	% Control	Hydrocarbon Emissions lb/ton	kg/ton	(16.1 tons/hour) lb/hr	kg/hr
Beer processing, uncontrolled	0	2.63	1.32	42.3	19.2
Beer processing, incineration	99	0.0263	0.0132	0.42	0.19

(Reference 1)

Control[1]

The major VOC species emitted during processing is ethyl alcohol which can be effectively controlled by incineration or absorption.

There is a limited quantity of ethyl alcohol from a typical processing plant. Incineration is accomplished by introducing ethyl alcohol fumes into a boiler air supply or by passing the fumes through a direct-flame after-burner. Absorption is accomplished by dissolving ethyl alcohol vapors in a selective liquid solvent. Consult AP-40 for further information on either control method (Ref. 3).

Profile Basis

The basis for Profile 3-02-009 was a survey of pertinent literature (Refs. 1, 2 and 4).

Data Qualification

The following profile may be applied to typical beer processing operations wherever grain fermentation occurs.