AP42 Section:	9.12.1
Title:	Comments and letters

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New

INTEROFFICE MEMORANDUM

MIDWEST RESEARCH INSTITUTE

March 19, 1997

To: AP-42 Section 9.12.1, Malt Beverages, Project File

From: Brian Shrager BLS

Subject: National Emission Estimate

I. Introduction

The recently published AP-42 Section 9.12.1, Malt Beverages, includes emission factors for filterable particulate matter (PM), PM-10, PM-2.5, carbon monoxide (CO), carbon dioxide (CO_2), volatile organic compounds (VOC) (as ethanol), VOC (as propane), and hydrogen sulfide. Sufficient data are not currently available to estimate national emissions of CO or hydrogen sulfide from breweries. However, breweries are not expected to be significant sources of CO or hydrogen sulfide. Sufficient process information is not currently available to complete a national emission estimate for filterable PM, PM-10, and PM-2.5. If the required information is obtained, national estimates of filterable PM, PM-10, and PM-2.5 will be completed at a later date. This memorandum presents national emission estimate for VOC and CO_2 emissions from breweries. The emission estimates were calculated by State, and a summation of the State estimates was used to develop the national estimates. To illustrate the emission contribution from different types of breweries, separate estimates are provided for four classes of breweries; large breweries, regional breweries, microbreweries, and brewpubs. The *Brewers Resource Directory*, compiled by the Institute for Brewing Studies, provides the following definitions for these four classes of breweries:

Large Brewery: A brewery with sales of more than 500,000 barrels per year (bbl/yr)
Regional Brewery: A brewery with a capacity to brew between 15,000 and 500,000 bbl/yr
Microbrewery: A brewery that produces less than 15,000 bbl/yr
Brewpub: A restaurant-brewery that sells the majority of its' beer on site

II. Annual Production Data[1-4]

The data for total beer production are based on information contained in an article from the *USA Today* that states that about 181 million barrels (1 barrel is equal to 31 U. S. gallons) of domestically-brewed beer were sold (assumed to represent total volume packaged) in 1993. This figure includes 179.1 million barrels produced by large-scale (assumed to include large and regional breweries) brewing operations and 1.7 million barrels from small-scale operations (assumed to include microbreweries and brewpubs). Small scale operations have grown at a rapid pace since 1993. In 1993, 471 small-scale breweries were reported in the United States. The *North American Brewery List* reports 1,014 small-scale breweries operating in 1996. Also, during this time, microbreweries have begun bottling more beer, primarily for regional distribution. Therefore, for purposes of this estimate, the production from large-scale operations is estimated as 176 million barrels packaged per year, and the production from small scale operations is estimated at about 5 million barrels packaged per year. These estimates are based on the assumption that the total volume of beer produced has remained relatively constant since 1993. The average production for each type of brewery was estimated using the following assumptions.

1. Total large and regional brewery production is estimated as 176 million bbl/yr

2. The Coors brewery in Golden, Colorado, production is estimated as 18 million bbl/yr

3. Anheuser-Busch controls about 40 percent of domestic beer production, or 72 million bbl/yr. The *North American Brewery List*, obtained from the Institute for Brewing Studies, lists 13 large breweries operated by Anheuser-Busch. Based on Anheuser-Busch's total production divided by the number of large breweries, the average production of each brewery is estimated as 5.54 million bbl/yr.

4. The Institute for Brewing Studies web page states that regional breweries brew between 15,000 and 500,000 bbl/yr. For this study, an average regional brewery was assumed to produce 250,000 barrels per year. The *North American Brewery List* lists 46 domestic regional breweries. Using these data, the total production from regional breweries is estimated as 11.5 million bbl/yr.

5. Using the above estimates for production totals from large and regional brewery (176 million bbl/yr), Coors (Golden, CO) brewery (18 million bbl/yr), the Anheuser-Busch breweries (72 million bbl/yr), and regional breweries (11.5 million bbl/yr), an average production for "other large breweries" (not including Coors [Golden, CO] and Anheuser-Busch) was calculated. The *North American Brewery List* lists 27 other large breweries. The total production estimate for other large breweries is estimated as (176 - 18 - 72 - 11.5) million bbl/yr, or 74.5 million bbl/yr. Using these data, the production from an average "other large brewery" is estimated as 2.76 million bbl/yr.

6. The Institute for Brewing Studies web page states that microbreweries brew less than 15,000 bbl/yr. For this study, an average microbrewery was assumed to produce 8,000 bbl/yr. The *North American Brewery List* lists 376 domestic microbreweries. Using these data, the total production from microbreweries is estimated at just over 3 million bbl/yr.

7. The Institute for Brewing Studies web page states that brewpubs sell the majority of beer on-site. For this study, an average brewpub was assumed to produce 3,000 bbl/yr, less than half of the production of an average microbrewery. This level of production is a conservative (high) estimate. Data that document the average size of a brewpub are not available. The *North American Brewery List* lists 638 domestic brewpubs. Using these data, the total production from brewpubs is estimated at just over 1.9 million bbl/yr.

III. VOC Emission Factors[5]

Estimates of VOC emissions from pre-fermentation processes are presented as VOC (as propane), and estimates of emissions from fermentation and post-fermentation processes are presented as VOC (as ethanol). The two estimates are summed to estimate total VOC emissions from breweries. Table 1 shows the data used to calculate the VOC emission estimates, and includes estimates, by State, for each type of brewery. Table 2 shows a summary of the VOC emission factors used to develop the estimate. Total brewery emission factors for VOC emissions from the four types of breweries were developed using the emission factors shown in AP-42 Section 9.12.1, Table 9.12.1-2. The units for all of the emission factors are pounds per 1000 barrels (lb/1000 bbl) of beer packaged. The following paragraphs present the assumptions and rationale used to develop each brewery emission factor.

A. VOC (as ethanol) emission factors

Large and Regional Breweries. For typical large and regional breweries, factors for the following processes were summed to determine a total brewery VOC (as ethanol) emission factor: activated carbon regeneration, aging tank--filling, bottle filling line, can filling line, fermenter venting--closed fermenter, and keg filling line. These process, and the assumptions used to estimate emissions, are described in the following paragraph.

Activated carbon regeneration systems are associated with closed fermenters. These systems remove ethanol and other organic impurities from the activated carbon that is used to purify the CO_2 collected from fermentation. In the "aging tank--filling" process, ethanol is released to the atmosphere as it is displaced (by liquid) from the aging tank. A filling line is mechanized system of filling bottles, cans, or kegs with beer. "Closed fermenter--venting" is the release to the atmosphere of fermenter exhaust prior to collection of CO_2. The length of the venting period varies by facility. All facilities with "closed fermenters" release, or vent, the fermenter exhaust until the exhaust is pure enough (CO_2) to collect, purify, and use elsewhere in the process. Although most regional breweries use "open" fermenters and do not have activated carbon regeneration systems, the sum of VOC emissions from "activated carbon regeneration" and "fermenter venting--closed fermenter" should provide a good estimate of VOC emissions from open fermentation. To avoid double counting emissions from filling operations, an assumption was made that 45 percent of beer packaged by large and regional breweries is canned, 45 percent is bottled, and 10 percent is kegged. The VOC (as ethanol) emission factors (shown in AP-42 Table 9.12.1-2) for the bottle crusher, bottle soaker, and can crusher were not included in the total factor because the emission factor units are different for these factors, and production data (in the appropriate units) are not available. However, these processes are expected to be minor contributors to total emissions. Separate emission factors were developed for breweries that use conventional filling lines and sterilized filling lines. The factor for sterilized filling lines is only used to estimate emissions from the three Coors breweries. Although other breweries use sterilized filling lines, the extent of the use is not known. The emission factor calculations for VOC (as ethanol) from large and regional breweries are as follows:

EF = act. carb. regen. + aging + 0.45 x (bottle line + can line) + 0.10 x keg line + ferm. vent.

Large and regional breweries with conventional filling lines

$$EF = 0.035 + 0.57 + (0.45 \times (17 + 14) + 0.10 \times 0.69) + 2.0 = 16.6 \text{ lb/1000 bbl}$$

Large breweries with sterilized filling lines

$$EF = 0.035 + 0.57 + (0.45 \times (40 + 35) + 0.10 \times 0.69) + 2.0 = 36.4 \text{ lb/1000 bbl}$$

Microbreweries. For microbreweries, factors for the following processes were summed to determine a total brewery VOC (as ethanol) emission factor: activated carbon regeneration, aging tank--filling, bottle filling line, fermenter venting--closed fermenter, and keg filling line. Although microbreweries use "open" fermenters and do not have activated carbon regeneration systems, the sum of VOC emissions from "activated carbon regeneration" and "fermenter venting--closed fermenter" was assumed to be equal to VOC emissions from open fermentation. To avoid double counting emissions from filling operations, an assumption was made that 50 percent of beer packaged by microbreweries is bottled, and 50 percent is kegged. To our knowledge, microbreweries do not package beer in cans. The filling estimates are likely to overestimate the amount of beer that is bottled by microbreweries, but data are not available on the amount of beer bottled by microbreweries. The VOC (as ethanol) emission factors (shown in AP-42 Table 9.12.1-2) for the bottle soaker were not included in the total factor because the emission factor units are different for this factor, and the required data are not available. However, this process is expected to be a minor contributor to total emissions. The emission factor calculation for VOC (as ethanol) from microbreweries is shown below.

EF = act. carb. regen. + aging + 0.5 x (bottle line + keg line) + ferm. vent.

or

$$EF = 0.035 + 0.57 + (0.5 \times 17 + 0.5 \times 0.69) + 2.0 = 11.5 \text{ lb/1000 bbl}$$

Brewpubs. For brewpubs, factors for the following processes were summed to determine a total brewery VOC (as ethanol) emission factor: activated carbon regeneration, aging tank--filling, fermenter venting--closed fermenter, and keg filling line. Although microbreweries use "open" fermenters and do not have activated carbon regeneration systems, the sum of VOC emissions from "activated carbon regeneration" and "fermenter venting--closed fermenter" was assumed to be equal to VOC emissions from open fermentation. An assumption was made that filling operations at brewpubs are 100 percent keg filling. Some brewpubs do bottle beer, but most brewpubs have very limited distribution. If more than 50 percent of a brewpub's beer is shipped off-site, the brewpub is reclassified as a microbrewery. Therefore, any emission factors associated with bottling or canning were not included in the emission factor calculation. The emission factor calculation for VOC (as ethanol) from microbreweries is shown below.

EF = act. carb. regen. + aging + keg line + ferm. vent.

or

$$EF = 0.035 + 0.57 + 0.69 + 2.0 = 3.3 \text{ lb/1000 bbl}$$

B. VOC (as propane) emission factors

Large Breweries. For typical large breweries, factors for the following processes were summed to determine a total brewery VOC (as propane) emission factor: brew kettle, brewers grain dryer, cereal cooker, hot wort settling tank, lauter tun, mash tun, open wort cooler, and trub vessel--filling. The brewers grain dryer emission factors shown in AP-42 have units of lb/ton of dried grain produced. Data provided by Coors (AP-42 Section 9.12.1, Reference 3) show a VOC (as propane) emission factor of 2.64 lb/1000 bbl of beer packaged. This factor was used to calculate the VOC (as propane) emission factor for large breweries. The emission factor calculation for VOC (as propane) from large breweries is shown below.

EF = brew kettle + brewers grain dryer + cereal cooker + hot wort settling tank + lauter tun + mash tun + open wort cooler + trub vessel--filling

or

EF = 0.64 + 2.6 + 0.0075 + 0.075 + 0.0055 + 0.054 + 0.022 + 0.25 = 3.7 lb/1000 bbl

Regional Breweries. For regional breweries, factors for the following processes were summed to determine a total brewery VOC (as propane) emission factor: brew kettle, cereal cooker, hot wort settling tank, lauter tun, mash tun, open wort cooler, and trub vessel--filling. An assumption that regional breweries do not operate brewers grain dryers was used in calculating this emission factor. The emission factor calculation for VOC (as propane) from regional breweries is shown below.

EF = brew kettle + cereal cooker + hot wort settling tank + lauter tun + mash tun + open wort cooler + trub vessel--filling

or

EF = 0.64 + 0.0075 + 0.075 + 0.0055 + 0.054 + 0.022 + 0.25 = 1.1 lb/1000 bbl

Microbreweries. For microbreweries, factors for the following processes were summed to determine a total brewery VOC (as propane) emission factor: brew kettle, cereal cooker, hot wort settling tank, lauter tun, mash tun, open wort cooler, and trub vessel--filling. Microbreweries do not operate brewers grain dryers. The emission factor calculation for VOC (as propane) from microbreweries is shown below.

EF = brew kettle + cereal cooker + hot wort settling tank + lauter tun + mash tun + open wort cooler + trub vessel--filling

or

EF = 0.64 + 0.0075 + 0.075 + 0.0055 + 0.054 + 0.022 + 0.25 = 1.1 lb/1000 bbl

Brewpubs. For brewpubs, factors for the following processes were summed to determine a total brewery VOC (as propane) emission factor: brew kettle, cereal cooker, hot wort settling tank, lauter tun, mash tun, open wort cooler, and trub vessel--filling. Brewpubs do not operate brewers grain dryers. The emission factor calculation for VOC (as propane) from brewpubs is shown below.

EF = brew kettle + cereal cooker + hot wort settling tank + lauter tun + mash tun + open wort cooler + trub vessel--filling

or

EF = 0.64 + 0.0075 + 0.075 + 0.0055 + 0.054 + 0.022 + 0.25 = 1.1 lb/1000 bbl

IV. Carbon Dioxide Emission Factors[5]

Total brewery emission factors for CO_2 emissions from the four types of breweries were developed using the emission factors shown in AP-42 Section 9.12.1, Table 9.12.1-2. Table 1 shows the data used to calculate the CO_2 emission estimates, and includes estimates, by State, for each type of brewery. Table 2 shows a summary of the CO_2 emission factors used to develop the estimate. The units for all of the emission factors are pounds per 1000 barrels (lb/1000 bbl) of beer packaged. The following paragraphs present the assumptions and rationale used to develop each brewery emission factor.

Large Breweries. For large breweries, factors for the following processes were summed to determine a total brewery CO_2 emission factor: aging tank--filling, brewers grain dryers, bottle filling line, can filling line, fermenter venting--closed fermenter, and keg filling line. To avoid double counting emissions from filling operations, an assumption was made that 45 percent of beer packaged by large breweries is canned, 45 percent is bottled, and 10 percent is kegged. Emission factors were not available for breweries that use conventional filling lines. Therefore, the CO_2 factors for sterilized filling lines were assumed to represent conventional filling line emissions. The brewers grain dryer emission factors shown in AP-42 have units of lb/ton of dried grain produced. Data provided by Coors (AP-42 Section 9.12.1, Reference 3) show a conversion factor of 3.62 to convert from lb/ton of dried grain produced to lb/1000 bbl of beer packaged. Using this conversion factor, emission factors for CO_2 emissions from brewers grain dryers were calculated for use in this estimate. For natural gas-fired dryers, the emission factor is 3040 lb/1000 bbl. For steam-heated dryers, the emission factor is 192 lb/1000 bbl. For simplicity, an assumption was made that half of the grain dryers are steam-heated and half are natural gas-fired. The emission factor calculation for CO_2 from large breweries is as follows:

EF = aging tank--filling + 0.5 x (gas-fired grain dryer + steam-heated grain dryer) + 0.45 x (bottle line + can line) + 0.10 x keg line + fermenter venting

or

$$EF = 26 + 0.5 \times (3040 + 192) + 0.45 \times (4300 + 1900) + 0.10 \times 46 + 2100 = 6{,}536 \text{ lb/1000 bbl}$$

Regional Breweries. For regional breweries, factors for the following processes were summed to determine a total brewery CO_2 emission factor: aging tank--filling, bottle filling line, can filling line, fermenter venting--closed fermenter, and keg filling line. An assumption that regional breweries do not operate brewers grain dryers was used in calculating this emission factor. To avoid double counting emissions from filling operations, an assumption was made that 45 percent of beer packaged by regional breweries is canned, 45 percent is bottled, and 10 percent is kegged. Emission factors were not available for breweries that use conventional filling lines. Therefore, the CO_2 factors for sterilized filling lines were assumed to represent conventional filling line emissions. Regional breweries typically have open fermenters, which, unlike closed fermenters, vent CO_2 to the atmosphere for the entire fermentation cycle. Therefore, the "fermenter venting--closed fermenter" emission factor provides a low estimate of CO_2 emissions from open fermentation operations. For this estimate, the closed fermenter factor is multiplied by 1.5 to estimate emissions from open fermenters. The emission factor calculation for CO_2 from regional breweries is as follows:

EF = aging tank--filling + 0.45 x (bottle line + can line) + 0.10 x keg line + 1.5 x ferm. vent.

or

EF = 26 + 0.45 x (4300 + 1900) + 0.10 x 46 + 1.5 x 2100 = 5,971 lb/1000 bbl

<u>Microbreweries</u>. For microbreweries, factors for the following processes were summed to determine a total brewery CO_2 emission factor: aging tank--filling, bottle filling line, fermenter venting--closed fermenter, and keg filling line. Microbreweries do not operate brewers grain dryers. To avoid double counting emissions from filling operations, an assumption was made that 50 percent of beer packaged by microbreweries is bottled and 50 percent is kegged. Emission factors were not available for breweries that use conventional filling lines. Therefore, the CO_2 factors for sterilized filling lines were assumed to represent conventional filling line emissions. Microbreweries use open fermenters, which, unlike closed fermenters, vent CO_2 to the atmosphere for the entire fermentation cycle. Therefore, the "fermenter venting--closed fermenter" emission factor provides a low estimate of CO_2 emissions from open fermentation operations. For this estimate, the closed fermenter factor is multiplied by 1.5 to estimate emissions from open fermenters. The emission factor calculation for CO_2 from microbreweries is as follows:

EF = aging tank--filling + 0.5 x bottle line + 0.5 x keg line + 1.5 x fermenter venting

or

EF = 26 + 0.5 x 4300 + 0.5 x 46 + 1.5 x 2100 = 5,349 lb/1000 bbl

<u>Brewpubs</u>. For brewpubs, factors for the following processes were summed to determine a total brewery CO_2 emission factor: aging tank--filling, fermenter venting--closed fermenter, and keg filling line. Brewpubs do not operate brewers grain dryers. Brewpubs use open fermenters, which, unlike closed fermenters, vent CO_2 to the atmosphere for the entire fermentation cycle. Therefore, the "fermenter venting--closed fermenter" emission factor provides a low estimate of CO_2 emissions from open fermentation operations. For this estimate, the closed fermenter factor is multiplied by 1.5 to estimate emissions from open fermenters. An assumption was made that filling operations at brewpubs are 100 percent keg filling. Some brewpubs do bottle beer, but most brewpubs have very limited distribution. If more than 50 percent of a brewpub's beer is shipped off-site, the brewpub is reclassified as a microbrewery. Therefore, any emission factors associated with bottling or canning were not included in the emission factor calculation. The emission factor calculation for CO_2 from brewpubs is as follows:

EF = aging tank--filling + keg line + 1.5 x fermenter venting

or

EF = 26 + 46 + 1.5 x 2100 = 3,222 lb/1000 bbl

V. Emissions From Other Associated Sources[6,7]

Several additional sources of VOC associated with beer production are yeast lysing, yeast storage, waste beer storage, and evacuation of aging tanks and closed fermentation tanks. Data of suitable quality for inclusion in the malt beverages section of AP-42 are not available for these sources. The emissions from these processes were not included in the emission estimates developed in this memorandum.

In addition, some large breweries have process wastewater treatment plants, which may or may not be considered to be part of the brewery. One brewery reported annual ethanol emissions from wastewater treatment of 42.2 tons (annual production of 5.3 million barrels). This corresponds to an emission factor of about 16 lb/1000 bbl. This emission factor is not used in this memorandum to estimate national emissions from breweries.

VI. Summary

The national emission estimate for VOC emissions from breweries is 2,027 tons per year. Of this total, 1,714 tons per year is ethanol. Large breweries account for about 93.9 percent of total VOC emissions (1,902 tons); regional breweries account for about 5.0 percent (102 tons); microbreweries account for about 0.9 percent (19 tons); and brewpubs account for about 0.2 percent (4 tons). The national emission estimate for CO_2 emissions from breweries is 583,000 tons per year. Large breweries account for about 92.3 percent of CO_2 emissions (538,000 tons); regional breweries account for about 5.8 percent (34,000 tons); microbreweries account for about 1.4 percent (8,000 tons); and brewpubs account for about 0.5 percent (3,000 tons). Table 1 shows the data used to estimate national emissions of VOC and CO_2, and includes estimates by State and by brewery type. If additional detail is needed on the location of breweries in the United States, Reference 3 provides the brewery locations by city.

References

1. *Tapping Micros' Success*, USA Today, October 21, 1994.

2. *Now and Then, History of Anheuser-Busch*, Budweiser Home Page, Internet Address http://budweiser.com/timeline.html, February 5, 1997.

3. *North American Brewery List*, The Institute for Brewing Studies, Boulder, CO, September 23, 1996.

4. *Brewery Sizes*, Institute for Brewing Studies Home Page, Internet Address http://alpha.rollanet.org/AOB/brewsize.html, October 10, 1996.

5. *Emission Factor Documentation for AP-42 Section 9.12.1, Malt Beverages, Final Report*, Midwest Research Institute, Cary, NC, October 1996.

6. Written communication from Jere Zimmerman, Adolph Coors Brewing Company, Golden, CO, to David Reisdorph, Midwest Research Institute, Kansas City, MO, March 11, 1993.

7. *Air Emissions Investigation Report, Miller Brewing Company, Fulton, New York*, RTP Environmental Associates, Inc., Westbury, New York, February, 1994.

	LARGE BREWERIES							
	Number of Breweries				CO2	VOC as propane	VOC as ethanol	Total VOC
State	Other Large Breweries	Coors	Anheuser-Busch	Production, 1,000 bbl/yr	emissions, tons/yr	emissions, tons/yr	emissions, tons/yr	emissions, tons/yr
Alabama				0	0	0.0	0.0	0.0
Alaska				0	0	0.0	0.0	0.0
Arizona				0	0	0.0	0.0	0.0
Arkansas				0	0	0.0	0.0	0.0
California	1		2	13840	45226	25.5	114.9	140.4
Colorado		1	1	23540	76924	43.4	373.6	417.0
Connecticut				0	0	0.0	0.0	0.0
Delaware				0	0	0.0	0.0	0.0
D.C.				0	0	0.0	0.0	0.0
Florida	1		2	13840	45226	25.5	114.9	140.4
Georgia	1		1	8300	27123	15.3	68.9	84.2
Hawaii				0	0	0.0	0.0	0.0
Idaho				0	0	0.0	0.0	0.0
Illinois	1			2760	9019	5.1	22.9	28.0
Indiana				0	0	0.0	0.0	0.0
Iowa				0	0	0.0	0.0	0.0
Kansas				0	0	0.0	0.0	0.0
Kentucky				0	0	0.0	0.0	0.0
Louisiana				0	0	0.0	0.0	0.0
Maine				0	0	0.0	0.0	0.0
Maryland	2			5520	18038	10.2	45.8	56.0
Massachusetts				0	0	0.0	0.0	0.0
Michigan	1			2760	9019	5.1	22.9	28.0
Minnesota	1			2760	9019	5.1	22.9	28.0
Missouri			1	5540	18104	10.2	46.0	56.2
Montana				0	0	0.0	0.0	0.0
Nebraska				0	0	0.0	0.0	0.0
Nevada				0	0	0.0	0.0	0.0
New Hampshire			1	5540	18104	10.2	46.0	56.2
New Jersey			1	5540	18104	10.2	46.0	56.2
New Mexico				0	0	0.0	0.0	0.0
New York	1		1	8300	27123	15.3	68.9	84.2
North Carolina	2			5520	18038	10.2	45.8	56.0
North Dakota				0	0	0.0	0.0	0.0
Ohio	1		1	8300	27123	15.3	68.9	84.2
Oklahoma				0	0	0.0	0.0	0.0
Oregon	1			2760	9019	5.1	22.9	28.0
Pennsylvania	3			8280	27057	15.3	68.7	84.0
Rhode Island				0	0	0.0	0.0	0.0
South Carolina				0	0	0.0	0.0	0.0
South Dakota				0	0	0.0	0.0	0.0
Tennessee**		1		2760	9019	5.1	50.2	55.3
Texas	4		1	16580	54180	30.6	137.6	168.2
Utah				0	0	0.0	0.0	0.0
Vermont				0	0	0.0	0.0	0.0
Virginia**		1	1	8300	27123	15.3	96.2	111.5
Washington	2			5520	18038	10.2	45.8	56.0
West Virginia				0	0	0.0	0.0	0.0
Wisconsin	3			8280	27057	15.3	68.7	84.0
Wyoming				0	0	0.0	0.0	0.0
Total	25	3	13	164,540	537,684	303.6	1,598.5	1,902.1

**The Coors breweries in Virginia and Tennessee are assumed to have average production levels.

Table 1. State and National Emission Estimates for VOC and CO2 from Breweries 3/19/97

	REGIONAL BREWERIES					
State	Number of Breweries	Production, 1,000 bbl/yr	CO2 emissions, tons/yr	VOC as propane emissions, tons/yr	VOC as ethanol emissions, tons/yr	Total VOC emissions, tons/yr
Alabama		0	0	0.0	0.0	0.0
Alaska	1	250	746	0.1	2.1	2.2
Arizona		0	0	0.0	0.0	0.0
Arkansas		0	0	0.0	0.0	0.0
California	5	1250	3732	0.7	10.4	11.0
Colorado	2	500	1493	0.3	4.2	4.4
Connecticut		0	0	0.0	0.0	0.0
Delaware		0	0	0.0	0.0	0.0
D.C.		0	0	0.0	0.0	0.0
Florida	1	250	746	0.1	2.1	2.2
Georgia		0	0	0.0	0.0	0.0
Hawaii		0	0	0.0	0.0	0.0
Idaho		0	0	0.0	0.0	0.0
Illinois		0	0	0.0	0.0	0.0
Indiana	1	250	746	0.1	2.1	2.2
Iowa	1	250	746	0.1	2.1	2.2
Kansas		0	0	0.0	0.0	0.0
Kentucky		0	0	0.0	0.0	0.0
Louisiana	2	500	1493	0.3	4.2	4.4
Maine	1	250	746	0.1	2.1	2.2
Maryland		0	0	0.0	0.0	0.0
Massachusetts	1	250	746	0.1	2.1	2.2
Michigan		0	0	0.0	0.0	0.0
Minnesota	4	1000	2985	0.5	8.3	8.8
Missouri	1	250	746	0.1	2.1	2.2
Montana		0	0	0.0	0.0	0.0
Nebraska		0	0	0.0	0.0	0.0
Nevada		0	0	0.0	0.0	0.0
New Hampshire		0	0	0.0	0.0	0.0
New Jersey		0	0	0.0	0.0	0.0
New Mexico		0	0	0.0	0.0	0.0
New York	1	250	746	0.1	2.1	2.2
North Carolina		0	0	0.0	0.0	0.0
North Dakota		0	0	0.0	0.0	0.0
Ohio	1	250	746	0.1	2.1	2.2
Oklahoma		0	0	0.0	0.0	0.0
Oregon	8	2000	5971	1.1	16.6	17.7
Pennsylvania	4	1000	2985	0.5	8.3	8.8
Rhode Island		0	0	0.0	0.0	0.0
South Carolina		0	0	0.0	0.0	0.0
South Dakota		0	0	0.0	0.0	0.0
Tennessee		0	0	0.0	0.0	0.0
Texas	2	500	1493	0.3	4.2	4.4
Utah		0	0	0.0	0.0	0.0
Vermont	1	250	746	0.1	2.1	2.2
Virginia	1	250	746	0.1	2.1	2.2
Washington	4	1000	2985	0.5	8.3	8.8
West Virginia		0	0	0.0	0.0	0.0
Wisconsin	4	1000	2985	0.5	8.3	8.8
Wyoming		0	0	0.0	0.0	0.0
Total	46	11,500	34,331	6.0	95.5	101.5

Table 1. State and National Emission Estimates for VOC and CO2 from Breweries 3/19/97

MICROBREWERIES						
State	Number of Breweries	Production, 1,000 bbl/yr	CO2 emissions, tons/yr	VOC as propane emissions, tons/yr	VOC as ethanol emissions, tons/yr	Total VOC emissions, tons/yr
Alabama	2	16	43	0.0	0.1	0.1
Alaska	8	64	171	0.0	0.4	0.4
Arizona	9	72	193	0.0	0.4	0.5
Arkansas	1	8	21	0.0	0.0	0.1
California	50	400	1070	0.2	2.3	2.5
Colorado	42	336	899	0.2	1.9	2.1
Connecticut	6	48	128	0.0	0.3	0.3
Delaware	1	8	21	0.0	0.0	0.1
D.C.		0	0	0.0	0.0	0.0
Florida	8	64	171	0.0	0.4	0.4
Georgia	5	40	107	0.0	0.2	0.3
Hawaii	4	32	86	0.0	0.2	0.2
Idaho	9	72	193	0.0	0.4	0.5
Illinois	6	48	128	0.0	0.3	0.3
Indiana	1	8	21	0.0	0.0	0.1
Iowa	2	16	43	0.0	0.1	0.1
Kansas	2	16	43	0.0	0.1	0.1
Kentucky	1	8	21	0.0	0.0	0.1
Louisiana	3	24	64	0.0	0.1	0.2
Maine	12	96	257	0.1	0.6	0.6
Maryland	8	64	171	0.0	0.4	0.4
Massachusetts	14	112	300	0.1	0.6	0.7
Michigan	10	80	214	0.0	0.5	0.5
Minnesota	2	16	43	0.0	0.1	0.1
Missouri		0	0	0.0	0.0	0.0
Montana	13	104	278	0.1	0.6	0.7
Nebraska		0	0	0.0	0.0	0.0
Nevada	1	8	21	0.0	0.0	0.1
New Hampshire	3	24	64	0.0	0.1	0.2
New Jersey	7	56	150	0.0	0.3	0.4
New Mexico	5	40	107	0.0	0.2	0.3
New York	10	80	214	0.0	0.5	0.5
North Carolina	13	104	278	0.1	0.6	0.7
North Dakota		0	0	0.0	0.0	0.0
Ohio	12	96	257	0.1	0.6	0.6
Oklahoma		0	0	0.0	0.0	0.0
Oregon	12	96	257	0.1	0.6	0.6
Pennsylvania	14	112	300	0.1	0.6	0.7
Rhode Island	1	8	21	0.0	0.0	0.1
South Carolina	3	24	64	0.0	0.1	0.2
South Dakota	1	8	21	0.0	0.0	0.1
Tennessee	3	24	64	0.0	0.1	0.2
Texas	12	96	257	0.1	0.6	0.6
Utah	5	40	107	0.0	0.2	0.3
Vermont	4	32	86	0.0	0.2	0.2
Virginia	6	48	128	0.0	0.3	0.3
Washington	30	240	642	0.1	1.4	1.5
West Virginia	1	8	21	0.0	0.0	0.1
Wisconsin	10	80	214	0.0	0.5	0.5
Wyoming	4	32	86	0.0	0.2	0.2
Total	376	3,008	8,045	1.6	17.3	18.9

	BREWPUBS					
State	Number of Brewpubs	Production, 1,000 bbl/yr	CO2 emissions, tons/yr	VOC as propane emissions, tons/yr	VOC as ethanol emissions, tons/yr	Total VOC emissions, tons/yr
Alabama	5	15	24	0.0	0.0	0.0
Alaska	3	9	14	0.0	0.0	0.0
Arizona	10	30	48	0.0	0.0	0.1
Arkansas	2	6	10	0.0	0.0	0.0
California	97	291	469	0.2	0.5	0.6
Colorado	37	111	179	0.1	0.2	0.2
Connecticut	5	15	24	0.0	0.0	0.0
Delaware	3	9	14	0.0	0.0	0.0
D.C.	2	6	10	0.0	0.0	0.0
Florida	38	114	184	0.1	0.2	0.2
Georgia	9	27	43	0.0	0.0	0.1
Hawaii	2	6	10	0.0	0.0	0.0
Idaho	7	21	34	0.0	0.0	0.0
Illinois	19	57	92	0.0	0.1	0.1
Indiana	9	27	43	0.0	0.0	0.1
Iowa	3	9	14	0.0	0.0	0.0
Kansas	11	33	53	0.0	0.1	0.1
Kentucky	5	15	24	0.0	0.0	0.0
Louisiana	3	9	14	0.0	0.0	0.0
Maine	11	33	53	0.0	0.1	0.1
Maryland	9	27	43	0.0	0.0	0.1
Massachusetts	22	66	106	0.0	0.1	0.1
Michigan	11	33	53	0.0	0.1	0.1
Minnesota	6	18	29	0.0	0.0	0.0
Missouri	9	27	43	0.0	0.0	0.1
Montana		0	0	0.0	0.0	0.0
Nebraska	6	18	29	0.0	0.0	0.0
Nevada	8	24	39	0.0	0.0	0.1
New Hampshire	7	21	34	0.0	0.0	0.0
New Jersey	7	21	34	0.0	0.0	0.0
New Mexico	8	24	39	0.0	0.0	0.1
New York	36	108	174	0.1	0.2	0.2
North Carolina	10	30	48	0.0	0.0	0.1
North Dakota	3	9	14	0.0	0.0	0.0
Ohio	13	39	63	0.0	0.1	0.1
Oklahoma	8	24	39	0.0	0.0	0.1
Oregon	40	120	193	0.1	0.2	0.3
Pennsylvania	13	39	63	0.0	0.1	0.1
Rhode Island	3	9	14	0.0	0.0	0.0
South Carolina	13	39	63	0.0	0.1	0.1
South Dakota	5	15	24	0.0	0.0	0.0
Tennessee	8	24	39	0.0	0.0	0.1
Texas	38	114	184	0.1	0.2	0.2
Utah	8	24	39	0.0	0.0	0.1
Vermont	8	24	39	0.0	0.0	0.1
Virginia	7	21	34	0.0	0.0	0.0
Washington	26	78	126	0.0	0.1	0.2
West Virginia	2	6	10	0.0	0.0	0.0
Wisconsin	16	48	77	0.0	0.1	0.1
Wyoming	7	21	34	0.0	0.0	0.0
Total	638	1,914	3,083	1.0	3.2	4.2

Table 1. State and National Emission Estimates for VOC and CO2 from Breweries

3/19/97

TOTAL, ALL BREWERIES						
State	Number of Breweries	Total production, 1,000 bbl/yr	CO2 emissions, tons/yr	VOC as propane emissions, tons/yr	VOC as ethanol emissions, tons/yr	Total VOC emissions, tons/yr
Alabama	7	31	67	0.0	0.1	0.1
Alaska	12	323	932	0.2	2.5	2.6
Arizona	19	102	241	0.1	0.5	0.5
Arkansas	3	14	31	0.0	0.1	0.1
California	155	15781	50,497	26.6	128.0	154.6
Colorado	83	24487	79,494	43.9	379.8	423.8
Connecticut	11	63	153	0.0	0.3	0.3
Delaware	4	17	36	0.0	0.1	0.1
D.C.	2	6	10	0.0	0.0	0.0
Florida	50	14268	46,327	25.8	117.5	143.3
Georgia	16	8367	27,273	15.3	69.2	84.5
Hawaii	6	38	95	0.0	0.2	0.2
Idaho	16	93	226	0.0	0.4	0.5
Illinois	26	2865	9,239	5.1	23.3	28.4
Indiana	11	285	811	0.1	2.2	2.3
Iowa	6	275	804	0.1	2.2	2.3
Kansas	13	49	96	0.0	0.1	0.2
Kentucky	6	23	46	0.0	0.1	0.1
Louisiana	8	533	1,571	0.3	4.3	4.6
Maine	24	379	1,056	0.2	2.7	2.9
Maryland	19	5611	18,253	10.2	46.2	56.5
Massachusetts	37	428	1,152	0.2	2.8	3.1
Michigan	22	2873	9,286	5.2	23.4	28.6
Minnesota	13	3794	12,076	5.6	31.3	37.0
Missouri	11	5817	18,893	10.4	48.1	58.5
Montana	13	104	278	0.1	0.6	0.7
Nebraska	6	18	29	0.0	0.0	0.0
Nevada	9	32	60	0.0	0.1	0.1
New Hampshire	11	5585	18,202	10.2	46.2	56.4
New Jersey	15	5617	18,287	10.3	46.3	56.6
New Mexico	13	64	146	0.0	0.3	0.3
New York	49	8738	28,257	15.5	71.6	87.1
North Carolina	25	5654	18,365	10.3	46.5	56.7
North Dakota	3	9	14	0.0	0.0	0.0
Ohio	28	8685	28,189	15.5	71.6	87.1
Oklahoma	8	24	39	0.0	0.0	0.1
Oregon	61	4976	15,440	6.3	40.3	46.5
Pennsylvania	34	9431	30,405	15.9	77.7	93.6
Rhode Island	4	17	36	0.0	0.1	0.1
South Carolina	16	63	127	0.0	0.2	0.2
South Dakota	6	23	46	0.0	0.1	0.1
Tennessee	12	2808	9,122	5.1	50.4	55.5
Texas	57	17290	56,113	31.0	142.5	173.5
Utah	13	64	146	0.0	0.3	0.3
Vermont	13	306	871	0.2	2.3	2.5
Virginia	16	8619	28,031	15.5	98.6	114.1
Washington	62	6838	21,791	10.9	55.6	66.5
West Virginia	3	14	31	0.0	0.1	0.1
Wisconsin	33	9408	30,334	15.9	77.6	93.4
Wyoming	11	53	119	0.0	0.2	0.2
Total	1,101	180,962	583,143	312.2	1,714.4	2,026.6

TABLE 2. Summary of Brewery Emission Factors

Brewery type	Pollutant	Emission factor, lb/1000 bbl
Large (conventional filling lines)	VOC as ethanol	16.6
	VOC as propane	3.7
	CO_2	6,536
Large (sterilized filling lines)	VOC as ethanol	36.4
	VOC as propane	3.7
	CO_2	6,536
Regional	VOC as ethanol	16.6
	VOC as propane	1.1
	CO_2	5,971
Micro	VOC as ethanol	11.5
	VOC as propane	1.1
	CO_2	5,349
Brewpub	VOC as ethanol	3.3
	VOC as propane	1.1
	CO_2	3,222

MRI

MIDWEST RESEARCH INSTITUTE
Suite 350
401 Harrison Oaks Boulevard
Cary, North Carolina 27513-2412
Telephone (919) 677-0249
FAX (919) 677-0065

Date: April 14, 1994

Subject: Site Visit--Stroh Brewery Company, Winston Salem, NC
Review and Update of AP-42 Chapter 6, Food and Agriculture, EPA Contract 68-D2-0159; MRI Project 3605-99

From: Brian Shrager

To: Dallas Safriet
EPA/EIB/EFMS (MD-14)
U. S. Environmental Protection Agency
Research Triangle Park, N.C. 27711

I. Purpose

The purpose of the visit was to familiarize the project team with brewery operations in order to facilitate the development of the new AP-42 section addressing beer brewing.

II. Place and Date

Stroh Brewery Company
U.S. Route 52
Winston Salem, North Carolina

Date: September 24, 1993

III. Attendees

Stroh Brewery Company (Stroh)

Greg Miller, Manager-Environmental Affairs
Joe Kwolkoski, Plant Engineer
Paul Heppler, Assistant Engineer

U.S. Environmental Protection Agency (EPA)

Dallas Safriet, EIB
Ron Ryan, EIB

Midwest Research Institute (MRI)

Roy Neulicht
Brian Shrager

IV. Discussion

The group began the trip with a brief discussion of the plant operations as well as Stroh operations throughout the United States. The following are some of the key points of the discussion:

1. Malting operations are not performed at this plant.

2. The plant uses corn syrup instead of corn in the brewing process. This eliminates corn cookers from the brewing process.

3. In addition to the normal can and bottle filling lines, the plant has two sterile filling lines. These lines are located within the filling area of the facility, but each line is located in plastic sheeting enclosures, which are maintained under positive air pressure during operation.

4. The plant produces about 5.5 million barrels of beer per year, and is relatively small compared to the Coors plant (20 million barrels per year) that furnished the filling operations emission data to EPA. There are 31 gallons in a barrel.

5. Mr. Miller indicated that the largest ethanol emission source at the plant is the alcohol stripper, which is used to decrease the ethanol content from waste beer. The alcohol stripper is a submerged burner which heats the liquid waste stream, resulting in evaporation of the ethanol. The alcohol stripper is needed to reduce the biological oxygen demand (BOD) load on the city sewer system. The alcohol stripper removes about 65 percent of the alcohol from the liquid stream. The source emits about 300 tons of ethanol per year. Mr. Miller indicated that the

plant is planning to replace the alcohol stripper with an ethanol recovery system in the next year.

6. Mr. Miller suggested that filler emission factors be based on beer spillage rather than production, because the only ethanol emissions from filling operations come from beer loss. Stroh is concerned about the use of the Coors data for filling operations because Coors filling operations are not representative of the industry.

Following the discussion, the group toured the facility. Figure 1 shows a process flow diagram for the plant. Malted barley is shipped to the plant by rail, and is pneumatically conveyed to 20 grain storage silos. Particulate matter (PM) emissions from the grain unloading process are controlled by filter receivers, which are cyclones followed by fabric filters. From the silos, malted grain is pneumatically conveyed to four whole malt scales, which weigh the malt and discharge the proper amount to three malt mills. The malt mills grind the malt, which is then screw-conveyed to two ground (milled) malt hoppers. Particulate matter emissions from the malt mills and milled malt hoppers are controlled by a fabric filter. From the milled malt hoppers, the ground malt is gravity fed to two mash tubs where hot water is added as the malt is being fed. Corn syrup is then added, and the mixture is cooked in the mash tubs. The product, known as wort, is pumped to one of two lauter tubs, in which the wet grain is separated from the wort. The mash tubs and lauter tubs are all vented to the atmosphere through natural draft stacks. The liquid wort from the lauter tubs is transferred to four brew kettles, and the wet or "spent" grain from the lauter tubs is pneumatically conveyed to the spent grain tank and is sold to a neighboring facility that dries and processes the grain. In the brew kettles, hops are added to the wort and the mixture is boiled for an extended period of time. In addition to boiling in the brew kettles, the Stroh brand of beer is cycled through a direct-fired brewing process. The wort is then

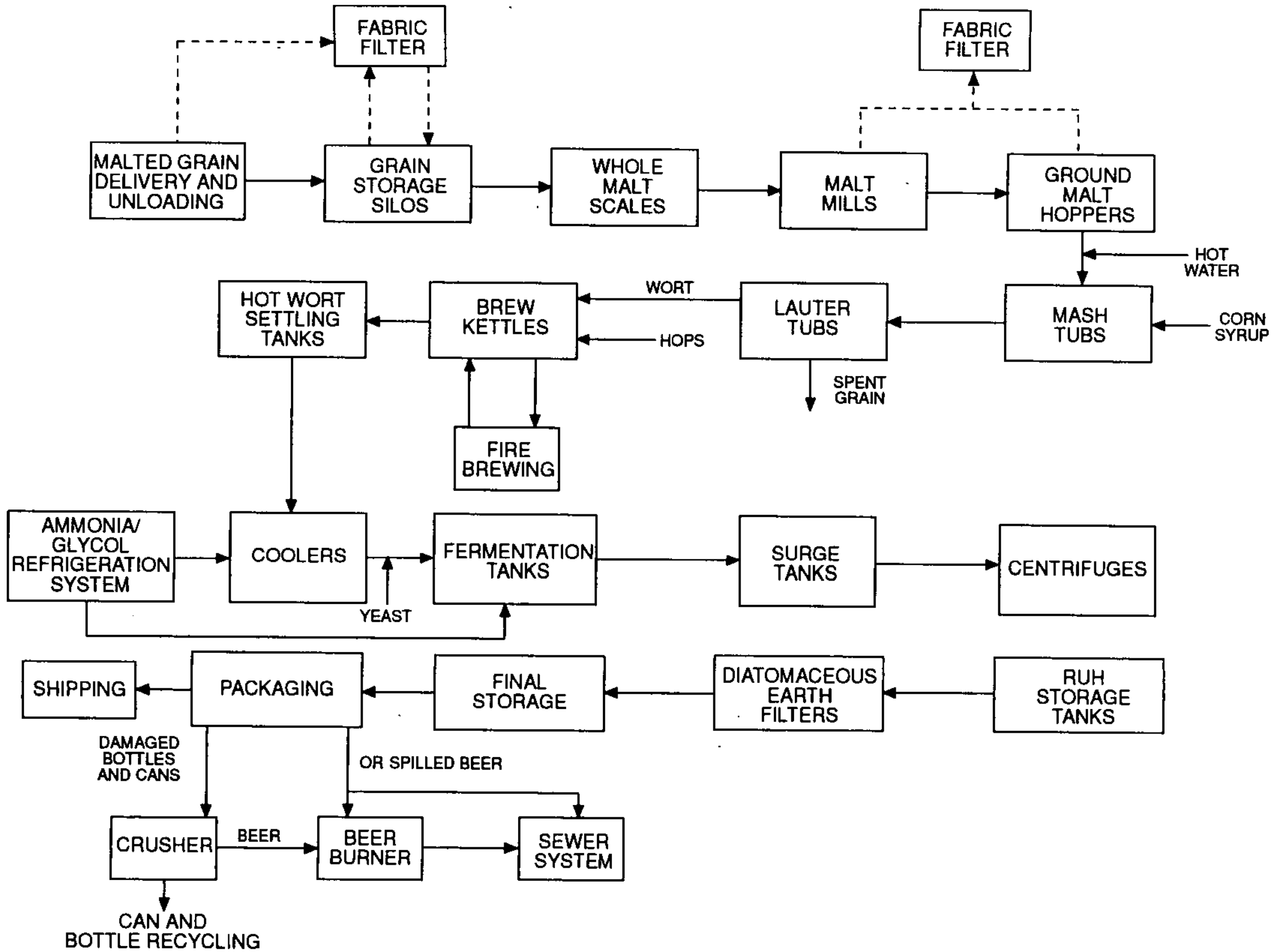

Figure 1. Process flow diagram for Stroh Brewery Company, Winston-Salem, NC.

transferred to the four hot wort settling tanks where the hot wort is held to allow settling of insoluble material called trub; the trub is introduced back into the lauter tubs. Emissions from the brew kettles are ducted to the atmosphere through four forced-air stacks, and the hot wort settling tanks are vented through a natural draft stack. The hot wort is pumped to coolers, which cool the liquid from about 99°C (210°F) to about 11°C (52°F). The cooling system is a glycol- and ammonia-based, refrigeration system. The only potential emissions from the cooling system are fugitive ammonia emissions from valves or seals. Yeast, which is produced in several yeast tanks, is mixed with the cooled wort as it is pumped into the fermentation tanks.

The plant has 86 fermentation tanks, each of which typically holds about 1270 barrels of liquid. The liquid is typically fermented for a little more than a week. The fermentation tanks are vented to the atmosphere (through a single six inch diameter stack) for the first 12 to 14 hours of the fermentation process. This is a potential VOC source. For about seven days (following the initial 12 to 14 hours), the emissions from the fermentation tanks are collected for the purpose of recovering the carbon dioxide (CO_2) generated during fermentation. Impurities in the CO_2 are removed by a wet scrubbing and carbon adsorption system; impurities collected in the carbon bed are released to the atmosphere as emissions during carbon regeneration. At the time of the visit, the stack venting emissions from the fermentation tanks was emitting a considerable amount of waste gas, but Mr. Kwolkoski noted that this was not typical and was probably due to a malfunctioning compressor in the CO_2 recovery system, which prevented recovery of gases from all the fermentation tanks. From the fermentation tanks, the liquid is transferred to surge tanks, and then processed through a centrifuge to remove waste yeast. After the centrifuge, the liquid is aged for 30 days (secondary fermentation) in "ruh" storage tanks. The ruh storage tanks are vented to the atmosphere. Following ruh storage, the liquid is sent through a filtration process.

Diatomaceous earth is added to the ruh and the mixture passes through a filtration system that includes a prefilter, final filter, and trap filter. This diatomaceous earth filtration process removes any remaining impurities in the beer. Carbonated water is added to the liquid and the beer is then pumped to final storage ("government tanks"). The surge tanks used in the filtration process and the government storage tanks are maintained under counterpressure using CO_2 (i.e., they are not vented to the atmosphere, except prior to and during cleaning).

The diatomaceous earth used in the filtration process is received in 50 lb bags; the earth is dumped into a mix tank and mixed with water to form the slurry which is used during filtration. The mix tank is a potential source of fugitive particulate matter emissions. The mix tanks were covered; the door in the cover was hooded and the exhaust is vented to a baghouse prior to discharge to the atmosphere.

From final storage, the beer is canned or bottled by several filling lines located in a large building. The two enclosed filling lines, for nonpasteurized products, were not operating during the visit. The canning lines that were operating did not appear to spill much beer, and some of the lines were shrouded at the point where spillage occurred. The shrouds contained the spilled beer which drained quickly into catchpans connected to the collection system, thus limiting potential ethanol emissions. One canning line was not shrouded, and beer spillage was more noticeable; more beer appeared to escape capture by the catch pans and instead ended up on the floor where it subsequently flowed to a floor drain. Bottling operations appeared to spill more beer than canning, with most of the spillage occurring as the beer foamed up after the injection of steam or CO_2 for oxygen removal prior to capping.

Damaged and partially filled cans and bottles from the filling lines are deposited in bins that feed two crushers, one can crusher and one bottle crusher. Beer from the crushed cans and bottles is collected in the waste beer collection system. The waste beer is pumped from the collection tank to the alcohol stripper. The cans and bottles are recycled. The alcohol stripper is a submerged combustion system that is a major source of ethanol emissions, but as discussed earlier, it is going to be replaced in the near future.

IV. Conclusions

The site visit was informative and assisted in identifying the potential sources of emissions which include:

PM	--	Grain/malt handling
	--	Diatomaceous earth mixing
VOC	--	Brew kettle
	--	Lauter tub
	--	Hot wort settle tank
	--	Fermentation
	--	Secondary fermentation
	--	Bottling
	--	Waste beer handling
CO_2	--	Fermentation
Other	--	Ammonia from refrigeration system

MRI

MIDWEST RESEARCH INSTITUTE
Suite 350
401 Harrison Oaks Boulevard
Cary, North Carolina 27513-2412
Telephone (919) 677-0249
FAX (919) 677-0065

Date: May 5, 1994

Subject: Site Visit--Stroh Brewery Company, Winston Salem, NC
Review and Update of AP-42 Chapter 6, Food and Agriculture, EPA Contract 68-D2-0159; MRI Project 3605-99

From: Brian Shrager

To: Dallas Safriet
EPA/EIB/EFMS (MD-14)
U. S. Environmental Protection Agency
Research Triangle Park, N.C. 27711

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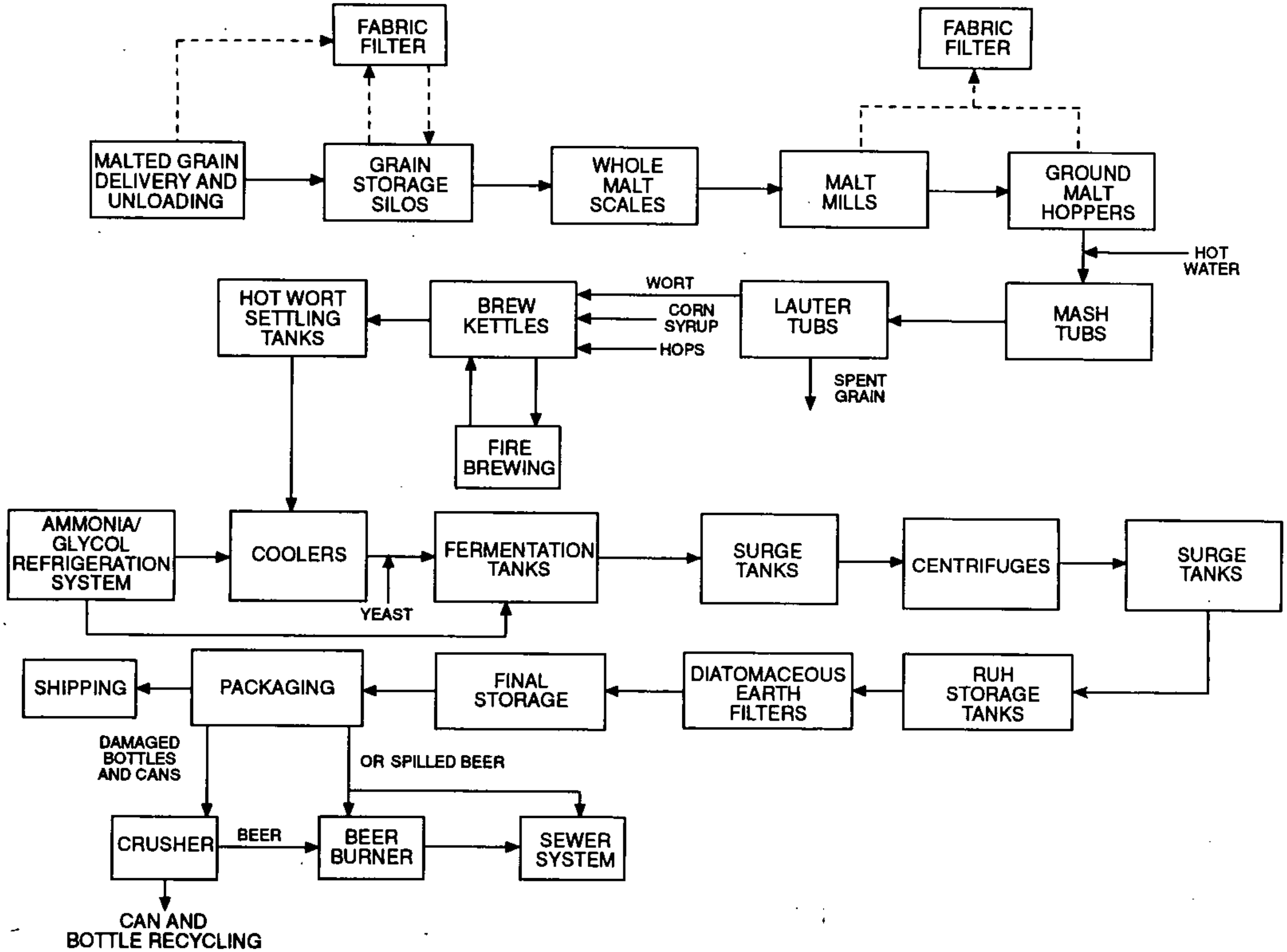

Figure 1. Process flow diagram for Stroh Brewery Company, Winston-Salem, NC.

is then screw-conveyed to two ground (milled) malt hoppers. Particulate matter emissions from the malt mills and milled malt hoppers are controlled by a fabric filter. From the milled malt hoppers, the ground malt is gravity fed to two mash tubs where hot water is added as the malt is being fed. The mixture is heated in the mash tubs. The product, known as mash, is pumped to one of two lauter tubs, in which the wet grain is separated from the mash to produce wort. The mash tubs and lauter tubs are all vented to the atmosphere through natural draft stacks. The liquid wort from the lauter tubs is transferred to one of four brew kettles, and the wet or "spent" grain from the lauter tubs is pneumatically conveyed to the spent grain tank and is sold to a neighboring facility that adds dry ingredients to reduce the moisture content and processes the grain. In the brew kettles, hops and corn syrup are added to the wort and the mixture is boiled for an extended period of time. In addition to boiling in the brew kettles, the several Stroh's brands of beer are cycled through a direct-fired brewing process. The wort is then transferred to one of four hot wort settling tanks where the hot wort is held to allow settling of insoluble material called trub; the trub is introduced into the spent grains for drying and processing. Emissions from the brew kettles are ducted to the atmosphere through four forced-air stacks, and the hot wort settling tanks are vented through a natural draft stack. The hot wort is pumped to coolers, which cool the liquid from about 99°C (210°F) to about 13°C (56°F). The cooling system is a chilled-water heat exchanger; water is chilled by an ammonia-based, refrigeration system. The only potential emissions from the plant refrigeration system are fugitive ammonia emissions from valves or seals. Yeast, which is collected from previous fermentations in several yeast tanks, is mixed with the cooled wort as it is pumped into the fermentation tanks.

The plant has 86 fermentation tanks, each of which typically holds about 1270 barrels of liquid. The liquid is typically fermented for approximately a week. The fermentation tanks are vented to the atmosphere (through a single six inch diameter stack) for the first 12 to 14 hours of the fermentation process. This is a potential VOC source. For about seven days (following the initial 12 to 14 hours), the emissions from the fermentation tanks are collected for the purpose of recovering the carbon dioxide (CO_2) generated during fermentation. Impurities in the CO_2 are removed by a wet scrubbing and carbon adsorption system; impurities collected in the carbon bed are released to the atmosphere as emissions during carbon regeneration. From the fermentation tanks, the liquid is transferred to surge tanks, and then processed through a centrifuge to remove the yeast. After the centrifuge, the liquid is aged for 7 to 14 days in "ruh" storage tanks. The ruh storage tanks are vented to the room on filling and emptying. Following ruh storage, the liquid is sent through a filtration process. Diatomaceous earth is added to the ruh and the mixture passes through a filtration system that includes surge tanks, a prefilter, final filter, and trap filter.

This diatomaceous earth filtration process removes any remaining impurities in the beer. Carbonated water is added to the liquid and the beer is then pumped to final storage in packaging release tanks. The surge tanks used in the filtration process and the packaging release tanks are maintained under counterpressure using CO_2 (i.e., they are not vented to the atmosphere, except prior to and during cleaning).

The diatomaceous earth used in the filtration process is received in 50 lb bags; the earth is dumped into a mix tank and mixed with water to form the slurry which is used during filtration. The mix tank is a potential source of fugitive particulate matter emissions. The mix tanks were covered; the door in the cover was hooded and the exhaust is vented to a baghouse prior to discharge to the atmosphere.

From final storage, the beer is racked, canned, or bottled by several filling lines located in a large building. The two enclosed filling lines, for nonpasteurized products, were not operating during the visit. The canning lines that were operating did not appear to spill much beer, and some of the lines were shrouded at the point where spillage occurred. The shrouds contained the spilled beer which drained quickly into catchpans connected to the collection system, thus limiting potential ethanol emissions. One canning line was not shrouded, and beer spillage was more noticeable; more beer appeared to escape capture by the catch pans and instead ended up on the floor where it subsequently flowed to a floor drain. The waste beer collected at the fillers is pumped to the alcohol stripper.

Damaged and partially filled cans and bottles from the filling lines are deposited in bins that feed two crushers, one can crusher and one bottle crusher. Beer from the crushed cans and bottles is collected in the waste beer collection system. The waste beer is pumped from the collection tank to the alcohol stripper. The cans and bottles are recycled. The alcohol stripper is a submerged combustion system that is a major source of ethanol emissions, but as discussed earlier, it is going to be replaced in the near future.

IV. Conclusions

The site visit was informative and assisted in identifying the potential sources of emissions which include:

PM -- Grain/malt handling
-- Diatomaceous earth mixing

VOC -- Brew kettle
-- Lauter tub
-- Hot wort settle tank
-- Fermentation
-- Ruh storage

	--	Bottling
	--	Waste beer handling
CO_2	--	Fermentation
Other	--	Ammonia from refrigeration system

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MRI

MIDWEST RESEARCH INSTITUTE
Suite 350
401 Harrison Oaks Boulevard
Cary, North Carolina 27513-2412
Telephone (919) 677-0249
FAX (919) 677-0065

June 8, 1994

Ms. Jere Zimmerman
Adolph Coors Company
Golden, Colorado 80401

Dear Jere:

Thank you for taking the time to discuss the Coors test data with me last Friday. I have put together a brief summary of our discussion for your review. I will begin to remove the confidential information from the summary report and test reports after I receive the replacement calculation pages from you. I am planning to send the pages containing confidential information back to you so that you can confirm that the confidentiality is not compromised. The pages that require white out will be copied, and I will send these originals to you also. I will take care of these matters as quickly as possible so that we can continue with the revision of the Malt Beverage AP-42 section. Thank you very much, and I look forward to hearing from you.

Sincerely,

Brian Shrager

Brian Shrager
Environmental Engineer

Enclosure

3061\460108

CONTACT REPORT--MRI Project No. 4601-08

From:	Brian Shrager, Environmental Engineering Department
Date of Contact:	June 3, 1994
Contacted by:	Telephone
Company/Agency:	Adolph Coors Company Golden, Colorodo 80401
Telephone Number:	(303) 277-3831

Person(s) Contacted/Title(s)

Jere Zimmerman, Environmental Control Manager

CONTACT SUMMARY: Ms. Zimmerman was contacted to discuss the possibility of using the Adolph Coors Company (Coors) emission test data (currently held in confidential business information [CBI] files) for developing emission factors for inclusion in AP-42. Prior to the discussion of any specific CBI, Ms. Zimmerman was informed that our telephone lines are not secured. The data and information in question include emissions data from 11 test reports supplied by Coors to MRI and one summary document that provides process descriptions, process rates, and emission factor calculations for the emission tests documented in the test reports. Ms. Zimmerman stated that there was very little information in the actual test reports that Coors would consider to be CBI, and she will provide a list of any CBI pages contained in the reports. We then discussed the summary document, which contains several items that Coors considers to be CBI. These items, however, are details that MRI does not need to use to accurately characterize emissions from the processes tested and to develop emission factors. Table 1 presents the pages of the document that were discussed, indicates the pages that contain cleared information and the pages that contain CBI, and the steps that will be taken by MRI and Coors to eliminate the need to treat the material as CBI.

Another topic that was discussed was the basis for the filling operation emission factors. Ms. Zimmerman stated that Coors has data that suggest that the amount of beer spilled does not affect the magnitude of ethanol emission from filling operations. However, the data may suggest that the surface area of the beer spilled (not the depth) is the determining factor in the magnitude of these emissions. These data will be supplied to MRI for use in the background information for the revised AP-42 section.

TABLE 1. STATUS OF INFORMATION IN COORS SUMMARY DOCUMENT

Page (ID by process)	Status	Action
Brewhouse	Cleared	None
Two brewhouse calc. sheets and article	Cleared	None
Wort processing	CBI	MRI to remove the length of the batch cycle
Wort processing calculations	Cleared	None
Fermentation	Cleared	None
Fermentation calc. sheet	CBI	Coors will provide a new calc. page that does not contain CBI.
Aging	Cleared	None
Aging calc. sheet	CBI	Coors will provide a new calc. page that does not contain CBI.
Graph of aging data	Cleared	None
Blending/finishing	CBI	MRI to remove the last 2 sentences of the 4th paragraph as well as note (5) of the table titled "Brewing Table" on the 5th page of the document
Blending/finishing calc. sheet	CBI	Coors will provide a new calc. page that does not contain CBI.
Packaging--fillers	Cleared	None
Packaging--Tables 2,3,4,5,6	Cleared	None
Packaging--defill	Cleared	Coors will provide a new defilling section because an error was made in the process description and the calculations (only 3 tanks were operating rather than the 6 reported).
Bottle wash	Cleared	These data are based on a mass balance. However, Coors has performed some subsequent tests including a stack test on the bottle wash process. Coors will provide these data.
Byproducts	Cleared	None
Spent grain calc. sheets	CBI	MRI will remove the 5th note on page 1 of 8
Yeast	Cleared	None
Waste beer	Cleared	None

Coors Brewing Company

CLEAN AIR ACT IMPACTS ON THE BREWING INDUSTRY

By: *Warren Heidt*
Coors, Shenandoah

Jere Zimmerman
Coors, Golden

Fred Varani
Coors, Golden

CLEAN AIR ACT IMPACTS ON THE BREWING INDUSTRY

Regulation of air quality related activities is not a new issue. Attempts to regulate air pollutants in 1955, 1963, and 1967 focused some attention on the subject, but resulted in little if any actual progress.

In 1970, several significant steps were taken to initiate a serious attempt at improving environmental quality in general. The National Environmental Policy Act was passed in January, the Federal Environmental Plan was drafted in February, the Environmental Protection Agency began operations in December, and the Federal Clean Air Act was passed in the same month.

The 1970 Clean Air Act, unlike previous attempts to regulate air emissions, is the first law that included standards and regulatory authority with substance and enforceable provisions. Despite this fact, major goals of the act were not met primarily due to the lack of technology available to accurately measure and monitor air pollutants.

After 20 years of progress in defining the major air pollution problems and developing the technology to measure air pollutants and analyze the environmental and health related impacts, the Clean Air Act was due for a major over-haul.

The 1990 Clean Air Act Amendments are structured around seven "TITLES" or Pollution Problem Areas:

TITLE I: **ATTAINMENT AND MAINTENANCE OF NATIONAL AMBIENT AIR QUALITY STANDARDS**
The National Ambient Air Quality Standards or "NAAQS" are federally defined air quality parameters. In numerous urban areas, the standards for Ozone, Carbon Monoxide and particulate matter are currently not being met. These areas are defined as "Non-Attainment" zones. The amendments provide a program and time schedule for compliance with the standards.

TITLE II: **MOBIL SOURCES**
This aspect of the act focuses primarily on the emission from vehicles.

TITLE III: **AIR TOXICS**
Air toxics are those pollutants which have been determined to be hazardous to human health or the environment. The new act lists 189 compounds targeted for emission reduction.

TITLE IV: ACID DEPOSITION CONTROL

This section of the act addresses the issue of Acid Rain which is primarily due to Sulfur Dioxide and Nitrogen Oxide emissions resulting from the combustion of fossil fuels.

TITLE V: PERMITS

One of the most dramatic changes in the Clean Air Act is the creation and implementation of a comprehensive operating permit program mandated at the state level. States that fail to adopt a permit program will operate under federal guidelines.

TITLE VI: STRATOSPHERIC OZONE PROTECTION PROGRAM

Chloroflourocarbons or CFC's and Halons which react photochemically to breakdown ozone in the upper atmosphere are targeted for major reductions or elimination.

TITLE VII: ENFORCEMENT

The enforcement provisions built into the new act are intended to provide substantial incentive for encouraging compliance. Not only has the authority of the regulatory agencies been expanded and strengthened, but the focus moves towards criminal rather than civil action. According to the EPA's 1991 Enforcement Accomplishment Report, during the first year that the new Clean Air Act amendments were in effect, one third of all criminal fines in EPA's history were assessed.

While the new Clean Air Act Amendments are expected to affect nearly every industry, as the provisions unfold, the Brewing industry is finding itself in a unique situation with regard to the discovery of previously unknown emission sources. All of the provisions of the new Clean Air Act could have an impact on your specific brewing operation, however the scope of this paper is to illustrate why TITLE I as it relates to ozone (smog) in the lower atmosphere and TITLE V covering the permit programs to be adopted by all states should be of universal concern to the Brewing industry as a whole.

Ozone is classified as a severe irritant and can impact human health and the environment. While ozone is desirable and necessary in the upper stratosphere to filter out harmful solar rays, the presence of elevated concentrations in the lower atmosphere can cause respiratory problems and tissue damage to plant life.

While ozone itself is normally not emitted from point sources, other pollutants such as Oxides of Nitrogen and volatile organic compounds are known to be precursors to the formation of ground level ozone or "smog". Any organic compound that participates in atmospheric photochemical reaction is considered to be a volatile organic compound of VOC.

Although most VOC emissions into the air have been regulated by state and federal laws prior to the 1990 amendments, members of the Brewing industry had not extensively investigated the potential of VOC emissions from Brewery sources previously, because reports from a number of state and federal agencies, including the Environmental Protection Agency, stated that Breweries are a negligible source or VOC s.

In 1991, the Coors Brewing Company began a comprehensive inventory of air emissions sources throughout the Golden, Colorado facility as part of an ongoing effort to assure compliance with environmental laws and regulations. As a result of this inventory, it was discovered that the facility was emitting large amounts of VOCs in the form of Ethanol associated with beer production, packaging and disposal. The emissions inventory effort consumed 19 months and more than $1 million, and is considered to be the most exhaustive evaluation of emissions from a Brewery ever completed

The following text provides the details of this study, and is intended to provide guidance to the environmental professional within your organization, and the regulators who will assist us in obtaining the appropriate permits for our facilities.

INTRODUCTION

The following general areas of the Coors' Golden, Colorado brewery were identified as potential sources of Particulate Matter (PM), and Volatile Organic Compounds (VOCs).

1. Brewery
2. Packaging
3. By-Products Handling
4. Grain Handling

This paper presents a brief description and discussion of each listed "source", and a table of emission factors which summarize the findings of emissions at the brewery.

These emission factors were developed by stack testing or by mass balance of the sources performed between 1990 and 1992 at the Coors' Golden, Colorado facility.

BREWHOUSE

General Process Description

In the brewhouse VOC and PM are emitted, primarily from the brew kettles. The VOC consists of a complex mixture of at least 60 different compounds. No measurable ethanol is present in the liquid at this point in the process.

Emission Factor

A source test was performed on a representative brew kettle stack and combined cooker stack. Our emission factor for VOC from brewhouse operations is 0.94 lbs/1000 barrels beer produced (finished product volume). The emission factor for PM from brewhouse operations is 0.52 lb/1000 barrels (finished product volume). The VOC is reported as propane, due to the complex nature of the stream.

Applicability

All breweries have brewhouse operations as part of their brewing process. This factor should apply to virtually any brewery, except where the emissions from brew kettles or other brewhouse vessels are controlled.

WORT PROCESSING

General Process Description

Once boiled, the wort must be processed to remove the trub. Small amounts of VOC can be emitted as the wort holding tanks are filled. Emissions might also come from the cooling and aeration of the wort.

Emission Factor

At the facility studied, the trub is removed from the hot wort in a whirlpool vessel. A source test was performed on the whirlpool vent and the trub receiving tank. The emission factor for this process is 0.075 lb/1000 barrels beer produced (finished product volume).

The open plate wort coolers were also source tested. In this process hot wort flows over a stainless steel plate filled with cooling liquid. Air is pulled in, filtered and blown countercurrently over the wort. Once contacting the wort this air is released to atmosphere. The stack test was performed on one cooler with a capacity of 22 barrels per minute. The emission factor for open wort cooling is 0.022 lb/1000 barrels (finished product volume).

Applicability

If a brewery removes the trub from the hot wort, the factor for the wort holding vessel should apply. Many breweries cool their wort using closed plate heat exchangers, so the wort cooling factor would not apply to them. However, where the wort aeration step is done as an open process, the open wort cooling factor gives a good approximation of emissions from that process.

FERMENTING

General Process Description

After the wort is cooled, yeast is introduced into the liquid, and the mixture is fermented, producing ethanol and carbon dioxide as products of fermentation. The CO_2 which is evolved contains ethanol, a VOC. Most large breweries collect the CO_2 to be reused later in their process. However, emissions can come from the initial venting period, or from purging of CO_2 from the fermenters after they are emptied.

Emission Factor

At the facility studied, the fermenter gases are vented to atmosphere for the first 24 hours of the fermentation cycle. After 24 hours the CO_2 is collected. A source test was performed on the venting of CO_2 for the first 24 hours. The emission factor for CO_2 venting, based on a 24 hour venting period, is 2.0 lb/1000 barrels (finished product volume). It should be noted that the measured emission rate is considerably higher than would be predicted from thermodynamic calculations.

Applicability

Depending on how the brewery operates their fermentation process this factor may or may not apply. Typically gases are vented to atmosphere during the beginning of the fermentation cycle to purge the headspace gases from the fermenter until the CO_2 is pure enough to collect. When this is the case the emission factor should apply. No emissions occur during the CO_2 collection period. However, the CO_2 purification system should be examined to determine whether it is a source of emissions.

AGING

General Process Description

Aging is the continuation of fermentation, also known as secondary fermentation. This process occurs under CO_2 pressure. Emissions of VOC from this process would occur during tank filling or after the tank is empty, if the tank is opened to atmospheric pressure for any reason. Conditions under which the pressure would require venting, and the CO_2 purged, would be any time the tank must be opened, any time manual tank entry is required, or any time the tank is to be automatically cleaned with a caustic solution.

Emission Factor

At the facility studied, emissions from the aging emissions occur as the tank is filled, and after the tank is emptied. During filling the displacement gas vented to atmosphere is air, CO_2, and ethanol. This process is called fill-on-vent. A source test was performed during the fill-on-vent process. The emission factor for this process is 0.09 lb/1000 barrels (finished product volume). This applies if the displacement gases are vented to atmosphere for every batch.

The actual aging process is conducted under CO_2 pressure. Once the tank is emptied of beer, the CO_2 pressure must be vented and the remaining CO_2 in the tank purged. A source test was conducted on the venting of CO_2 pressure from the aging tank.

After the pressure is vented, the CO_2 must sometimes be purged. Valves are opened to allow fresh air in and the tank is hooked up to the building's tank evacuation system, which pulls the tank gases, CO_2 and ethanol, outside through a fan, allowing fresh air to enter. A source test was conducted on a set of three tanks undergoing CO_2 evacuation. The emission factor for venting of CO_2 pressure from an aging tank is 0.43 lb/1000 barrels and for purging of CO_2 from an aging tank is 3.1 lb/1000 barrels, both based on finished product volume.

Applicability

An aging or cold stabilization process is universal to most breweries, these emission factors apply only to those which vent displacement gas to atmosphere, and those that open the aging tank to atmospheric pressure and/or purge the CO_2 from the tank after the aging cycle. The emission factor given assumes that the tank is opened and purged after each cycle. If this is not the case, the factor could be divided by the frequency of purging. For example a brewery might automatically remove the yeast and clean with water only for two cycles and caustic clean on the third cycle. In this case the emission factor could be applied by dividing it by three.

BLENDING/FINISHING

General Process Description

Blending/Finishing is the process in which aged beer is filtered and blended into the final product. The beer is then stored in tanks prior to being packaged. There are two processes that occur during finishing/blending that cause the emission of ethanol (VOC) to the atmosphere. First is fill-on-vent (FOV) which occurs each time a clean empty tank is filled with beer. As

Coors

Brewing

Heat Reclaim off reported as propane

Operation	Emission Factor
Brewhouse - VOC	0.94 lb/1000 barrels (7)
Brewhouse - PM	0.52 lb/1000 barrels
Extract-Grain Separation (CARB report)	0.63 lb/1000 barrels
Wort Processing - Trub Settling Tank	0.075 lb/1000 barrels
Wort Processing - Open Wort Cooling/Aeration (1)	0.022 lb/1000 barrels
Fermenting - venting of CO2 (2)	2.0 lb/1000 barrels
Aging - fill on vent	0.09 lb/1000 barrels
Aging - venting of CO2 pressure (3)	0.43 lb/1000 barrels
Aging - tank purging of CO2 (4)	3.1 lb/1000 barrels
Blending/Finishing - fill on vent (5)	0.29 lb/1000 barrels
Blending/Finishing - tank evacuation (6)	1.0 lb/1000 barrels

What about third

(1) Based on emission data from open wort cooler.
(2) Based on venting of CO2 for the first 24 hours of fermentation cycle.
(3) Factor applies to facility which opens aging vessel to atmosphere for any reason after each batch.
(4) Factor applies to facility which purges CO2 from aging vessels after each batch.
(5) Based on an average of 3 tanks for blending/finishing operations, and caustic cleaning after every third use.
(6) Factor will vary slightly depending on atmospheric conditions to which tank is evacuated.
(7) In all cases "1000 barrels" refers to finished product volume i.e. total volume of beer produced at the facility.

the tank is filled, a CO_2 blanket is provided so that the beer does not come in contact with oxygen. The air (CO_2, O_2, and ethanol) above the blanket is displaced as the tank is filled and vented to atmosphere. The second process, known as evacuation, occurs after a tank has been emptied to allow tank cleaning by production personnel. The evacuation process draws outside air through the tank to atmosphere to increase the oxygen content within the tank.

Emission Factor

On average, the blending/finishing process takes aged beer through three steps, each in a different tank. At the tested facility the tanks can be cleaned with the CO_2 in place two times. The CO_2 must be evacuated for a caustic cleaning after the third use. The emission factor for blending/finishing was derived using stack test data from aging. The emission factors are 0.29 lb/1000 bbl finished product volume for fill on vent, and 1.0 lb/1000 bbl finished product volume for tank evacuation.

Applicability

All breweries have the finishing/blending process. The application of these emission factors will depend on the average number of steps (tanks) the beer is processed through prior to packaging. It is important to note that the frequency of venting and evacuation depends on several factors such as throughput and cleaning schedule.

FILLERS

General Process Description

After Blending/Finishing, the beer is packaged in cans, bottles, or kegs. The filling process is a high speed process similar for all container types. To keep the beer from foaming as it is introduced into the container and to prevent contact with oxygen, the container is first filled with CO_2. As the container fills with cold beer the CO_2 is displaced . Typically some mechanism is used to foam the beer and purge any oxygen from the headspace before the container is closed.

The filling process generates VOC emissions. The emissions are primarily ethanol from the beer. The process is a combination point and fugitive source. The point source emission rate is much smaller than the fugitive emission rate. The point source portion of the process is the filling machine. The CO_2 which is displaced as the container is filled is returned to the filling machine and vented. The CO_2 carries ethanol as a result of its contact with the beer. This constitutes the point source. Fugitive emissions from the process result primarily from spilled beer. Evaporation of ethanol from wetted surfaces appears to be the primary mechanism for producing fugitive emissions. This mechanism is enhanced if beer contacts warm or hot process equipment.

Emission Factor

At the facility studied the filling systems for bottles and cans are located in enclosed rooms. Filtered air is forced into each filler room to provide ventilation for the filler machine operators. Approximately half of this ventilation air exits the filler rooms through the filler room vents. The other half of the filler room ventilation air exits the filler rooms as fugitive into the building through various openings in the filler room.

Multiple source tests were conducted to determine emission rates from the filler machine bowls, the keg fillers, and the can and bottle filler rooms. Beer filling rate data was collected during the source tests and have been used to develop emission factors. The tested emission rates from the filler rooms was multiplied by the ratio of the inlet air over the collected outlet air, to account for fugitive emissions from the filler rooms. The emission rate was then divided by the fill rate during that test run. Then the emission rate for the filler machine vent on a pounds per barrel basis was added to determine the overall emission factor. The average emission factors from all the tests are: 38 lbs/1000 barrels filled for can filling, 37 lbs/1000 barrels filled for bottle filling, and 0.69 lbs/1000 barrels filled for keg filling.

Applicability

VOC emissions would be expected from the filling machines due to the displacement of the gas in the container by the beer, and evaporative emissions from spilled beer. Since not all breweries have enclosed filling machines, the evaporative emissions may be fugitive. Several factors affect the rate of VOC emissions and will vary based on the filling operation used. In addition to the rate of filling, three of the most important factors are the HVAC air flowrate, the quantity of beer spilled, and the temperature of the beer after spilling. It is expected that the greater the quantity of spilled beer the greater the emission rate, as more ethanol would be available for vaporization and for stripping. A greater air flowrate would also be expected to increase the emission rate, as the larger airflow would strip more ethanol from the available spilled beer. Finally, if the temperature of the spilled beer is increased by exposure to heat sources, such as hot gearboxes, higher emissions would be expected.

These emission factors were derived specifically from a sterile fill operation, and would apply most directly to other sterile fill operations. Non-sterile fill processes at breweries which utilize pasteurization as an alternative to sterile filling may have different emissions rates from filling.

PACKAGING - DEFILL

General Process Description

The defill operation is utilized to remove beer from containers (cans and bottles) for a variety of reasons, including rejects from beer filling operations. A defiller is typically comprised of a conveyor system which leads the containers to a grinder. Full cans and bottles are then crushed by the system's grinder to evacuate the contained beer. From this point the waste beer is pumped into a holding tank and the container material, which may still contain residual beer, is sent to recycling or to landfill for disposal.

Emission Factor

At the tested facility the can defiller was configured with open system crusher and pneumatic conveyor which transported the crushed cans to a cyclone for collection. A protocol stack test was performed on the can defill operation just prior to the cyclone. Ethanol emission rates remained fairly steady independent of throughput in barrels per hour. The calculated emission factor from defilling is 6.6 lbs/hour operation.

Applicability

The purpose of this operation is to recover the alcohol taxes paid on the product. Typically, defilling is a fugitive VOC source. Emissions arise from evaporation of alcohol from wetted surfaces, or from beer droplets which become airborne. Additional sources of VOCs from defilling might include breathing and working losses from the waste beer storage tank. The emission factor will vary depending on the method of defilling and the conditions in the defill operation.

PACKAGING - BOTTLE WASHER

General Process Description

Bottle wash systems are used to clean returned long neck bottles prior to refilling with beer. The "as received" bottles are removed from their cases and loaded onto a conveyor system. As the bottles move through the system, they are tilted to allow residual liquid to pour out. The bottles are then given an interior and exterior warm-water prerinse. Residual liquid and rinse water are collected and filtered before disposal.

The bottle wash system is a source of VOC (ethanol), glycolethers and sodium hydroxide. Bottle wash systems also have several fugitive emission locations. For ethanol, the first is the trough where the residual liquid and prerinse spray are collected and the second is at the filtering system. For glycolethers, the soaker (bottle label removal system) is the fugitive emission source due to the use of surfactants.

Emission Factor

A mass balance approach was utilized to calculate the bottle washer VOC emission factor. The calculation is based on bottle case input to the system. The emission factor for bottle washers is 3.0 lb/1000 cases input. A mass balance approach can also be used to determine glycolether

15

Coors

Packaging

Operation	Emission Factor
Can Filling (1)	38 lb/1000 barrels filled
Bottle Filling (1)	37 lb/1000 barrels filled
Keg Filling	0.69 lb/1000 barrels filled
Defill (2)	6.6 lb/hour operation
Bottlewash - VOC (3)	3.0 lb/1000 cases

(1) Includes point and fugitive emissions, derived from sterile fill process.
(2) Defill system utilized a pneumatic crushed can transport system.
(3) Based on cases input into the system (case = 24 - 12 oz. cans).

emissions. They are a component of the surfactant used in the label removal process in the bottle soaker. Due to the low vapor pressure of the glycolethers and the high temperature within the soaker, it was assumed that they completely volatilized out of solution. Glycolether emission will greatly depend on the surfactant type. Consultation of the surfactant's MSDS for percent volatiles will provide the information required to perform the mass balance.

An emission factor for sodium hydroxide is available through the EPA's AIR CHIEF CD-ROM, Version 2.0, Record number 21,858, May 1992. The factor is 9.0 lb/hour of operation.

<u>Applicability</u>

The emission factor for bottle washing should be applicable to any facility which utilizes a beer bottle return system. This would include most breweries. The factor is based on fugitive VOC emissions from the initial high temperature pre-rinse prior to entering the bottle washer.

PACKAGING - MISCELLANEOUS SOURCES

Other common packaging sources which have potential fugitive VOC emissions include:

Bottle line conveyor lubricants/cleaners;
Inkjet printers; and
Box and label gluing operations.
Use of volatile solvents to clean air driven can conveyors.

Bottle line conveyor lubricants are typically a soap solution which is sprayed onto the conveyor system to allow the bottles to move along. These detergents often contain alcohols or other volatile compounds. The use of the lubricant reduces bottle breakage. Inkjet printers are used to code and date bottles, cans, and cases after filling.

Emissions from these processes depend on the chemicals utilized (e.g., solvent, glue, ink, etc. VOC content), therefore, an emission factor could not be developed. However, by tracking the chemical's consumption rate and percent volatility (check chemical MSDS) an emission rate can be calculated.

WASTE YEAST HANDLING AND STORAGE

<u>General Process Description</u>

At the completion of the fermentation process, beer is decanted from the fermenting vessel and a beer/yeast slurry remains in the bottom. Once removed, this slurry must either be returned to the production process or handled as a waste or byproduct. This is also true of the aging process except that aging yeast is not suitable for return to the production process and must be handled as a waste product. Yeast handling and storage is a potential source of VOC emissions because both the beer in the beer/yeast slurry and the yeast cell itself contain ethanol.

Emission Factor

At the facility studied , waste yeast from fermenting goes through one of two high pressure chamber filter presses to recover the beer. The yeast is then heat lysed. Heat lysing of yeast releases large amounts of ethanol because the yeast cell is broken, thereby releasing the ethanol in the cell. The heat tends to vaporize the ethanol and drive off any entrained CO_2 from both the beer and the yeast. The CO_2 which is given off also tends to carry ethanol with it.

Source testing was conducted on the yeast lysing process. During the process, ethanol is released from the yeast receiving hopper, and the yeast holding tank. A factor of 4.8 lbs/1000 barrels beer produced (finished product volume) was calculated from that source test.

Because the source test did not take into account the capture efficiency of the roof fan, an emission rate was estimated using a mass balance approach and production data . This method of estimation produces an emission factor of 7.12 lbs/1000 barrels beer produced (finished product volume). A recent pseudo stack test has confirmed this emission factor.

The storage of the yeast also generates emissions. In the storage tanks, air is constantly sparged through the tanks. A source test was conducted on the yeast storage tank vents. An emission factor of 7.7 lbs/1000 barrels for VOC emissions from the yeast storage tanks has been calculated. The majority of this comes from storage of lysed yeast, however, aging yeast and waste live yeast also contribute to the emissions from the storage facility.

Applicability

All breweries produce waste yeast in a slurry of beer, which must be handled in some way. Handling , storing, and processing waste yeast can result in significant ethanol emissions. The method of waste yeast handling is expected to vary from brewery to brewery. These emission factors would best apply to heat or chemical yeast lysing processes, and to storage of waste yeast, especially at ambient or higher temperatures.

WASTE BEER HANDLING AND STORAGE

General Process Description

A brewery generates waste beer from various processes and operations. Off-specification beer, spillage, defilling, and liquids recovered from byproduct and waste streams contribute to the waste beer volume. Waste beer is usually collected in a separate collection system apart from the normal sewage system, due to its high TOC (total organic carbon) content. Waste beer

Coors

Byproducts

Operation	Emission Factor
Yeast Lysing - VOC (1)	4.8 lb/1000 barrels (4)
Yeast Storage - VOC	7.7 lb/1000 barrels
Waste Beer - VOC	1.1 lb/1000 barrels
Spent Grain Drying - VOC (2)	2.6 lb/1000 barrels
Spent Grain Drying - PM (2)(3)	0.94 lb/1000 barrels
Spent Grain Drying - PM10 (2)(3)	0.29 lb/1000 barrels
Spent Grain Drying - CO (2)	0.91 lb/1000 barrels

(1) Based on heat lysing operation.
(2) Based on steam heated dryers.
(3) Controlled emission rates. Control device is a wet scrubber.
(4) In all cases "1000 barrels" refers to finished product volume i.e. the total volume of beer produced at the facility.

storage, processing, and disposal produce VOC emissions in the form of ethanol.

Emission Factor

The facility studied collects waste liquids and waste beer in storage tanks. A waste beer condensing system is used to recover alcohol from waste beer and concentrate the waste liquid. Condensate from this system is stored in tanks. Breathing and working losses from all these tanks result in ethanol emissions. There is also a truck loadout system for loading of liquids into trucks for transport.

Stack tests were conducted on the waste beer storage tanks and the alcohol condensate storage tanks. Emissions from each type of vent were monitored for 12-24 hours. The emission rate for the truck loadout system was estimated using the calculation method found in AP-42, Section 4.3 "Storage of Organic Liquids". The calculated emission factor for waste beer handling is 1.1 lbs/1000 barrels beer produced (finished product volume).

Applicability

All breweries produce waste beer and other ethanol containing liquid waste streams. Although emissions will vary from brewery to brewery, it is important to note that high emissions of VOCs can result from byproducts operations, especially where heat processing is used and where storage occurs at ambient temperatures. Several factors will determine the emission rate for a particular brewery. These include: the amount of waste beer generated per barrel of beer produced, the manner in which waste products are processed prior to disposal or sale as byproducts, the degree to which waste products are handled on site, and the collection, storage, processing, and disposal methods used for waste liquids.

SPENT GRAIN DRYING SYSTEM

General Process Description

Drying of spent grains and hops produces VOCs, particulate matter, and carbon monoxide emissions. The composition of VOCs emitted during the drying process is similar to the composition of the VOCs emitted from the brew kettles. Ethanol is not emitted from the dryers, as the spent grain is removed from the brewing process prior to fermentation.

Emission Factor

At the facility studied, the spent grains are dried in nine, counterflow rotary steam-heated dryers equipped with wet scrubbers. Three separate source testing exercises have been conducted on the drying system. A separate source test was conducted as part of a program designed to determine if the degree to which the grain is dried affects VOC emissions. Results from the test program indicate that the VOC emissions cannot be controlled by controlling the moisture content or temperature in the discharged grain.

This emission factor is an average of all available test data. The emission factors are as follows: 2.6 lbs per 1000 barrels VOC (as propane), 0.94 lbs per 1000 barrels PM (controlled using wet scrubbers), 0.29 lbs per 1000 barrels PM10 (controlled using wet scrubbers), and 0.91 lbs per 1000 barrels CO. These emission factors are on a finished product volume basis.

Applicability

All breweries generate spent grain as a waste stream. Most breweries do not dry the spent grain on site. It is more typically transported wet and used as cattle feed. In some cases, especially at large facilities, more wet spent grain is generated than can be consumed by the local market. In those cases grains may be dried on-site. These factors apply to steam heated dryers. Gas fired dryers would also have emissions from combustion.

GRAIN HANDLING

All breweries produce beer from malt other cereals, and water. The handling of some of these raw materials produces emissions of particulate matter (PM). At the facility studied, emission factors were used to estimate these emissions. The factors most useful for this effort are shown on the following table.

WASTE TREATMENT

General Process Description

At the facility studied, liquid wastes containing ethanol are sent to the dedicated process waste treatment facility. The liquid wastes are treated in a variety of common waste treatment steps. Some of the processes common to most treatment facilities have the potential to be sources of VOC emissions.

Emission Factor

At the facility studied, the liquid wastes and the treatment plant itself were modeled with several computer models. These models have been developed by the U.S. EPA and independent waste treatment consultants to estimate emissions of various chemical compounds from wastewater treatment processes.

The BASTE model (Bay Area Sewage Toxics Emissions) model developed by the firm of CH2M -Hill, was configured to represent the processes in use at the Coors' Golden, Colorado Process Waste Treatment Plant (PWTP). This model was operated with influent conditions simulating

20

12

Coors Grain Handling

Operation	Emission Factor
Receiving, cleaning, storage and transfer of barley or malt PM emissions	AP-42 Section 6.4, Grain Elevators, Table 6.4-1, Inland Terminal Elevator
Receiving, cleaning, storage and transfer of barley or malt PM10 emissions	AP-42 Appendix C, Tables C.2-2 and C.2-3
Malting of barley, Kilning Process	AIRS, p. 84, malt dryer
Starch receiving, transfer	AP-42 Section 6.11-1, starch manufacturing
Rice receiving, transfer	AP-42 Section 6.4 Table 6.4-6, rice precleaning and handling
Raw materials milling	AIRS, p. 81, barley milling

By FAX to 919-541-0684

THE GENESEE BREWING COMPANY, INC.
P.O. BOX 762, ROCHESTER, NEW YORK 14603 PHONE (716) 546-1030

February 7, 1995

Mr. Dallas W. Safriet
Emission Factor Inventory Group (MD-14)
OAQPS
Resarch Triangle Park, NC 27711

RE: Draft AP-42 for Brewery Emissions
Supplementary Comments of Genesee Brewing Company

Dear Mr. Safriet:

This letter supplements comments mailed you on January 27, 1995 by Genesee Brewing Company's Plant Engineer, Mark Minnuni. Our earlier comments, like those of the Beer Institute, are incorporated to the extent this letter does not conflict with them.

We respect the Group's AP-42 work, which has long been conducted under difficult resource constraints. But we also recognize the unintended uses to which AP-42 can be put and the way it acquires a life of its own. As Group members recently acknowledged, "Uses of emission factors that would not have been conceivable a few years ago are now commonplace." Moreover, the accuracy and precision of those factors tend to vary widely by type of use, with site-specific (as opposed to aggregate inventory) uses often showing the most bias and deviation. E.g., Southerland et al., *"Developing Improved Emission Factors and Assessment of Uncertainties* (or, *Filling the Holes in Swiss Cheese)"* (TTN, 1994) (n.d.)

These supplementary comments are offered to help the Group limit potentially adverse effects of such variability, which in the long run benefit neither states, affected sources nor the AP-42 process.

We are mainly concerned with two such effects. Those effects flow largely from the limited nature of EPA's database and the current draft's failure to differentiate very large from other breweries. They are:

1. <u>Possible over-estimation of brewery emissions</u> (especially VOC emissions), due to the fact that EPA has used data only from the country' s most gigantic brewery (Coors-Golden, 22 mm bbl/yr. design capacity) plus two other large major breweries (Busch-Columbus, 6.8 mm bbl./yr.; Miller-Fulton, 8 mm bbl/yr.) . The draft factors do not distinguish these operations from mid-size breweries or micro-

breweries, despite the numerous differences in production-line configuration and emitting processes identified in our earlier letter.

2. Possible widespread testing requirements as a result of this lack of differentiation, which could shift to individual sources the burden of rebutting emission factors derived from the database above. That shift would undermine one of the major purposes of AP-42, i.e., to reduce the need for costly individual source testing. Instead, it would tend to expand the need for testing.

In addition, we are generally concerned with the inventory and other distortions, SIP implementation difficulties, and anti-competitive effects which may result from effectively requiring states and Regions to apply the so-called "Coors Factors" (or even adjusted Coors factors) to microbreweries and mid-size breweries.

Out earlier comments should be considered in light of this general framework. We expand several of those comments below. We also suggest ways EPA should address these concerns.

- Sterile Filling. Where filling is not sterile, EPA should either: (a) provide an emission-factor reduction ratio based on engineering estimates and/or an equation derived from the proportional difference between the sterile Coors the non-sterile data from Busch or Miller; or (b) use some form of the Busch data (perhaps an average of the three different test method results) as the recommended factor. Like many of our other suggestions, this could be done in a clarifying footnote to the draft tables.

- Filler Emissions Due to Product Loss. We suggest that any fill factors adopted be adjusted by a ratio based either on percent product loss at the specific facility divided by percent product loss at Coors, or percent product loss at the facility divided by average percent product loss at Coors and the pertinent Busch/Miller facilities.

- Fugitive Emissions. We are mainly concerned with filling-operation VOC emissions because that draft factor so dominates the draft's overall estimated VOC emissions from beer production. However, this comment also applies to emissions of regulated pollutants from several different parts of our brewing operations, all of which we believe meet the regulatory definition of "fugitives." As you know, developing emission factors for fugitives has long been one of the Agency's most difficult and controversial tasks, dating back to the rural and fugitive dust battles of the Seventies.

  More important, under long-standing EPA rules fugitive brewery emissions do not count for threshold determinations of whether a facility is an "existing major source" or "existing major emitting facility," since breweries are not one of the 27 listed source categories whose fugitive emissions must be included in such determinations. See, e.g., CAAA § 302 (j); 40 CFR §§ 52.21(b) (1) (iii), 52.21 (i) (4) (vii) ; 54 Fed. Reg. 48870, 48880-84 (Nov. 28, 1989). That fact is crucial not only for determining whether New Source Review applies to new facilities or new major modifications, but for determining RACT applicability under Title I. See, e.g., CAAA §§ 182 (b) (2) (C) , 184(b)(2).

Put differently, EPA and many states implementing delegated or approved SIP programs are legally barred from using any fugitive emission factors (or indeed, actual fugitives measurements) to impose categorical or site-specific control, permit or similar requirements on breweries which are not otherwise "major" under Title I. Similar results appear to hold for Titles III and V, since (among other reasons) ethanol is not a listed HAP. Cf., e.g. 40 CFR § 70.2 (definitions of covered "major source"); Guidance, "Consideration of Fugitive Emissions in Major Source Determinations," Wegman to Regions (March 8, 1994) . To avoid confusion, in light of the thin database, and in view of the notorious past history of control-related attempts to use fugitive emission factors, the tables should plainly indicate that any factors which apply to emitting processes whose emissions usually are or are determined to be fugitives are meant to be used "solely" for inventory or other aggregate purposes.

- Presumptive Size Differentiation. We are aware of the difficulties with the current database. But as courts have repeatedly noted, EPA must "take account of circumstances that appear to warrant different treatment for different parties," and cannot ignore reasonable concerns by adopting "blanket, highly conservative assumptions." Moreover, "While the (Agency) may 'err' on the side of overprotection, it may not engage in sheer guesswork." Leather Industries of America v. EPA, 40 F.3d 392 (D.C. Cir., 1994); see, e.g., CMA v. EPA, 28 F.3d 1259 (D.C. Cir., 1994).

The Group does not have to "engage in sheer guesswork" by assuming its choices are either to develop a single set of factors without regard to source size, or forego any brewery factors. Instead, it could adopt various "middle grounds" better calculated to minimize adverse effects but still advance program development. We leave aside microbreweries (e.g., under 60,000 bbl/yr.), since there is some evidence their unit emissions are anomalously high due to different process configurations. Moreover, their ambient contributions are relatively minuscule.

But with respect to mid-size breweries like Genesee (e.g.,, under 5 mm bbl design capacity and/or 3.5 mm bbl historical actuals), the Group could responsibly recommend use of interim factors until better data become available. Indeed, that is the normal course of AP-42 development.

Taking the draft filling factors as an example, we are convinced these emissions are fugitives at our brewery and are likely fugitives at numerous other brewing installations. However, we also recognize that in light of AP-42's multiple uses the Group has some obligation to disseminate reasonably-derived emission factors despite that fact, even though some of those uses may inhibit the SIP development process which AP-42 was meant to promote.

To balance these concerns, and for the reasons stated above, we urge that the lowest available substantiated emissions data (e.g., an average Busch FTIR-based factor of about 13.1) be selected on this interim basis for mid-size breweries. Alternatively, the Group could "discount" or "ratio down" the revised factors by some significant percent based on generic process differences or engineering estimates. *There is ample precedent for use of such discounts to compensate for uncertainty* under such other Clean Air programs as offsets, the 1986 Emissions Trading Policy, and the recent Economic Incentive Program (EIP) Rules.

This "interim" approach would give states, Regions and sources a more reasonable factor to use for our category of sources than either current AP-42 or the draft Coors numbers, while minimizing the kinds of adverse effects indicated above. It could then be adjusted in either direction when the Agency obtains more representative brewery emissions data as a result of Title V operating permit applications, "best established monitoring" reports, or similar means.

Thank you for your consideration of these supplementary comments. Please do not hesitate to call me or Mr. Minnuni if you have any questions after reviewing them. Another copy of our earlier comments is enclosed for your convenience.

Very truly yours,

Mark W. Leunig
Vice President and General Counsel

MWL:mll

GENESEE BEER & ALE

THE GENESEE BREWING COMPANY, INC.

RECEIVED

JAN 30 1995

M.W.L.

January 27, 1995

Mr. Dallas Safriet
Emission Factor and Inventory Branch (MD-14)
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
Research Triangle Park, N.C. 27711

Dear Mr. Safriet,

Having reviewed the Draft Report concerning "Emission Factor Documentation for AP-42" dated November 1994, we would like to offer the following comments.

1. I have attended the working group session of the Beer Institute members and The Genesee Brewing Company endorses the comments sent to you in a separate letter.

2. Certain brewing and packaging processes differ throughout the industry. It is our belief that the differences will have a significant effect on some emission factors. The major differences are as follows:

   a) Several operations mentioned within the draft do not apply to our operation and should be labelled optional. These include Malting, Beer Sump, Waste Beer and ethanol recovery.

   b) With the exception of Coors, can, bottle, and keg filling operations are not done in a sterile environment. Due to the high air velocity associated with sterile filling, the filling factor may be considerably lower for a normal operation. Filling should be labelled sterile filling where the factors are developed from a sterile operation (such as Coors).

   c) Collection of CO_2 from the fermenting process begins after a certain venting period at all large breweries. The time the fermenter vents before collection begins varies considerably between breweries. The fermenter factor should relate to the venting period, since there are no emissions during the collection process.

Mr. Dallas Safriet
US Environmental Protection Agency

Page 2

3. Beer loss at the filler varies greatly between facilities. Since the emissions at the filler are a result of evaporation of beer, it is reasonable to expect that less loss would result in less evaporation of ethanol, and therefore a lower factor.

4. Production and packaging of Non-alcoholic or low alcohol beverages should not be included in emission calculations. These beverages either lack ethanol totally or contain ethanol in very small quantities. The potential for emissions from these beverages is very small.

5. Some emissions are released directly into the facility from the operation. These emissions do not pass directly through a stack or vent and may or may not be released to the outside atmosphere. These emissions would be very difficult to measure or collect. Due to the configuration of a normal bottling facility, it would not be reasonable to attempt to capture these emissions.

Yours truly,

Mark D. Minunni
Plant Engineer

cc:
G. Geminn
M. Leunig
R. Sieben
J. Morrison

BEER INSTITUTE

January 27, 1995

BY TELECOPIER;
Hard copy by First Class Mail

Mr. Dallas Safriet
MD-14
Environmental Protection Agency
OAQPS--Emission Inventory Branch
Research Triangle Park, NC 27711

Re. AP-42 Draft Section
on malt beverage industry
(§9.12.1)

Dear Mr. Safriet:

I appreciate your call, and thank you for your willingness to extend the comment period until February 15th for the draft AP-42 section covering malt beverages. The extension will enable brewers to refine their comments so that your final document reflects the most accurate and technically correct information available. The purpose of this letter is to confirm the extension and to provide you with further background on the involvement of the Beer Institute in this process.

The Beer Institute is a trade association for the malt beverage industry representing the five largest American brewers as well as more than eighty smaller brewers. The Institute has been asked to assist our member companies in developing an industry response to the EPA's request for comments on the draft AP-42 document. We would like to be included as a reviewer in the process. As General Counsel, I will be the contact person for Beer Institute. On January 13th, representatives of seven brewers met to conduct a thorough review of the EPA draft. The brewers represented were Anheuser-Busch, Miller Brewing Company, Coors Brewing Company, Stroh Brewery Company, G. Heileman Brewing Company, Genesee Brewing Company, and Pabst Brewing Company.

The Beer Institute looks forward to working with the Agency during the AP-42 process. The Institute plans to submit industry comments on this matter. In addition, some shorter, company-specific comments will be prepared and submitted by individual brewers.

Mr. Dallas Safriet continued...

Once the comments are submitted and reviewed by your office, we would like to set up a meeting for the brewer engineers and appropriate EPA personnel to discuss the comments in further detail.

Please contact me at 202-737-2337 if you have any questions. Thank you again for your consideration.

Sincerely,

Arthur J. DeCelle

Arthur J. DeCelle
General Counsel

/ad

BEER INSTITUTE

BY TELECOPIER;
Hard copy by
overnight courier

February 15, 1995

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500,00

Dallas W. Safriet
Environmental Engineer
U.S. Environmental Protection Agency
Emission Factor Inventory Group (MD-14)
Research Triangle Park, North Carolina 27711

Re: Draft Version of Section 9.12.1, Malt Beverages For Publication in AP-42, Compilation of Air Pollutant Emission Factors

Dear Mr. Safriet:

Enclosed please find a copy of comments developed by members of the Beer Institute (Anheuser Busch Companies, Miller Brewing Co., Coors Brewing Co., Stroh Brewery Company, G. Heileman Brewing Co., Pabst Brewing Co., and Genesee Brewing Co.) on the draft version of Section 9.12.1, Malt Beverages, which has been proposed for publication in AP-42, the EPA Compilation of Air Pollutant Emission Factors. The Beer Institute is a national trade association for the malt beverage industry.

These comments are submitted based on EPA's public guidance document Public Participation Procedures for EPA's Emissions Estimation Guidance Materials and are being submitted in a timely manner based on the Beer Institute's recent correspondence dated January 27, 1995.

EPA's proposed Section 9.12.1 (Malt Beverages) for inclusion in AP-42 is of vital interest to the malt brewing industry. Pursuant to section 130 of the Clean Air Act, the Beer Institute wishes to have the opportunity to participate in the development and evaluation of this section of the AP-42 manual and to act as a public reviewer in connection with any proposed changes to Section 9.12.1. After you have had an opportunity to review these comments, the Beer Institute wishes to meet with EPA officials to discuss its view on this emission factor initiative in further detail. We would appreciate being contacted in a timely manner to arrange this meeting.

1225 Eye Street, N.W., Suite 825 • Washington, D.C. 20005 • 202/737-2337 • Fax: 202/737-7004

Mr. Dallas W. Safriet continued...

Thank you for your attention to the Beer Institute's views on this matter. If you have any questions regarding these comments or any general questions regarding the malt beverage industry, please do not hesitate to contact the undersigned.

Sincerely,

Arthur J. DeCelle

Arthur J. DeCelle
General Counsel

DMS/AD:jlc
Encls.

Emission Factor Documentation for AP-42, Section 9.12.1, Malt Beverages
Comments on Draft November 1994 Report

February 15, 1995

The comments listed below are common to the majority of brewing segment. Comments on use of specific testing data and subsequent emission factor development presented in Section 4 will be addressed separately by individual brewers.

Page 2-1; 1st paragraph;	Delete phrase (used for industrial purposes). Ethanol is used for a variety of non-industrial purposes.
	Clarify that factors for three of the SCC operations are included in this report; Drying spent grains, Brewing and Aging. Grain Handling and Malt Drying should be covered in other sections of AP-42.
Page 2-1; last paragraph;	Delete reference to malting in the brewhouse operation. This is typically done at malting operations which are not located at the brewery site. If described, these operations should reference other sections of AP-42 that apply.
Page 2-2; 1st paragraph;	Change Some to Most breweries purchase grain that is already malted.
Page 2-3; Flow chart;	Change Malt Dryer to Malt Kiln.
Page 2-4; Flow chart;	Change Spent Grain to Brewers Grain. Change Wet Scrubber or Other Control Device to optional process.
Page 2-5; Flow chart;	Change Yeast Production to Yeast Propagation. Change Waste Yeast to Brewers Yeast. Change Brewers Yeast Removal to Brewers Yeast Recovery. Change Brewers Yeast Disposal or Recovery to Brewers Yeast Disposal or Re-use. Draw a product stream from Brewers Yeast Recovery to Yeast Propagation.
Page 2-6; Flow chart;	Change Beer Sump to optional process. Change waste beer recovery, waste beer storage tanks, and ethanol recovery to optional process. Change Discharge as industrial sewage to Discharge as process waste water.
Page 2-7; 3rd paragraph;	Delete and help to sterilize the wort.
Page 2-7; last paragraph;	In second sentence, change Some to Most, change off-gas to CO2.
Page 2-8; 1st paragraph;	Delete sentence starting with Common impurities...
Page 2-8; 2nd paragraph;	In last sentence, delete for a day or less.
Page 2-8; 3rd paragraph;	Delete for about 2 weeks.
Page 2-8; 4th paragraph;	Delete waste (spent). Change industrial sewage to process waste water.

PAGE 2--2/14/95

Page 2-8; 5th paragraph;	Change impurities to solids.
Page 2-9; 1st paragraph;	Change industrial sewage to process waste water.
Page 2-9; 2nd paragraph;	Define small breweries as equal to or less than 60,000 BBLs per year production. Delete sentence starting with Many microbrews are held...
Page 2-9; 3rd paragraph;	Change pollutant to Volatile Organic Compound. Delete Aldehydes, ethyl acetate from start of next sentence.
Page 2-9; last paragraph;	Delete grain malting operations. Change production to propagation. Consider re-writing paragraph to list all sources or major sources of emissions. Reference sources to flow charts. Delete references to ethyl acetates and various aldehydes.
Page 2-10; 1st paragraph;	Delete sentence starting with Other VOC that are emitted...
Page 2-10; 4th paragraph;	Factors from Anchor brewing seem to indicate that emissions from microbreweries are typically higher on a per BB1 basis. This is partially due to the lack of CO2 recovery. Delete only in smaller quantities.
Page 2-10; 5th paragraph;	Change first sentence to Process loss controls are effectively used to reduce emissions in the production of malt beverages. Add-on emission controls are widely used to recover CO2 in the fermentation process and control particulate emissions from grain handling and brewers grain drying. Change industrial sewage to process waste water.
Page 4-3; 5th paragraph;	Change units from lb of pollutant per 1,000 bbl of beer produced to lb of pollutant per 1,000 bbl of beer packaged. This change should be made throughout the document.
Page 4-4; Table 4-2;	Factors for <u>small breweries</u> are based on a 60,000 bbl/yr facility. Delete this table and reference due to limited date available. These data should <u>not</u> be combined with large brewery emissions to get an average factor.
Page 4-20; Table 4-4;	All TOC factors should be converted to as methane (pre-fermentation) or as ethanol (post-fermentation). The first five factors are from a microbrewer and should be deleted from the table. Can and bottle filling from references 11,15 and 16 should be re-named to sterilized can and bottle filling. Change wort cooler to open wort cooler. Change Beer storage tank-filling to Aging tank-filling. Clarify definition of term waste beer storage tank.
Page 4-21; Table 4-4;	Change spent grain dryer to brewers grain dryer. All references throughout the document referring to spent grain should be changed to brewers grain. All emission factors for brewers grain dryers should be expressed in lbs of pollutant per ton of grain dried.

Page 4-22; Table 4-4;	Change spent grain dryer to brewers grain dryer. All emission factors for brewers grain dryers should be expressed in lbs of pollutant per ton of grain dried. Change Crushed can pneumatic conveyor to Can crusher with pneumatic conveyor. All emission factors for Bottle soaker and Bottle crusher should be expressed in lbs of pollutant per 1000 cases processed.
Page 4-23; Table 4-4;	Change spent grain dryer to brewers grain dryer. All emission factors for brewers grain dryers should be expressed in lbs of pollutant per ton of grain dried.
Page 4-24 to 4-26; Table 4-5;	Incorporate comments as outlined for Table 4-4. Delete data from small brewers from table. An average emission factor based upon large and small breweries is not representative. If small brewery factors are to be included, they should be stated in a separate table.
Section 9.12.1	Incorporate comments as outlined in previous sections. For clarity, the emission points shown on the process flow diagrams should be linked to the two emission factor tables. As a general note, the large number of footnotes on Table 9.12.1-2 make it very difficult to follow and understand. These footnotes should be consolidated to the largest extent possible.
Section 9.12.1.1 New Paragraph 2	Each brewery is unique in many respects, and source to source variations can be significant. These result from differences in the brewing process, the type and age of equipment used, and total production. Each brewer uses unique recipes with time and temperature differences during various stages of production that directly affect emissions.

February 15, 1995

STROH
THE STROH BREWERY COMPANY
100 RIVER PLACE
DETROIT, MICHIGAN 48207-4291
(313) 446-2000

April 26, 1994

Mr. Dallas Safriet
US Environmental Protection Agency
Office of Air Quality Planning and Standards
4201 Building, 4th Floor
79 Alexander Drive
Research Triangle Park, NC 27711

RE: **Draft Site Visit**
ATTN: **EPA/EIB/EFMS (MD-14)**

Dear Mr. Safriet:

We have reviewed the copy of the draft site visit report that you sent to us on April 14. Our comments and annotations are included on that document.

We will be looking forward to receiving a copy of the final report and any official "emission factors" that apply to brewery processes.

Sincerely,
The Stroh Brewery Company

Gregory Miller
Director, Environmental Affairs

encl

GM/gm/pt

MRI

MIDWEST RESEARCH INSTITUTE
Suite 350
401 Harrison Oaks Boulevard
Cary, North Carolina 27513-2412
Telephone (919) 677-0249
FAX (919) 677-0065

Date: April 14, 1994

Subject: Site Visit--Stroh Brewery Company, Winston Salem, NC Review and Update of AP-42 Chapter 6, Food and Agriculture, EPA Contract 68-D2-0159; MRI Project 3605-99

From: Brian Shrager

To: Dallas Safriet
EPA/EIB/EFMS (MD-14)
U. S. Environmental Protection Agency
Research Triangle Park, N.C. 27711

I. Purpose

The purpose of the visit was to familiarize the project team with brewery operations in order to facilitate the development of the new AP-42 section addressing beer brewing.

II. Place and Date

Stroh Brewery Company
U.S. Route 52
Winston Salem, North Carolina

Date: September 24, 1993

III. Attendees

Stroh Brewery Company (Stroh)

Greg Miller, Manager-Environmental Affairs
Joe Kwolkoski, Plant Engineer
Paul Heppler, Assistant Engineer

U.S. Environmental Protection Agency (EPA)

Dallas Safriet, EIB
Ron Ryan, EIB

Midwest Research Institute (MRI)

Roy Neulicht
Brian Shrager

IV. Discussion

The group began the trip with a brief discussion of the plant operations as well as Stroh operations throughout the United States. The following are some of the key points of the discussion:

1. Malting operations are not performed at this plant.

2. The plant uses corn syrup instead of corn in the brewing process. This eliminates corn cookers from the brewing process.

3. In addition to the normal can, ~~and~~ bottle, AND Keg filling lines, the plant has two sterile filling lines. These lines are located within the filling area of the facility, but each line is located in plastic sheeting enclosures, which are maintained under positive air pressure during operation.

4. The plant produces about 3.9 million barrels of beer per year, AND HAS A CAPACITY OF approximately 5.0 million barrels per year and is relatively small compared to the Coors plant (20 million barrels per year) that furnished the filling operations emission data to EPA. There are 31 U.S. gallons in a barrel.

5. Mr. Miller indicated that the largest ethanol emission source at the plant is the alcohol stripper, which is used to decrease the ethanol content from waste beer. The alcohol stripper is a submerged burner which heats the liquid waste stream, resulting in evaporation of the ethanol. The alcohol stripper is needed to reduce the biological oxygen demand (BOD) load on the city sewer system. The alcohol stripper removes about 65 percent of the alcohol from the liquid stream. The source emits about 300 tons of ethanol per year. Mr. Miller indicated that the

Check: $15\ \text{gpm} \times 1440\ \frac{\text{m}}{\text{d}} \times 275\ \text{d} \times 0.015\ \text{v/v} \times 6.7\ \text{LB/GAL} \div 2000\ \text{LB/TON} = 298\ \frac{\text{tons}}{\text{yr}}$

plant is planning to replace the alcohol stripper with an ethanol recovery system in the next year.

6. Mr. Miller suggested that filler emission factors be based on beer spillage rather than production, because the only ethanol emissions from filling operations come from beer loss. Stroh is concerned about the use of the Coors data for filling operations because Coors filling operations are not representative of the industry.

Following the discussion, the group toured the facility. Figure 1 shows a process flow diagram for the plant. Malted barley is shipped to the plant by rail, and is pneumatically conveyed to 20 grain storage silos. Particulate matter (PM) emissions from the grain unloading process are controlled by filter receivers, which are cyclones followed by fabric filters. From the silos, malted grain is pneumatically conveyed to four whole malt scales, which weigh the malt and discharge the proper amount to three malt mills. The malt mills grind the malt, which is then screw-conveyed to two ground (milled) malt hoppers. Particulate matter emissions from the malt mills and milled malt hoppers are controlled by a fabric filter. From the milled malt hoppers, the ground malt is gravity fed to two mash tubs where hot water is added as the malt is being fed. ~~Corn syrup is then added, and~~ The mixture is heated ~~cooked~~ in the mash tubs. The product, known as MASH ~~wort~~, is pumped to one of two lauter tubs, in which the wet grain is separated from the mash to produce ~~the~~ wort. The mash tubs and lauter tubs are all vented to the atmosphere through natural draft stacks. The liquid wort from the lauter tubs is transferred to one of four brew kettles, and the wet or "spent" grain from the lauter tubs is pneumatically conveyed to the spent grain tank and is sold to a neighboring facility that adds dry ingredients to reduce moisture content ~~dries~~ and processes the grain. In the brew kettles, hops AND CORN SYRUP are added to the wort and the mixture is boiled for an extended period of time. In addition to boiling in the brew kettles, the several Stroh's brands of beer are ~~is~~ cycled through a direct-fired brewing process. The wort is then

NO CORN SYRUP

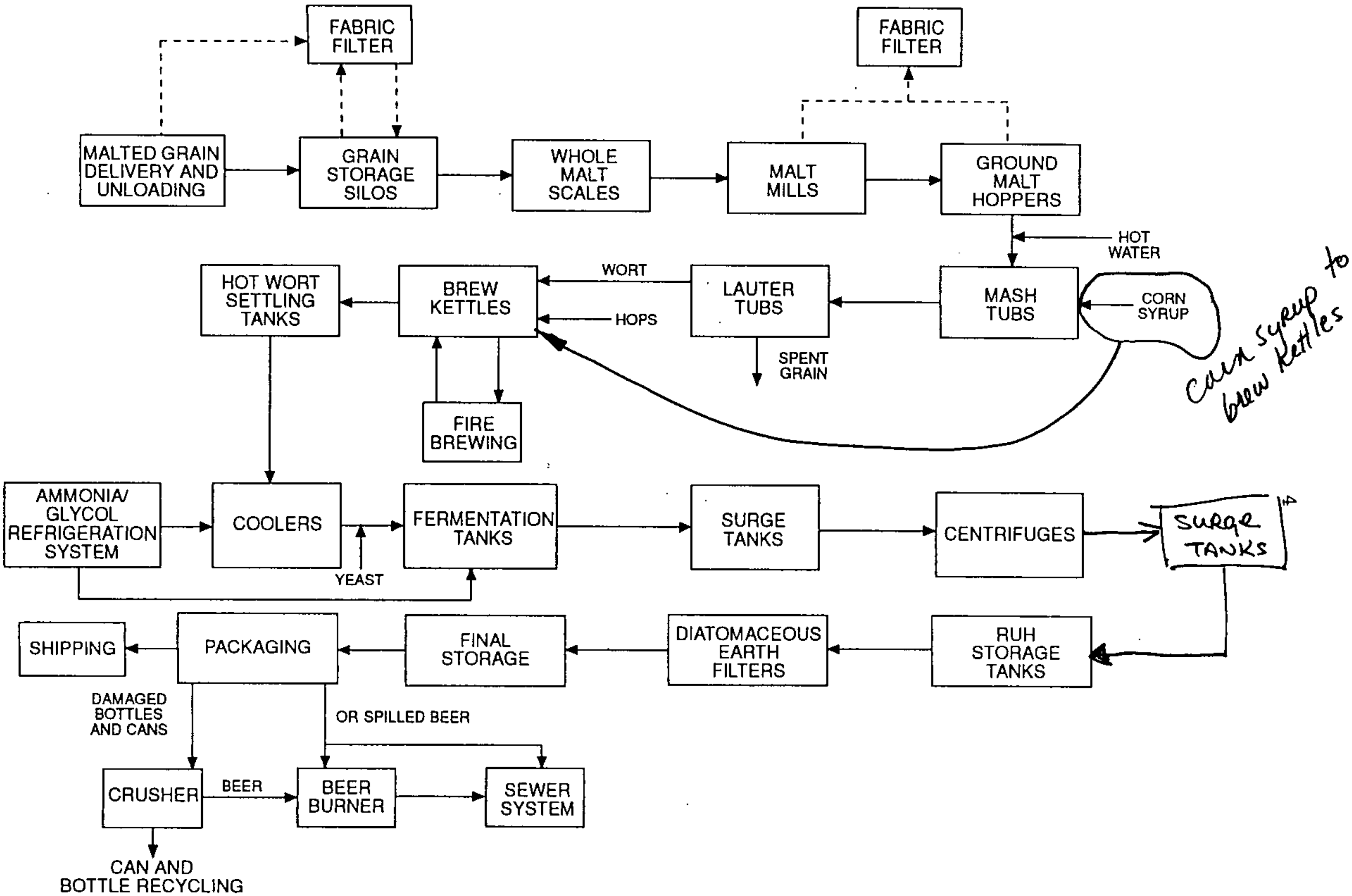

Figure 1. Process flow diagram for Stroh Brewery Company, Winston-Salem, NC.

transferred to one of the four hot wort settling tanks where the hot wort is held to allow settling of insoluble material called trub; the trub is introduced ~~back into the lauter tubs.~~ INTO THE SPENT GRAINS FOR DRYING AND PROCESSING. Emissions from the brew kettles are ducted to the atmosphere through four forced-air stacks, and the hot wort settling tanks are vented through a natural draft stack. The hot wort is pumped to coolers, which cool the liquid from about 99°C (210°F) to about 13°C ~~11°C~~ 56°F ~~(52°F)~~. The cooling system is a chilled water heat exchange; water is chilled by an ~~glycol and~~ ammonia-based, refrigeration system. The only potential emissions from the plant refrigeration ~~cooling~~ system are fugitive ammonia emissions from valves or seals. Yeast, which is COLLECTED FROM PREVIOUS FERMENTATIONS ~~produced~~ in several yeast tanks, is mixed with the cooled wort as it is pumped into the fermentation tanks.

The plant has 86 fermentation tanks, each of which typically holds about 1270 barrels of liquid. The liquid is typically fermented for ~~a little more than~~ approximately (NOT MORE THAN) comment a week. The fermentation tanks are vented to the atmosphere (through a single six inch diameter stack) for the first 12 to 14 hours of the fermentation process. This is a potential VOC source. For about seven days (following the initial 12 to 14 hours), the emissions from the fermentation tanks are collected for the purpose of recovering the carbon dioxide (CO_2) generated during fermentation. Impurities in the CO_2 are removed by a wet scrubbing and carbon adsorption system; impurities collected in the carbon bed are released to the atmosphere as emissions during carbon regeneration. At the time of the visit, the stack venting emissions from the fermentation tanks was emitting a considerable amount of waste gas, but Mr. Kwolkoski noted that this was not typical and was probably due to a malfunctioning compressor in the CO_2 recovery system, which prevented recovery of gases from all the fermentation tanks. From the fermentation tanks, the liquid is transferred to surge tanks, and then processed through a centrifuge to remove ~~waste~~ the yeast. After the centrifuge, the liquid is aged for 7-14 DAYS ~~30 days (secondary fermentation)~~ (NO SECONDARY FERMENTATION IN OUR PROCESS) comment in "ruh" storage tanks. The ruh storage tanks are vented to the ~~atmosphere~~ room on filling and emptying. Following ruh storage, the liquid is sent through a filtration process.

Please delete this section. Problem was not confirmed at time of visit. Info not necessary for this report. At most, a simi[lar] reference to CO_2 collection malfunction would vent to atmosphere.

comment NOT JUST WASTE ALL

Diatomaceous earth is added to the ruh and the mixture passes through a filtration system that includes surge tanks, a prefilter, final filter, and trap filter. This diatomaceous earth filtration process removes any remaining impurities in the beer. Carbonated water is added to the liquid and the beer is then pumped to final storage in PACKAGING RELEASE TANKS ~~("government tanks")~~. The surge tanks used in the filtration process and the packaging release ~~government storage~~ tanks are maintained under counterpressure using CO_2 (i.e., they are not vented to the atmosphere, except prior to and during cleaning).

The diatomaceous earth used in the filtration process is received in 50 lb bags; the earth is dumped into a mix tank and mixed with water to form the slurry which is used during filtration. The mix tank is a potential source of fugitive particulate matter emissions. The mix tanks were covered; the door in the cover was hooded and the exhaust is vented to a baghouse prior to discharge to the atmosphere.

END OF HERTRICH EDIT

From final storage, the beer is racked, canned or bottled by several filling lines located in a large building. The two enclosed filling lines, for nonpasteurized products, were not operating during the visit. The canning lines that were operating did not appear to spill much beer, and some of the lines were shrouded at the point where spillage occurred. The shrouds contained the spilled beer which drained quickly into catchpans connected to the collection system, thus limiting potential ethanol emissions. One canning line was not shrouded, and beer spillage was more noticeable; more beer appeared to escape capture by the catch pans and instead ended up on the floor where it subsequently flowed to a floor drain. Bottling operations appeared to spill more beer than canning, with most of the spillage occurring as the beer foamed up after the injection of steam or CO_2 for oxygen removal prior to capping. The waste beer collected at the fillers is pumped to the alcohol stripper.

this is conjecture and should be removed from report.

Damaged and partially filled cans and bottles from the filling lines are deposited in bins that feed two crushers, one can crusher and one bottle crusher. Beer from the crushed cans and bottles is collected in the waste beer collection system. The waste beer is pumped from the collection tank to the alcohol stripper. The cans and bottles are recycled. The alcohol stripper is a submerged combustion system that is a major source of ethanol emissions, but as discussed earlier, it is going to be replaced in the near future.

IV. Conclusions

The site visit was informative and assisted in identifying the potential sources of emissions which include:

PM	--	Grain/malt handling
	--	Diatomaceous earth mixing
VOC	--	Brew kettle
	--	Lauter tub
	--	Hot wort settle tank
	--	Fermentation
	--	~~Secondary fermentation~~ Ruh Storage
	--	Bottling
	--	Waste beer handling
CO_2	--	Fermentation
Other	--	Ammonia from refrigeration system

Nixon, Hargrave, Devans & Doyle
Attorneys and Counselors at Law
A PARTNERSHIP INCLUDING PROFESSIONAL CORPORATIONS
SUITE 800
ONE THOMAS CIRCLE
WASHINGTON, D. C. 20005
(202) 457-5300
FAX: (202) 457-5355

ONE KEYCORP PLAZA
ALBANY, NEW YORK 12207
(518) 427-2650

1600 MAIN PLACE TOWER
BUFFALO, NEW YORK 14202
(716) 853-8100

990 STEWART AVENUE
GARDEN CITY, NEW YORK 11530
(516) 832-7500

30 ROCKEFELLER PLAZA
NEW YORK, NEW YORK 10112
(212) 603-3000

CLINTON SQUARE
POST OFFICE BOX 1051
ROCHESTER, NEW YORK 14603
(716) 263-1000

WRITER'S DIRECT DIAL NUMBER:
(202) 457-5316

June 13, 1994

303-277-3831
Jeff Zimmerman

Dallas W. Safriet
Environmental Engineer
Emission Inventory Branch
Technical Support Division (MD-14)
Office of Air Quality Planning & Standards
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

RE: AP-42 revisions for breweries

Dear Dallas:

Thanks very much for your June 7 package (received today) forwarding copies of the 1983 CARB emissions study and Miller's recent 1994 submittal detailing emissions from their Fulton NY brewery. I appreciate your responsiveness and cooperation in this regard, as well as your promise to send me copies of the new draft AP-42 section when that draft is ready for external review.

This is also to clarify our conversations regarding next steps. According to my notes, in addition to the above I also asked you and/or Howard Hoffman for copies of (a) any data similar to Miller's submitted by other breweries; and (b) at least the test protocols from the Coors study, pending the Agency's determination of what else in that study (e.g., raw individual test results) might be CBI. The grounds for (b) were that the test protocols themselves could not be confidential, since without those protocols no other brewery---including especially smaller breweries---can tell what the "Coors numbers" mean or what effect potential EPA adoption of those numbers might have on its specific operations.

I assume from your cover letter that EPA does not have other recent data similar to Miller's. I also assume that you mean to send me the non-CBI Coors data as soon as it is or

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becomes available---at the very least, sufficiently before the external review draft so that we can evaluate that data for purposes of commenting on the draft. Finally, I'm assuming that with respect to the Coors test protocols or other aspects of the so-called "Coors study" which plainly are or ought to be non-CBI, the Agency is proceeding in stages so that any material which is proper to release can be released early, without waiting until every Coors confidentiality issue is resolved.

I believe this is all a fair reading of your cover letter in light of previous conversations. But I would very much appreciate your either confirming that we're both on the same page, or letting me know if I've assumed something erroneous. You don't need to write me back; a phone call or message from you or Howard would be enough.

Thanks again.

Cordially,

Michael H. Levin

cc: Howard Hoffman, EPA/OCG (LE-132A)

Nixon, Hargrave, Devans & Doyle
Attorneys and Counsolors at Law
A PARTNERSHIP INCLUDING PROFESSIONAL CORPORATIONS
SUITE 800
ONE THOMAS CIRCLE
WASHINGTON, D. C. 20005
(202) 457-5300
FAX: (202) 457-5355

ONE KEYCORP PLAZA
ALBANY, NEW YORK 12207
(518) 427-2650

1600 EMPIRE TOWER
BUFFALO, NEW YORK 14202
(716) 853-8100

990 STEWART AVENUE
GARDEN CITY, NEW YORK 11530
(516) 832-7500

30 ROCKEFELLER PLAZA
NEW YORK, NEW YORK 10112
(212) 603-3000

CLINTON SQUARE
POST OFFICE BOX 1051
ROCHESTER, NEW YORK 14603
(716) 263-1000

WRITER'S DIRECT DIAL NUMBER:
(202) 457-5316

202-223-7200

April 14, 1994

Dallas W. Safriet
Emission Factor & Methodologies Section
Emission Inventory Branch
Office of Air Quality Planning & Standards (MD-14)
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

Dear Dallas:

This will confirm my telephoned request that I be placed on the mailing list to receive any and all versions of the new draft AP-42 emission factors for brewery operations (and related supporting or explanatory materials) at the same time they are sent for informal or other external review to EPA Regions, state air personnel, and major breweries such as Coors and Miller. Among other things, your compliance with this request will help assure that all segments of the brewing industry have prompt notice of the Agency's tentative conclusions and their potential SIP effects. It may also help EPA receive better data on which to act, before the draft factors become "final."

If feasible, please send the requested materials to me by fax at the above fax number as and when they become available. Otherwise delivery by Federal Express would be greatly appreciated. I'd be pleased to give you our FedEx account number if necessary to defray costs.

Thanks in advance for your attention to this.

Cordially,

Michael H. Levin

Talk with his
on 5-11-94
will send copies
of test report

WASH01:18643

TELECOPY TRANSMITTAL

from

SMITH HELMS MULLISS & MOORE, L.L.P.

Attorneys at Law
Post Office Box 21927
Greensboro, North Carolina 27420

Suite 1400
300 North Greene Street
Greensboro, N.C. 27401

Telephone 910/378-5200
Telecopier 910/379-9558

DATE: 9/19/94

TO: Dallas Safriet

COMPANY: EPA at RTP

FROM: Julie Lehman ATTY #:

SENDER'S DIRECT DIAL NO.: (910) 378-5356

NUMBER OF PAGES (INCLUDING COVER PAGE): 2

MESSAGE: Sorry so late. I wanted to confirm this with Harold before I had him added to the list. He's grateful for the invitation + opportunity

Julie Lehman

IF ANY PROBLEMS: CALL 910/378-5372 AND ASK FOR Warren Miller

227 North Tryon Street
Charlotte, NC 28202
Telephone 704/343-2000

316 West Edenton Street
Raleigh, NC 27603
Telephone 919/755-8700

SMITH HELMS MULLISS & MOORE, L. L. P.
ATTORNEYS AT LAW
GREENSBORO, NORTH CAROLINA

September 19, 1994

Mr. Dallas Safriet
Mail Drop 14
Environmental Protection Agency
Research Triangle Park, NC 27711

Dear Mr. Safriet:

Harold Bynum and I both appreciate your returning our calls last week. We are curious about the work you are doing with regard to ethanol emissions. Please do add Harold's Name to the Peer Review list so that he can receive information and comment on the drafts of AP-42, 5th Supplement. In addition, would you send him copies of all the information which may have already been sent out to others on the Peer Review list? Please send such information to the attention of Harold Bynum at Smith Helms Mulliss & Moore, L.L.P., P.O. Box 21927, Greensboro, NC 27420.

Once again, thank you for your assistance in this matter.

Sincerely,

SMITH HELMS MULLISS & MOORE, L.L.P.

Julie Lehman

Julie Lehman
Legal Assistant, Environmental

SMITH HELMS MULLISS & MOORE, L. L. P.
ATTORNEYS AT LAW
GREENSBORO, NORTH CAROLINA

CHARLOTTE
MAILING ADDRESS
POST OFFICE BOX 31247
CHARLOTTE, N. C. 28231

STREET ADDRESS
227 NORTH TRYON STREET
CHARLOTTE, N. C. 28202

TELEPHONE 704/343-2000
FACSIMILE 704/334-8467

MAILING ADDRESS
POST OFFICE BOX 21927
GREENSBORO, N. C. 27420

STREET ADDRESS
SUITE 1400
300 NORTH GREENE STREET
GREENSBORO, N. C. 27401

TELEPHONE 910/378-5200
FACSIMILE 910/379-9558

RALEIGH
MAILING ADDRESS
POST OFFICE BOX 27525
RALEIGH, N. C. 27611

STREET ADDRESS
316 WEST EDENTON STREET
RALEIGH, N. C. 27603

TELEPHONE 919/755-8700
FACSIMILE 919/828-7938

WRITER'S DIRECT DIAL
910/378-5285

July 7, 1995

Mr. Dallas W. Safriet
Emission Inventory Branch (MD-14)
Environmental Protection Agency
Research Triangle Park, North Carolina 27711

Re: Brewery Ethanol Emissions

Dear Dallas:

With my letter to Brian Shrager at Midwest Research Institute of January 12, 1995, I transmitted a copy of a report entitled "Air Emissions Investigation Report" from an assessment conducted for Miller Brewing Company at one of its breweries. The letter indicated that Exhibit J was not included because it contained confidential processing information.

Having removed Exhibit J, Miller intended that EPA be able to use the information contained in the report for your ethanol emissions project. Consequently, you may disregard the "Confidential" claim on the cover page of the report.

I look forward to hearing from you regarding the status of this project.

Very truly yours,

SMITH HELMS MULLISS & MOORE, L.L.P.

Harold N. Bynum

Harold N. Bynum

HNB/rc