Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

AP-42 Section 9.12.2
Reference 11
Report Sect.
Reference

RECEIVED
DEC 18 1992
San Joaquin Valley Unified
Air Pollution Control District

E. & J. GALLO WINERY

Modesto, California

December 14, 1992

Maria Lima
S.J.U.V.A.P.C.D.
1999 Tuolumne Street
Fresno, CA 93721

Dear Ms. Lima:

Enclosed is the protocol for, and results of, the full scale fermentation emission tests conducted at E. & J. Gallo's Fresno Winery. As the attached documentation shows, these tests were devised in conjunction with the staff of the California Air Resources Board, and monitored by members of the staff. The primary purpose was to develop emission factors for ethanol during fermentation. This could be done very accurately since all of the emissions during each of eight fermentations were trapped on granular activated carbon, then steamed off and condensed. The volume of the condensate was measured in each case, and a comprehensive chemical analysis performed by gas chromatography. Although the chief objective was to obtain an accurate measurement of ethanol content, other constituents, including acetaldehyde, were also quantitated. This provided the basis for our estimate of total acetaldehyde emissions. The average acetaldehyde emitted during the red and white fermentations was calculated in pounds per thousand gallons and then applied to the total amount of wine fermented that year in each category.

Copies of the analytical data sheets, the volume of condensate for each test fermentation, the calculations of the average acetaldehyde content for the red and white fermentations, and (as confidential information) the total gallons of red and white wine fermented that year are included.

These should give the background on the whole ethanol emission measurement history, and the information taken from those experiments which were used to quantitate the acetaldehyde emissions and to give a rough estimate of the H_2S levels based on frequent sampling using Dräger tubes. (We realize that Dräger

- continued -

ZIP CODE 95353 TELEPHONE (209) 579-3111

December 14, 1992

tubes are not sanctioned for official measurement, but we were able to take measurements throughout a fermentation cycle to get an idea of the amounts emitted and if those emissions varied within the duration of the fermentation. As the results showed, H_2S quantities varied tremendously; some fermentations had none, and those which tested positive did not show a consistent pattern of emission.

Sincerely,

Arthur Caputi, Jr.

Arthur Caputi Jr.

ACJ:el

In accordance with our proposed inventory plan for the Emission Inventory Criteria and Guidelines Regulation for the Administration of the Air Toxics "Hot Spots" Information and Assessment Act of 1987, Gallo formulated a source test to determine the amount of acetaldehyde emitted from our fermenters. During the fermentation, condensate was collected and the acetaldehyde concentration was determined by gas chromatography. The following calculations were used to determine the total amount of acetaldehyde emitted from the fermentations during our 1990 crushing season.

Acetaldehyde Calculations

(Modesto Lab Results)

Fermentation #1
(White)
(170,016 gals)

383 gal. condensate x 3.78 L = 1,447.7 L
22 mg/L x 1,447.7 = 31,849.4 mg = 31.8 g
31.8g ÷ 453.5 g/lb = 0.07 lb
0.07 lb ÷ 170.0 = 0.00041 lb/1000 gals.

Fermentation #2
(White)
(172,322 gals)

484 gal. condensate (fraction #1) x 3.78 L = 1,829.5 L
20 mg/L x 1,829.5 = 36,590 mg = 36.6 g
36.6 g ÷ 453.5 g/lb = 0.08 lb

291 gal. condensate (fraction #2) x 3.78 L = 1,100 L
23 mg/L x 1,100 = 25300 mg = 25.3 g
25.3 g ÷ 453.5 g/lb = 0.06 lb

0.08 lb + 0.06 lb = 0.14 lb
0.14 lb ÷ 172.3 = 0.00081 lb/1000 gals.

Fermentation #3
(Red)
(157,120 gals)

275 gal. condensate x 3.78 L = 1,039.5 L
84 mg/L x 1,039.5 = 87,318 mg = 87.3 g
87.3 g ÷ 453.5 g/lb = 0.19 lb
0.19 lb ÷ 157.1 = 0.0012 lb/1000 gals.

Fermentation #4
(Red)
(152,740 gals)

220 gal. condensate x 3.78 = 831.6 L
87 mg/L x 831.6 L = 72,349 mg = 72.3 g
72.3 g ÷ 453.5 g/lb = 0.16 lb
0.16 lb ÷ 152.7 = 0.001 lb/1000 gals.

Fermentation #5
(Red)
(145,280 gals)

325 gal. condensate x 3.78 = 1,228.5 L
114 mg/L x 1,228.5 L = 140,009 mg = 140.0g
140.0 g ÷ 453.5 g/lb = 0.31 lb
0.31 lb ÷ 145.3 = <u>0.0021 lb/1000 gals.</u>

Fermentation #6
(Red)
(146,145 gals)

352 gal. condensate x 3.78 = 1,330.6 L
169 mg/L x 1,330.6 = 224,871.4 mg = 224.9g
224.9 g ÷ 453.5 g/lb = 0.50 lb
0.50 lb ÷ 146.1 = <u>0.0034 lb/1000 gals.</u>

Fermentation #7
(Red)
(144,475 gals)

454 gal. condensate x 3.78 = 1,716 L
226 mg/L x 1,716.1 = 387,838.6 mg = 387.8g
387.8 g ÷ 453.5 g/lb = 0.86 lb
0.86 lb ÷ 144.5 = <u>0.0060 lb/1000 gals.</u>

Fermentation #8
(White)
(169,028 gals)

339 gal. condensate x 3.78 = 1,281.4 L
58 mg/L x 1,281.4 = 74,321.2 mg = 74.3 g
74.3 g ÷ 453.5 g/lb = 0.16 lb
0.16 lb ÷ 169.0 = <u>0.0009 lb/1000 gals.</u>

<u>Average lb acetaldehyde (white)</u> = 0.00041 + 0.00081 + 0.0009 ÷ 3
= 0.00071 lb/1000 gals

<u>Average lb acetaldehyde (red)</u> = 0.0012 + 0.001 + 0.0021 + 0.0034 + 0.0060 ÷ 5
= 0.00274 lb/1000 gals

A. CAPUTI-RES

ID: RES TANK: ART 5100=60=0358 EXP. RUN #1

173 REQ 07Sep90 1120 DRAW 04Sep90 0000 C B

Fermentation #1

[redacted]	22 [redacted]	MG/L	acetal
ALC	11.75	VOL %	
ALD	40.	MG/L	
FO	281.	MG/L	
FSO2	5.	MG/L	free SO_2
ISOA	149.	MG/L	isoamyl alc.
ISOB	23.	MG/L	isobutyl "
MEOH	47.	MG/L	
NBUT	UND	MG/L	n-butanol UNDETECTABLE
NPRO	87.	MG/L	n-propyl alc.
PH	3.56		
RSLC	0.04	GM/100ML	reducing sugar by liq. chrom.
SECB	UND	MG/L	sec-butanol UNDETECTABLE
TA	0.64	G/100ML	total acids
TSO2	65.	MG/L	total SO_2
VA	0.023	G/100ML	volatile acid

10-10-90 07:17 AM RESEARCH SUMMARY

ID: RES TANK: AC 0000=00=0000

9798 REQ 090ct90 1526 DRAW 090ct90 0000 C B RUN #7

ACTA	226.	MG/L	acetal
ALC	21.35	VOL %	EtOH
ALD	170.	MG/L	aldehyde
FO	1558.	MG/L	fusel oil
ISOA	1010.	MG/L	
ISOB	217.	MG/L	
MEOH	88.	MG/L	
NBUT	2.	MG/L	
NPRO	100.	MG/L	
SECB	2.	MG/L	
VA	0.019	G/100ML	

9799 REQ 090ct90 1526 DRAW 090ct90 0000 C B RUN #5

ACTA	114.	MG/L	
ALC	21.95	VOL %	
ALD	260.	MG/L	
FO	1082.	MG/L	
ISOA	631.	MG/L	
ISOB	193.	MG/L	
MEOH	119.	MG/L	
NBUT	2.	MG/L	
NPRO	140.	MG/L	
SECB	UND	MG/L	UNDETECTABLE
VA	0.009	G/100ML	

ACC 9800 REQ 090ct90 1527 DRAW 090ct90 0000 C B RUN #6

ACTA	169.	MG/L
ALC	21.80	VOL %
ALD	180.	MG/L
FO	1298.	MG/L
ISOA	793.	MG/L
ISOB	217.	MG/L
MEOH	109.	MG/L
NBUT	2.	MG/L
NPRO	114.	MG/L
SECB	3.	MG/L
VA	0.011	G/100ML

ACC 9801 REQ 090ct90 1527 DRAW 090ct90 0000 C B [redacted]

[redacted]	20 [redacted]	MG/L	
ALC	7.10	VOL %	Fermentation #2A
ALD	105.	MG/L	
FO	259.	MG/L	
ISOA	143.	MG/L	
ISOB	22.	MG/L	
MEOH	22.	MG/L	
NBUT	UND	MG/L	UNDETECTABLE
NPRO	74.	MG/L	
SECB	UND	MG/L	UNDETECTABLE
VA	0.013	G/100ML	

10-10-90 07:17 AM RESEARCH SUMMARY

CC: A CAPUTI-RES CC: A. CAPUTI-RES

L ID: RES TANK: AC 0000=00=0000

ACC 9795 REQ 090ct90 1526 DRAW 090ct90 0000 C B [redacted]

[redacted]	[redacted] 23	MG/L	
ALC	9.15	VOL %	
ALD	55.	MG/L	
FO	324.	MG/L	
ISOA	189.	MG/L	
ISOB	23.	MG/L	
MEOH	19.	MG/L	
NBUT	UND	MG/L	UNDETECTABLE
NPRO	89.	MG/L	
SECB	UND	MG/L	UNDETECTABLE
VA	0.006	G/100ML	

fermentation #2 B

ACC 9796 REQ 090ct90 1526 DRAW 090ct90 0000 C B RUN #3

ACTA	84.	MG/L	
ALC	25.05	VOL %	
ALD	745.	MG/L	
FO	1212.	MG/L	
ISOA	632.	MG/L	
ISOB	152.	MG/L	
MEOH	230.	MG/L	
NBUT	5.	MG/L	
NPRO	338.	MG/L	
SECB	UND	MG/L	UNDETECTABLE
VA	0.010	G/100ML	

ACC 9797 REQ 090ct90 1526 DRAW 090ct90 0000 C B RUN #4

ACTA	87.	MG/L
ALC	24.60	VOL %
ALD	550.	MG/L
FO	1299.	MG/L
ISOA	671.	MG/L
ISOB	165.	MG/L
MEOH	199.	MG/L
NBUT	6.	MG/L
NPRO	369.	MG/L
SECB	2.	MG/L
VA	0.011	G/100ML

10-10-90 07:17 AM

RESEARCH SUMMARY

A. CAPUTI-RES CC: A. CAPUTI-RES

ID: RES TANK: AC 0000=00=0000

9795 REQ 09Oct90 1526 DRAW 09Oct90 0000 C B RUN #2B

ACTA	23.	MG/L	
ALC	9.15	VOL %	
ALD	55.	MG/L	
FO	324.	MG/L	
ISOA	189.	MG/L	
ISOB	23.	MG/L	
MEOH	19.	MG/L	
NBUT	UND	MG/L	UNDETECTABLE
NPRO	89.	MG/L	
SECB	UND	MG/L	UNDETECTABLE
VA	0.006	G/100ML	

ACC 9796 REQ 09Oct90 1526 DRAW 09Oct90 0000 C B [redacted]

Fermentation #3

[redacted]	[redacted]	MG/L	
ALC	25.05	VOL %	
ALD	745.	MG/L	
FO	1212.	MG/L	
ISOA	632.	MG/L	
ISOB	152.	MG/L	
MEOH	230.	MG/L	
NBUT	5.	MG/L	
NPRO	338.	MG/L	
SECB	UND	MG/L	UNDETECTABLE
VA	0.010	G/100ML	

ACC 9797 REQ 09Oct90 1526 DRAW 09Oct90 0000 C B RUN #4

ACTA	87.	MG/L
ALC	24.60	VOL %
ALD	550.	MG/L
FO	1299.	MG/L
ISOA	671.	MG/L
ISOB	165.	MG/L
MEOH	199.	MG/L
NBUT	6.	MG/L
NPRO	369.	MG/L
SECB	2.	MG/L
VA	0.011	G/100ML

CC: A. CAPUTI-RES CC: A. CAPUTI-RES

L ID: RES TANK: AC 0000=00=0000

ACC 9795 REQ 09Oct90 1526 DRAW 09Oct90 0000 C B RUN #2B

ACTA	23.	MG/L	
ALC	9.15	VOL %	
ALD	55.	MG/L	
FO	324.	MG/L	
ISOA	189.	MG/L	
ISOB	23.	MG/L	
MEOH	19.	MG/L	
NBUT	UND	MG/L	UNDETECTABLE
NPRO	89.	MG/L	
SECB	UND	MG/L	UNDETECTABLE
VA	0.006	G/100ML	

ACC 9796 REQ 09Oct90 1526 DRAW 09Oct90 0000 C B RUN #3

ACTA	84.	MG/L
ALC	25.05	VOL %
ALD	745.	MG/L
FO	1212.	MG/L
ISOA	632.	MG/L
ISOB	152.	MG/L
MEOH	230.	MG/L
NBUT	5.	MG/L
NPRO	338.	MG/L
SECB	UND	MG/L
VA	0.010	G/100ML

UNDETECTABLE

ACC 9797 REQ 09Oct90 1526 DRAW 09Oct90 0000 C B [redacted]

87

[redacted]		MG/L
ALC	24.60	VOL %
ALD	550.	MG/L
FO	1299.	MG/L
ISOA	671.	MG/L
ISOB	165.	MG/L
MEOH	199.	MG/L
NBUT	6.	MG/L
NPRO	369.	MG/L
SECB	2.	MG/L
VA	0.011	G/100ML

Fermentation #4

10-10-90 07:17 AM RESEARCH SUMMARY

L ID: RES TANK: AC 0000=00=0000

ACC 9798 REQ 09Oct90 1526 DRAW 09Oct90 0000 C B RUN #7

ACTA	226.	MG/L
ALC	21.35	VOL %
ALD	170.	MG/L
FO	1558.	MG/L
ISOA	1010.	MG/L
ISOB	217.	MG/L
MEOH	88.	MG/L
NBUT	2.	MG/L
NPRO	100.	MG/L
SECB	2.	MG/L
VA	0.019	G/100ML

ACC 9799 REQ 09Oct90 1526 DRAW 09Oct90 0000 C B [redacted]

114

[redacted]	[redacted]	MG/L
ALC	21.95	VOL %
ALD	260.	MG/L
FO	1082.	MG/L
ISOA	631.	MG/L
ISOB	193.	MG/L
MEOH	119.	MG/L
NBUT	2.	MG/L
NPRO	140.	MG/L
SECB	UND	MG/L UNDETECTABLE
VA	0.009	G/100ML

Fermentation #5

ACC 9800 REQ 09Oct90 1527 DRAW 09Oct90 0000 C B RUN #6

ACTA	169.	MG/L
ALC	21.80	VOL %
ALD	180.	MG/L
FO	1298.	MG/L
ISOA	793.	MG/L
ISOB	217.	MG/L
MEOH	109.	MG/L
NBUT	2.	MG/L
NPRO	114.	MG/L
SECB	3.	MG/L
VA	0.011	G/100ML

ACC 9801 REQ 09Oct90 1527 DRAW 09Oct90 0000 C B RUN #2A

ACTA	20.	MG/L	
ALC	7.10	VOL %	
ALD	105.	MG/L	
FO	259.	MG/L	
ISOA	143.	MG/L	
ISOB	22.	MG/L	
MEOH	22.	MG/L	
NBUT	UND	MG/L	UNDETECTABLE
NPRO	74.	MG/L	
SECB	UND	MG/L	UNDETECTABLE
VA	0.013	G/100ML	

L ID: RES TANK: AC 0000=00=0000

ACC 9798 REQ 09Oct90 1526 DRAW 09Oct90 0000 C B RUN #7

ACTA	226.	MG/L	
ALC	21.35	VOL %	
ALD	170.	MG/L	
FO	1558.	MG/L	
ISOA	1010.	MG/L	
ISOB	217.	MG/L	
MEOH	88.	MG/L	
NBUT	2.	MG/L	
NPRO	100.	MG/L	
SECB	2.	MG/L	
VA	0.019	G/100ML	

ACC 9799 REQ 09Oct90 1526 DRAW 09Oct90 0000 C B RUN #5

ACTA	114.	MG/L	
ALC	21.95	VOL %	
ALD	260.	MG/L	
FO	1082.	MG/L	
ISOA	631.	MG/L	
ISOB	193.	MG/L	
MEOH	119.	MG/L	
NBUT	2.	MG/L	
NPRO	140.	MG/L	
SECB	UND	MG/L	UNDETECTABLE
VA	0.009	G/100ML	

ACC 9800 REQ 09Oct90 1527 DRAW 09Oct90 0000 C B [redacted]

[redacted]	169	MG/L	
ALC	21.80	VOL %	fermentation #6
ALD	180.	MG/L	
FO	1298.	MG/L	
ISOA	793.	MG/L	
ISOB	217.	MG/L	
MEOH	109.	MG/L	
NBUT	2.	MG/L	
NPRO	114.	MG/L	
SECB	3.	MG/L	
VA	0.011	G/100ML	

ACC 9801 REQ 09Oct90 1527 DRAW 09Oct90 0000 C B RUN #2A

ACTA	20.	MG/L	
ALC	7.10	VOL %	
ALD	105.	MG/L	
FO	259.	MG/L	
ISOA	143.	MG/L	
ISOB	22.	MG/L	
MEOH	22.	MG/L	
NBUT	UND	MG/L	UNDETECTABLE
NPRO	74.	MG/L	
SECB	UND	MG/L	UNDETECTABLE
VA	0.013	G/100ML	

10-10-90 07:17 AM RESEARCH SUMMARY

L ID: RES TANK: AC 0000=00=0000

ACC 9798 REQ 090ct90 1526 DRAW 090ct90 0000 C B [redacted]

226

[redacted]		MG/L
ALC	21.35	VOL %
ALD	170.	MG/L
FO	1558.	MG/L
ISOA	1010.	MG/L
ISOB	217.	MG/L
MEOH	88.	MG/L
NBUT	2.	MG/L
NPRO	100.	MG/L
SECB	2.	MG/L
VA	0.019	G/100ML

Fermentation #7

ACC 9799 REQ 090ct90 1526 DRAW 090ct90 0000 C B RUN #5

ACTA	114.	MG/L	
ALC	21.95	VOL %	
ALD	260.	MG/L	
FO	1082.	MG/L	
ISOA	631.	MG/L	
ISOB	193.	MG/L	
MEOH	119.	MG/L	
NBUT	2.	MG/L	
NPRO	140.	MG/L	
SECB	UND	MG/L	UNDETECTABLE
VA	0.009	G/100ML	

ACC 9800 REQ 090ct90 1527 DRAW 090ct90 0000 C B RUN #6

ACTA	169.	MG/L
ALC	21.80	VOL %
ALD	180.	MG/L
FO	1298.	MG/L
ISOA	793.	MG/L
ISOB	217.	MG/L
MEOH	109.	MG/L
NBUT	2.	MG/L
NPRO	114.	MG/L
SECB	3.	MG/L
VA	0.011	G/100ML

ACC 9801 REQ 090ct90 1527 DRAW 090ct90 0000 C B RUN #2A

ACTA	20.	MG/L	
ALC	7.10	VOL %	
ALD	105.	MG/L	
FO	259.	MG/L	
ISOA	143.	MG/L	
ISOB	22.	MG/L	
MEOH	22.	MG/L	
NBUT	UND	MG/L	UNDETECTABLE
NPRO	74.	MG/L	
SECB	UND	MG/L	UNDETECTABLE
VA	0.013	G/100ML	

10-03-90 07:12 AM

RESEARCH SUMMARY

CC: A. CAPUTI-RES

L ID: RES TANK: ART 0000-00-0000 EXP. RUN #8

ACC 7645 REQ 02Oct90 0858 DRAW 28Sep90 0000 C 4 TK: 2930 CONDENSATE

ACTA	58.	MG/L	
ALC	12.35	VOL %	
ALD	105.	MG/L	
FO	638.	MG/L	
ISOA	388.	MG/L	
ISOB	47.	MG/L	
MEOH	16.	MG/L	
NBUT	UND.	MG/L	UNDETECTABLE
NPRO	145.	MG/L	
SECB	UND	MG/L	UNDETECTABLE
VA	0.020	G/100ML	

Fermentation #8

Fermentation #5
(Red)
(145,280 gals)

325 gal. condensate x 3.78 = 1,228.5 L
114 mg/L x 1,228.5 L = 140,009 mg = 140.0g
140.0 g ÷ 453.5 g/lb = 0.31 lb
0.31 lb ÷ 145.3 = <u>0.0021 lb/1000 gals.</u>

Fermentation #6
(Red)
(146,145 gals)

352 gal. condensate x 3.78 = 1,330.6 L
169 mg/L x 1,330.6 = 224,871.4 mg = 224.9g
224.9 g ÷ 453.5 g/lb = 0.50 lb
0.50 lb ÷ 146.1 = <u>0.0034 lb/1000 gals.</u>

Fermentation #7
(Red)
(144,475 gals)

454 gal. condensate x 3.78 = 1,716 L
226 mg/L x 1,716.1 = 387,838.6 mg = 387.8g
387.8 g ÷ 453.5 g/lb = 0.86 lb
0.86 lb ÷ 144.5 = <u>0.0060 lb/1000 gals.</u>

Fermentation #8
(White)
(169,028 gals)

339 gal. condensate x 3.78 = 1,281.4 L
58 mg/L x 1,281.4 = 74,321.2 mg = 74.3 g
74.3 g ÷ 453.5 g/lb = 0.16 lb
0.16 lb ÷ 169.0 = <u>0.0009 lb/1000 gals.</u>

<u>Average lb acetaldehyde (white)</u> = 0.00041 + 0.00081 + 0.0009 ÷ 3
= 0.00071 lb/1000 gals

<u>Average lb acetaldehyde (red)</u> = 0.0012 + 0.001 + 0.0021 + 0.0034 + 0.0060 ÷ 5
= 0.00274 lb/1000 gals

Confidential Information

<u>Total Gallons White Wine Produced</u>
<u>Total Gallons Red Wine Produced</u>

<u>Lb acetaldehyde/ Total Gallons (white)</u> = (0.00071 x 1,000) x 25,783,890 = 18.3
<u>Lb acetaldehyde/ Total Gallons (red)</u> = (0.00274 x 1,000) x 12,615,098 = 34.6

<u>**Total lb acetaldehyde - 1990**</u> = 52.9