Appendix W

http://www.bape.gouv.qc.ca/sections/mandats/prod-porcine/documents/Bio117.PDF

Data Gaps for Emission Factors

Sector	Model Farm Component	Pollutants
Dairy	Solid manure land application	NH3, N20
	Liquid manure land application	N2O,H2S,VOC
	Storage ponds	NH3,H2S,VOC
	Drvlot feed allev (flush)	NH3

from : EMISSION FROM ANIMAL FEEDING OPERATION

Summary of **Dairy** Emission Factors

Emission Source	Substance	Emission Factor Range (lb/yr-AU)	Number of Emission Factors	Average Emission Factor (lb/yr-AU)	References	kg/yr-AU	kg/cow-yr
Freestall barn (flush)	NH3	—	—	28	**d**	12.73	
Freestall barn (scrape)	NH3	15.2 - 16.8	2	16/16.0	Demmers, et al., 2001; University of Minnesota, 1999.	7.27	
Drylot	NH3	4.5 - 13.4	3	10.2/9.0	Bouwman, et al., 1997; Misselbrook, et al., 1998; Van der Hoek, 1998.	4.64	
	N2O	—	—	4.4	**a**	2.00	
	PM	2.3	1	2.3/2.3	USDA, 2000	1.05	
Anaerobic	NH3	—	—	40	**b**	18.18	
lagoon	N2O	—	—	0.22	**a**	0.10	
	H2S	—	—	15.7**e**, 4.1**f**	**b**	7.14	2.61
	VOC	—	—	**4.5**	**c**	**2.05**	**2.86**
Storage pond	N2O	—	—	0.22	**a**	0.10	
Liquid manure land application	NH3	18.7	1	18.7/18.7	Van der Hoek, 1998.	8.50	
Solids	NH3	5.9	1	5.9/5.9	Van der Hoek, 1998.	2.68	
storage	N2O	—	—	4.4	**a**	2.00	

a Calculated using a nitrogen in manure to nitrous oxide conversion factor. See Section 8.2.2.
b Calculated by transferring emissions from swine anaerobic lagoons. See Sections 8.2.1, 8.2.3, and Appendix E.
c Calculated using a volatile solids to VOC conversion factor. See Section 8.2.5.
d Calculated by transferring emissions from swine flush houses. See Appendix E for calculations.

e Used for model farms D1A, D1B, D4A and D4B; data was transferred from anaerobic lagoons following flush houses for swine.

f Used for model farms and D2A and S2B; data was transferred from anaerobic lagoons not following flush houses for swine.

Estimation Methodology: 2005 Ventura County Air Pollution Control ...

2002 LIVESTOCK HUSBANDRY□PROCESS RATES, EMISSION FACTORS, AND EMISSIONS

EIC	Livestock	TOC Emission factor Lbs/head/year	TOC Emission factor kg/head/year	ROC Emission factor Lbs/head/year	ROC Emission factor kg/head/year	NH3 Emission factor Lbs/head/year	NH3 Emission factor kg/head/year
620-618-0262-0101	Dairy Cattle	160	72.73	12.8	5.82	74	33.6

TOC= total organic compounds
ROC=reactive organic compound

http://japr.fass.org/cgi/reprint/14/2/3 374 (2 of 5)

TABLE 1. California emission factor for volatile organic compounds (VOC)

Source	Year	Type	Methane	TOG1	VOC
Ritzman and Benedict [1]	1938	Experiment	160		
Hutchinson [2]	1948	Literature review	160		
Ehhalt [3]	1974	Literature review	160		
Keller and Cowherd [4]	1977	Literature review	160		
Taback [5]	1977	Literature review		160	
Halberg [6]	1984	Literature review		160	
Dickson [7]	1988	Literature review		160	
CARB [8]	1997	Literature review		160	12.8 (2)

1. The VOC and nonreactive methane are summarized under the term total organic gas (TOG).

2.The current California emission factor for dairy VOC of 12.8 lb/cow per year developed as follows. A 1938 study [1] provided a methane production value of 200 g/d per cow. This is approximately 160 lb/yr. In 1977, Taback [5] cited this methane value incorrectly as TOG emission. Regulatory agencies (California Air Resources Board, CARB) [8] later used this incorrect dairy TOG value and assumed that 8% of TOG equals VOC. Therefore, it was determined that 8% of 160 lb/cow per year equals 12.8 lb/cow per year, which is the current emission factor for VOC in California.

http://www.aqmd.gov/titlev/spreadsheets/AgScreeningCalculatorRev1Area2.xls

Type	VOC Emission Factor (1bs/head-yr)	VOC Emission Factor (kg/head-	
Milking Cows-recommended	19.3	8.773	8.754422571
Milking Cows	12.8	5.818	
Dry Cows	8.7	3.955	

http://www.valleyair.org/farmpermits/applications/appendix/manual_emissions_calculator.pdf

San Joaquin Valley Air Pollution Control District
Emissions Calculations Sheets for CAFOs

Dairy Cows	Pollutant	Emission Factor (lbs/head–year)	kg/head-year
Milking Cow	VOC	21	9.545
Dry Cow	VOC	11.9	5.409

LIVESTOCK						
		Emission Factor **(kg NH3/month)**	(kg NH3/hd-year)	Sum (kg NH3/hd-year)		lb/hd/yr
Dairy Cattle	Deep-pit Dairy-Confinement	2.420	29.04			64
	Deep-pit Dairy-Storage	0.113	1.356	46.236		3
	Deep-pit Dairy-Land App	1.320	15.84			35
	Drylot/Pasture Dairy-Confinement	0.680	8.16			18
	Drylot/Pasture Dairy-Storage	0.028	0.3396	16.6596		1
	Drylot/Pasture Dairy-Land App	0.680	8.16			18
	Flush Dairy-Confinement	2.000	24			53
	Flush Dairy-Storage	5.590	67.08	96.972		148
	FlushDairy-Land App	0.491	5.892			13
	Scrape Dairy-Confinement	0.793	9.516		74.364	21
	Scrape Dairy-Storage	2.270	27.24	51.756		60
	Scrape Dairy-Land App	1.250	15			33
	Dairy - Composite	2.830	33.96			75

http://www.iowadnr.com/air/afo/files/section3.pdf

Ammonia Emission Factors

Animal	Type	Notes		E.F.	E.F. Units	lb NH3/yr/head	kg N/head/yr	g NH3 /Auday	g NH3/m2-day	Original Source	Studies Included In
Dairy	Scrape Barn			8.9	kg/500 kg/yr	23.7				Demmers et al., 2001	1
				7~13	g/LU/day	9.7				Jungbluth, 1997	1
				8.3	g/N/cow/day	8.1				Misselbrook et al., 1998	1
				14.5	kg/animal/yr	32				Van Der Hoek, 1998	1
				AVERAGE		18.5				Calculated by EPA	1
Dairy	Dry lots			8.3	g N/cow/day	8.1				Misselbrook et al., 1998	1
				8	kg/cow/yr	17.6				USDA, 2000	1
				30	lb/head/yr	30				USDA, 2000	1
				AVERAGE		18.58	8.45			Calculated by EPA	1
Dairy											3
	Stable*			28	kg-NH3/animal-yr					Battye et al., 2003	1,3,4,5
	Meadow			36	% NH3-N loss		50			Bowman et al., 1997	3,4,5
	Total			8	% NH3-N loss		30			Bowman et al., 1997	3,4,5
				25.5	% NH3-N loss		80			Bowman et al., 1997	
Dairy	Manure Storage Tanks	-		6.6	% of N					Safely, 1980	1
Dairy	Solid Storage	-		20~40	% of N					Sutton et al., 2001	1
Dairy		On bedding	VA	260 - 890	mg NH3/AU-h			6.2 - 21.4		Groot Kooerkamp et al., 1998	2
Dairy	Free-stall	-	VA	843 - 1,769	mg NH3/AU-h			20 - 42.5		Groot Kooerkamp et al., 1998	2
		Manure slatted floor	ST	400	mg NH3/m2-h				9.6	Kroodsma et al., 1993	2
		Scraped slatted floor	ST	380	mg NH3/m2-h				9.1	Kroodsma et al., 1993	2
		Unstirred slurry below slats	ST	320	mg NH3/m2-h				7.7	Kroodsma et al., 1993	2
		Stirred slurry below slats	ST	290	mg NH3/m2-h				7	Kroodsma et al., 1993	2
		Manure solid floor	ST	670	mg NH3/m2-h			16		Kroodsma et al., 1993	2
		Scraped solid floor	ST	620	mg NH3/m2-h			15		Kroodsma et al., 1993	2
		Flushed solid floor	ST	210	mg NH3/m2-h			5		Kroodsma et al., 1993	2
		-	ST	4	ug NH3/m2-s			0.35		Zhu et al., 2000	2
Dairy	Manure Land Application	Liquid (>200 head)		20	% N lost					Calculated by EPA	1
		Liquid (100 - 200 head)		22	% N lost					Calculated by EPA	1
		Liquid (<100 head)		24	% N lost					Calculated by EPA	1
		Solid (>200 head)		17	% N lost					Calculated by EPA	1
		Solid (100 - 200 head)		18	% N lost					Calculated by EPA	1
		Solid (<100 head)		19	% N lost					Calculated by EPA	1

* Emissions from stables include those from animal waste stored outside the stable and from spreading of animal waste.

Abbreviations

AU = Animal Unit, **LW** = Live Weight, **VA** = Ventilated Area, **ST** = Storage, **LA** = Land Application
Codes for "Studies Included In" in Table 3-2

1. National Emission Inventory - Ammonia Emissions from Animal Husbandry Operations, Draft Report. EPA, January 2004.

2. Iowa Concentrated Animal Feeding Operations Air Quality Study. Iowa State University and The University of Iowa Study Group, February2002

3. Research and Development of Ammonia Emission Inventories for the Central States Regional Air Planning Association. Coe, Dana L., and Stephen B. Reid, 2003.

4. Scenarios of Animal Waste Productions and Fertilizer Use and Associated Ammonia Emission for the Developing Countries. Bouwman, A.F. and K. W. Van Der Hoek, 1997.

5. CMU Ammonia Model version 3.0. Davidson, Cliff et al, 2003. http://www.cmu.edu/ammonia

From Evaluation and improvement of ammonia emissions inventories.

Summary of recent published emission factors for livestock (kg-NH3/Animal-yr)

Source	Recent Estimates and Measurements							
	ECETOC(1994)	EMEP (McInnes,1996)	Buowman et al. (1997)	UNECE (Van Der Hoek,1998)	Misselbrook et al.(2000)	Other Measurements	Estimated from waste design handbook	Selected for the current case studies
Dairy Cow	40	29	25	29	27	23 **a**	20~70	28

(•) Indicates that no estimates or measurements were available.

a Based on results of Schmidt and Winegar (1996) as modified by Winegar and published in the SCAQMD emissions inventory (Botsford et al., 1997).

SOURCE : Data are from Arogo et al. (2001, Table9 and 10). Lagoon surface area varied from 0.39 to 3.07 ha.

Air Emissions from Animal Feeding Operations: Current Knowledge, Future Needs
By Ad Hoc Committee on Air Emissions, National Research Council (U.S.), ebrary, Inc

http://books.google.com/books?id=ohGQi1xwk6AC&dq=what+is+the+emission+factor&pg=PA57&ots=MTqJFIOU6B&sig=7xXqzQF0zjFa8rUdqclzf3s2qmM&prev=http://www.google.com/search%3Fq%3Dwhat%2Bis%2Bthe%2Bemission%2Bfactor%26hl%3Dko%26rls%3DADBS%252CADBS%253A2006-29%252CADBS%253Aen&sa=X&oi=print&ct=result&cd=1#PPA99,M1

Average live weight (ALW), Nexcrertionrate, Emission factor and % N loss per MMT for each livestock category

Livestock	MMT	ALW (kg)	Nexcretion rate (kg/day)	Emission Factor (kg NH3/head/year)	% N loss
Milk cows	Flash burn	604.2	0.45		23.5
	Flash Burn with Solids separation	604.2	0.45		23.8
	Scrape Burn			8.16	
	Scrape Burn with Solids separation			8.16	
	Daily Spread			8.43	
	Outdoor Confinement				

http://www.cabq.gov/airquality/pdf/berncoei042706.pdf

from: Colorado 2002 Ammonia Emission Inventory

Livestock Emissions

Source Category	Emission Factor (lbs/head-year)	kg/head-yr
Dairy Cattlle	55.1	25

from : National Emission Inventory—Ammonia Emissions from Animal Husbandry Operations Draft Report

Ammonia Emission Factors for **Cattle (Outdoor Confinement Area)**

					Emission Factor
Animal	TAM (kg animal mass/ hd)	Nex Rate (kg N/ 1000 kg animal mass/ day)	Nex (lbN/hd/yr)	lb NH3/hd	%
Dairy Drylot Cattle - Dry Cows - Heifers	604 476	0.36 0.31	175 119	18.58 (1)	12.6 (1)
AVERAGE DRYLOT					16.6

Ammonia Emission Factor for Scrape Barns at Dairy Operations

Reference	Emission Factor (EF)	Units of Emission Factor	Avg EF	Conversion Factc	EF (lb NH3/yr/head)
Demmers et.al., 2001	8.9	kg/500 kg/yr	8.9	2.2046 lb/kg 604 kg/head	23.7
Jungbluth, 1997	7~13	g/LU/day	10	1 LU/500 kg LW 1 lb/ 453.6 g 604 kg/head 365 days in barn/yr	9.7
Misselbrook et al., 1998	8.3	g N/cow/day	8.3	365 days in barn/yr, 1lb/453.6 g 17 NH3/14 N	8.1
Van Der Hoek, 1998	14.5	kg /animal/year	14.5	2.2046 lb/kg	32
AVERAGE					18.5

Ammonia Emission Factor for Drylots at Dairy Operations

Reference	Emission Factor (EF)	Units of Emission Factor	Avg EF	Conversion Factor	EF (lb NH3/yr/head)
Misselbrook et al., 1998	8.3	g N/cow/day	8.3	1,000 g/kg, 2.2046 lb/kg 365 days/yr 17 NH3/14 N	8.1
USDA, 2000	8	kg/cow/yr	8	2.2046 lb/kg	17.6
USDA, 2000	30	lb/head/yr	30	NA	30
AVERAGE					18.58

Ammonia Emission Factor for Dairy Outdoor Confinement Areas

Reference	Emission Factor (EF)	Units of Emission Facto	Conversion Factors	EF
Bouwman et al., 1997	8	Percent of N	NA	8 percent of N

Particulate Matter (PM10) Emission Factors

Species	Location	Type	Size/ Number/Units	Emission Factor Average/median	Range	Units	Reference	Emission Factor Average/median (kg/yr/au)
Dairy	USA	Dry lot	500 au	2.3 lb/yr/au	N/a		1	1
Dairy	USA	Free stall	1000 hd/d	4.4 lb/1000 hd/d			7	2
Dairy	UK	Housed livestock		284 lbs/1000 hd			8	129

References

1 USDA. 2000. Confined Livestock Air Quality Subcommittee, J.M. Sweeten, Chair. U.S. Department of Agriculture, Agricultural Air Quality Task Force Meeting, Washington, DC. Air Quality Research & Technology Transfer Programs for Concentrated Animal Feeding Operations.

2 Grenlinger, M.A. 1997. Improved Emission Factors for Cattle Feedlots. Emission Inventory: Planning for the Future, Proceedings of Air and Waste Management Association, U.S. Environmental Protection Agency Conference. Volume 1, pp. 515-524. October 28-30.

3 Grelinger, M.A. and A. Page. 1999. Air Pollutant Emission Factors for Swine Facilities. Air and Waste Management Conference Proceedings. Pp. 398-408. October 26-28.

4 Takai et al. 1991

5 Grub, w., C.A. Roolo, J.R. Howes. 1965. Dust Problems in Poultry Environments. Transactions of the American Society of Agricultural Engineers. Pp. 338-39, 352.

6 Takai, H., S. Pederson, J.O. Johnson, J.H.M., Mertz, P.W.G. Groot Koerkamp, G.H. Uenk, V.R. Phillips, M.R. Holden, R.W. Sneath, J.L. Short, R.P. White, J. Hurtung, J. Seedorf, M. Schroder, K.H. Linker, C.M. Wathes. 1998. Concentrations and Emissions of Airborne Dust in Livestock Building in Northern Europe. Journal of Agricultural Engineering Resources 70:59-70

7 Goodrich, L.B., Parnell, C.B., Makhtar S., Lacey, R.E., Shaw, B.W Preliminary PM10 Emission Factors for Free stall Dairies. Department of Biological And Agricultural Engineering, Texas A&M University, College Station, TX. Paper # 024214 at 2002 ASAE Annual International Meeting.

8 The UK Emission Factor Database, National Atmospheric Emissions Inventory, www.naei.org.uk/emissions/index.php, 2000.

http://www.epa.gov/ttn/chief/conference/ei14/session7/reid_pres.pdf

	kg-PM10/1000head-day	
Emission factor from EPA guidance:		
•93 lbs of PM10/ 1,000 head of feeding beef cattle / day	42	
Emission factors from a literature search:		
•28.9 lbs of PM10/ 1,000 head of feeding beef cattle / day (University of California at Davis, 2001)	13	
•19 lbs of PM10/ 1,000 head of feeding beef cattle / day (Texas A&M University, 2002)	9	
•4.4 lbs of PM10/ 1,000 head of dairycattle / day (Texas A&M University, 2002)	2	0.73

Selected emission factors for CENRAP:

•24 lbs of PM10/ 1,000 head of feeding beef cattle / day

•4.4 lbs of PM10/ 1,000 head of dairy cattle / day

http://www.wrapair.org/forums/dejf/fdh/content/Ch13-Livestock_Husbandry_Rev06.pdf

PM10 Emission Factors for Cattle Feedlot and Dairy Operations

Source Category	Operation	PM10 Emission Factor	kg/head-yr		
Dairies	Corral/Manure Handling	1.845 lb/head-yr (freestall)	0.84		
		4.6 lb/head-yr (open corral)	2.09		
	Overall Management/Feeding	1.845 lb/head-yr (freestall)	0.84	1.90	Used for Dairy Task Force
		4.6 lb/head-yr (open corral)	2.09		
	Unpaved Road	0.369 lb/head-yr	0.17		
	Unpaved Area	0.123 lb/head-yr	0.06		

http://www.valleyair.org/busind/pto/dpag/FYI_%20Dairy_Feedlot_PM10_Emission_Factor.pdf

SAN JOAQUIN VALLEY UNIFIED AIR POLLUTION CONTROL DISTRICT

Source	Year	Location	EF (lbs-PM10/hd-yr)	EF (kg-PM10/hd-yr)	
USDA Report – UC Davis	Apr-01	Tulare and Kern	Feedlot Cattle –10.55 Dairy Cows – 32.85	4.8	14.9
ASAE – Texas A&M Univ1	Jul 28 – Jul 31, 2002	Relatively dry West Texas dairy	Milk cows – 1.6	0.73	
ASAE – Texas A&M Univ2	July 27 – 30 2003	Relatively dry West Texas dairy	• Box (total herd) – 2.17 • ISC Total herd – 2.39 • ISC – Freestalls with exercise pens – 1.37 • ISC Open Corrals – 5.46		

ASAE – Texas A&M – Phone Conv w/ Barry Goodrich	Summary of 2002 and 2003 study	Relatively dry West Texas dairy	• Freestall – 3.77 • Open Corrals – 7.1		
ASAE – Texas A&M Univ	August 1-4, 2004	Texas Cattle Feed yard	ISC Total Herd – 2.4		
ARB – Livestock Emissions inventory	May-04		• All Dairy Cattle – 2.46 (ASAE 2002) • Feedlot Cattle – 10.55 (USDA 2001)	1.1	4.8

1 Shade structures were provided for cows in the open corrals during this study

2 There were no shade structures in the open corrals during this study

http://www.valleyair.org/notices/Docs/1-17-06/ATC%20Application%20Review.pdf

PM10 Emission Factors for Open Corrals

	(lbs- PM10/head-y	Source	(kg- PM10/head-yr)	
Milk cows	4.6	SJVAPCD	2.09091	
Support stock	7.94	SJVAPCD	3.60909	3.601560374

PM10 Emission Factor for Freestalls

	(lbs- PM10/head-y	Source	(kg- PM10/head-yr)
Milk cows	1.845	CARB & SJVAPCD	0.83864

Methane

http://www.ec.gc.ca/pdb/ghg/inventory_report/2004_report/ann13_e.cfm#sa13_5

CH_4 Emission Factors for Livestock and Manure

Animal Type	Emission Factors		
	Enteric Fermentation	Manure Management	Total
	kg CH_4/head per year	*kg CH_4/head per year*	*kg CH_4/head per year*
Cattle	**<1>**	**<2>**	
Dairy Cows	134.8	29.6	164.4
Dairy Heifers	73	15.4	88.4

Notes:

<1> Sources of emission factors (Tier 2) are country-specific (Boadi *et al.* , 2004).

<2> Sources of emission factors (Tier 2) are country-specific (Marinier *et al.* , 2004).

Nitrogen Excretion Rate Animal Type

Animal Type	Average Manure Nitrogen Excretion per 1000kg Live Animal Mass Per Day 1.	Nitrogen Excretion (N ex) kg N/head-year
Non-Dairy Cattle	0.34	58.1
Dairy Cattle	0.45	108.2

Note:

1 ASAE Standards (ASAE, 2003).

Emission factors for U.S. Cattle by Region (lbs CH4/head/yr)

Mechanistic Model vs. IPCC Model

Animal Type/Region	National Average Mechanistic Model	IPCC Method	kg/hd/yr
Dairy Cattle			
Replacements 0-12 months	43.1	46.9	103.18
Replacements 12-24 months	129.4	127.5	280.5
Mature Cows	252.1	248.7	547.14

The IPCC emission factors for beef replacements 12-24 months were calculated to reflect the net energy for growth for medium frame heifer calves as cited in NRC (1984).

Feed and growth rates for weanlings in the U.S. are different from rates in the rest of the world; the IPCC method does not account for these differences, which could explain the differences in the estimates obtained from the two models.

The IPCC emission factors for bulls were calculated to reflect the intake requirements as cited in NRC (1984).

http://www.onep.go.th/projects/climate/comm/inventory/livestock/table5_7.html#5

Methane Producing Capacities (B_0) of the Manure of livestock[1]

Animal Types	B0, m3/kg VS
Dairy cattle	0.13

http://www.epa.gov/ttn/chief/ap42/ch14/final/c14s04.pdf

EMISSION FACTORS FOR U. S. CATTLE BY REGION (a)

EMISSION FACTOR RATING: E

Animal Type/Region	English Emission Factors					
	North Atlantic	South Atlantic	North Central	South Central	West **(oregon)**	National Average (b)
Dairy Cattle						
Replacements 0-12 months(c)	42.9	45.1	41.6	44.7	45.5	43.1
Replacements 12-24 months (c)	128.5	129.1	126.3	135.7	134.6	129.4
Mature Cows	258.5	278.3	240.7	257.7	262.5	252.1

(a) Units are lbs CH4 /head/year. Metric units are kg CH4 /head/year. Reference 5.

(b) National averages are weighted by regional populations as of 1990.

(c) A portion of the offspring are retained to replace mature cows that die or are removed from the herd (culled) each year. Those that are retained are called "replacements."

(d) In "weanling systems," calves are moved directly from weaning to confined feeding programs. This system represents a very fast movement of cattle through d to marketing. Weanling system cattle are marketed at about 420 days of age (14 months).

(e) These cattle types are typically not found in the North Atlantic and South Atlantic regions. If desired, it is appropriate to use the national total emission factor e for these regions.

(f) Yearling systems represent a relatively slow movement of cattle through to marketing. These systems include a wintering over, followed by a summer of f grazing on pasture. Yearling system cattle are marketed at 565 days of age (18.8 months). If desired, it is appropriate to use the national total emission factor for these regions.

source Emissions From Animal Feeding Operations

Animal Feeding Operations (146 of 414)

The EPA methodology is based on equation 8.3. Emissions are a function of the mass of volatile solids excreted, the methane producing capacity of manure from different animals, the type of waste management system, and the temperature of the manure.

Methane Emissions (per head)= VSexcreted × Bo × 0.67 kg/m 3 × MCF

Where:

VSexcreted = Volatile solids excreted (kg/yr)

Bo = Maximum methane producing capacity (m3 CH4/kg VS)

MCF = Methane conversion factor based on the waste management system (%)

0.67 = Methane density at 20 oC, 1 atmosphere (kg/m3)

The methane production potential of animal waste (Bo) is the maximum quantity of methane (m3 CH4) that can be produced per kilogram of volatile solids (VS) in the manure. Values for Bo are available from literature and are based on the animal species and diet.

Table 8-6 presents the values for Bo that have been used in developing EPA's greenhouse gas inventory and other EPA studies (USEPA, 2001).

Methane Production Potentials From Livestock and Poultry Manures

Animal type	B0 (m3 CH4/kg VS excreted)	Reference
Mature dairy cow	0.24	Morris (1976)

http://www.factoryfarm.org/docs/dairy_paper_sectI_III_IV.doc

Estimated methane emissions from livestock and poultry waste

Animal Type	Methane Emissions (kg/year per animal)
Dairy	70

Source: Jacobson, Larry D., et al., Generic Environmental Impact Statement on Animal Agriculture, University of Minnesota, College of Agriculture, Food, and Environmental Sciences, http://www.mnplan.state.mn.us/eqb/scoping.html, September, 1999, p. H-41.

Measured methane emission factors (MCF) for **dairy cows**

System Type	MCF estimates	MCF measured at
		20°C
Pasture/Feedlot	10	0.3
Liquid slurry	20-90	55.3
Solid	10	45.7

Source: Jacobson, Larry D., et al., Generic Environmental Impact Statement on Animal Agriculture, University of Minnesota, College of Agriculture, Food, and Environmental Sciences, http://www.mnplan.state.mn.us/eqb/scoping.html, September, 1999, p. H-41.

State GreenHouse Inventory Tool - Methan

H:\GHG\EPA_Guid_Tools\State Inventory Tools

	Emission Factor (kg CH4/head)
Dairy Cattle	
Dairy Cows	124.6
Dairy Replacement Heifers	56.6
Replacements 0-12 mos.	40.3
Replacements 12-24 mos.	63.4

from : EMISSION FROM ANIMAL FEEDING OPERATION
\\deqhq1\ei_files\CAFO\EmissionFromAnimalFeedingOperations.pdf

Summary of **Dairy** Emission Factors (Table 8-15)

Emission Source	Substance	Emission Factor Range (lb/yr-AU)	Number of Emission Factors	Average Emission Factor (lb/yr-AU)	References	kg/yr-AU	kg/yr-AU	Kg/yr-cow	
Freestall barn (flush)	NH3	—	—	28	**d**	12.7			
Freestall barn (scrape)	NH3	15.2 - 16.8	2	16/16.0	Demmers, et al., 2001; University of Minnesota, 1999.	7.3			
Drylot	NH3	4.5 - 13.4	3	10.2/9.0	Bouwman, et al., 1997; Misselbrook, et al., 1998; Van der Hoek, 1998.	4.6			
	N2O	—	—	4.4	**a**	2			
	PM	2.3	1	2.3/2.3	USDA, 2000	1.0			
Anaerobic lagoon	NH3	—	—	40	**b**	18.2			
	N2O	—	—	0.22	**a**	0.1			
	H2S	**—**	**—**	**15.7e, 4.1f**	**b**	7.1	1.86	2.61	9.99
	VOC	—	—	4.5	c	2.05			
Storage pond	N2O	—	—	0.22	**a**	0.1			
Liquid manure land application	NH3	18.7	1	18.7/18.7	Van der Hoek, 1998.	8.5			
Solids	NH3	5.9	1	5.9/5.9	Van der Hoek, 1998.	2.7			
storage	N2O	—	—	4.4	**a**	2			

a Calculated using a nitrogen in manure to nitrous oxide conversion factor. See Section 8.2.2.
b Calculated by transferring emissions from swine anaerobic lagoons. See Sections 8.2.1, 8.2.3, and Appendix E.
c Calculated using a volatile solids to VOC conversion factor. See Section 8.2.5.
d Calculated by transferring emissions from swine flush houses. See Appendix E for calculations.
e Used for model farms D1A, D1B, D4A and D4B; data was transferred from anaerobic lagoons following flush houses for swine.
f Used for model farms and D2A and S2B; data was transferred from anaerobic lagoons not following flush houses for swine.

Hydrogen Sulfide Emission Factors - Housing

Where does this come from?

Livestock	Housing System	Operation Type	Ventilation System	H2S Emissions	H2S Emission Factors (lb/day.place)	H2S Emission Factors (g/day.AU)	Comments	Ref	H2S Emission Factors (kg/day.place)	H2S Emission
Dairy	Freestall		Passive	0.4 ug/sec.m2	0.00028	0.0332	Assumes 40ft2/cow	1	0.000033	0.012

Animal Units (AU)

Tables 3-1A and 3-1B assume 2.5 swine > 25 kg = 1 AU, 1 feeder cattle = 1 AU. 1 dairy cow = 1.4 AU, 100 Broilers = 1 AU

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