# SAN JOAQUIN VALLEY UNIFIED AIR POLLUTION CONTROL DISTRICT

# OFFICE MEMO

**DATE:** April 12, 2006; Revised October 24, 2017

**TO:** SJVAPCD Permit Services Staff

**FROM:** Sheraz Gill; Revised by Ramon Norman, Air Quality Engineer II

**SUBJECT: Dairy and Feedlot $PM_{10}$ Emission Factors**

## I. Purpose

The purpose of this memo is to outline the $PM_{10}$ emission factors used by the District to calculate $PM_{10}$ emissions from the housing of animals at dairy and feedlot operations for permitting purposes. As with other emission factors and pollutant control efficiencies used by the District, the $PM_{10}$ emission factors in this document are subject to revision if better data become available.

## II. Summary

The uncontrolled $PM_{10}$ emission factors that will be used by the District to calculate $PM_{10}$ emissions from dairy and feedlot operations for permitting purposes are summarized in the tables below:

| Uncontrolled Dairy $PM_{10}$ Emission Factors | | | |
|---|---|---|---|
| **Type of Housing** | **Type of Cattle** | **Emission Factor (lb/head-yr)** | **Source** |
| Freestalls with Exercise Pens | Milk Cows, Dry Cows, Heifers, & Calves[1] | **1.37** | 2003 Texas A&M (ASAE 2003) |
| Open Corrals/Pens with no shade structures | Milk Cows & Dry Cows | **5.46** | 2003 Texas A&M (ASAE 2003) |
| | Large Heifers (15-24 months) | **8.01** | SJVAPCD |
| | Small Heifers (3-6 months) and Medium Heifers (7-14 months)[2] | **10.55** | 2001 USDA Report – UC Davis |
| | Calves | **1.37** | SJVAPCD |

[1] It is assumed that $PM_{10}$ emissions from heifers and calves kept in freestalls are the same as mature cows.
[2] It is assumed that the young heifers at a dairy are as active as feedlot cattle.

| $PM_{10}$ Emission Factors for Calves in Calf Hutches[3] | | |
|---|---|---|
| **Type of Housing** | **Emission Factor (lb/head-yr)** | **Source** |
| Calf Hutches, On-Ground | **0.343**[4] | SJVAPCD |
| Calf Hutches – Aboveground, Scraped | **0.206**[5] | SJVAPCD |
| Calf Hutches – Aboveground, Flushed | **0.069**[6] | SJVAPCD |

| Feedlot $PM_{10}$ Emission Factor | | | |
|---|---|---|---|
| **Type of Housing** | **Type of Cattle** | **Emission Factor (lb/head-yr)** | **Source** |
| Open Corrals with no shade structure | Feedlot Cattle | **10.55**[7] | 2001 USDA – ARB |

## III. Sources of Data

A total of six sources were considered for the determination of the dairy and feedlot $PM_{10}$ emission factors. These sources included five research studies as well as the $PM_{10}$ emission factors used in the California Air Resources Board (ARB) emissions inventory. These sources and the associated emission factors are shown in the table below. Additional discussion of each of these sources is given below with a brief description of the methodology that was used to arrive at the emission factors.

| | **Source** | **Year** | **Location of Study** | **EF (lb-$PM_{10}$/head-yr)** |
|---|---|---|---|---|
| 1 | USDA Report – UC Davis | April 2001 | Tulare and Kern Counties | Feedlot Cattle –10.55<br>Dairy Cows – 32.85 |
| 2 | Texas A&M University[8] (ASAE 2002) | June 2002 | Relatively dry West Texas dairy | Milk cows – 1.6 |
| 3 | Texas A&M University[9] (ASAE 2003) | June 2003 | Relatively dry West Texas dairy | • Box Model - total herd: 2.17<br>• ISC Model - total herd: 2.39<br>• ISC Model – freestalls with exercise pens: 1.37<br>• ISC Model - open corrals: 5.46 |

[3] Only calves are kept in calf hutches.
[4] As discussed in Section IV, on-ground calf hutches are assumed to reduce $PM_{10}$ emissions by 75% compared to calves in corrals/pens.
[5] As discussed in Section IV, aboveground calf hutches with manure removed by scraping are assumed to reduce $PM_{10}$ emissions by 85% compared to calves in corrals/pens.
[6] As discussed in Section IV, aboveground calf hutches with manure removed by flushing are assumed to reduce $PM_{10}$ emissions by 95% compared to calves in corrals/pens.
[7] This emission factor takes an average of March samples and during July. In July, water trucks were used for dust control in the animal enclosures and on the unpaved portions of roads surrounding the feedlot.
[8] Shade structures were provided for cows in the open corrals during this study
[9] There were no shade structures in the open corrals during this study

| | Source | Year | Location of Study | EF (lb-$PM_{10}$/head-yr) |
|---|---|---|---|---|
| 4 | Texas A&M University | 2006 (Summary of 2002 and 2003 studies) | Relatively dry West Texas dairy | • Freestalls – 3.77<br>• Open Corrals – 7.1 |
| 5 | Texas A&M University (ASAE/CSAE 2004) | Spring of 2004 | Texas cattle feed yard | ISC Model - total herd: 2.4 |
| 6 | ARB – Livestock Emissions inventory | May 2004 | | • All Dairy Cattle: 2.45 (Texas A&M - ASAE 2002)<br>• Feedlot Cattle: 10.55 (USDA/UC Davis 2001) |

1. USDA Report – UC Davis: This study was performed by UC Davis for the United States Department of Agriculture (USDA) and involved extensive testing for many agricultural sources, including field crops, orchard crops, and livestock. The dairy and feedlot studies were performed in Kern County and Tulare County from 1996-1998 using a series of models (Block Profile Model, Logarithmic Profile Model, and Box Model). The studies resulted in $PM_{10}$ emission factors of 10.55 lb/head-yr for feedlot cattle and 32.85 lb/head-yr for dairy cattle.

2. Texas A&M University (ASAE 2002): This study was performed by Texas A&M University in 2002 at a Texas dairy with the majority of milk cows housed in freestalls with exercise pens and the remaining milk cows housed in open corrals. No support stock was present during the testing. In this study a Box Model approach was used to estimate the PM emissions from the dairy. The PM emission factors reported in the study did not differentiate the emissions from the different types of housing (freestall or open corral). The preliminary results of this study were presented at the 2002 American Society of Agricultural Engineers (ASAE) Annual International Meeting in Chicago, IL, USA. The daily average $PM_{10}$ emission factor was reported as 2.0 kg/1000-head-day (1.6 lb/head-yr).

   During the study sampling period, the dairy was harvesting silage. This process involves cutting and chopping the silage in the field and transporting it to the storage pits with large trucks. The trucks were traveling on unpaved roads, which generated significant PM emissions. Road dust could not be avoided and the data was not corrected to account for this source of PM.

3. Texas A&M University (ASAE 2003): This study was a continuation of the 2002 Texas A&M Study at the same Texas dairy. The results of this study were presented at the 2003 ASAE Annual International Meeting in Las Vegas, NV, USA. The testing was performed a year later, during one week in June 2003. This study added the Industrial Source Complex (ISC) dispersion model to the original Box Model approach in order to differentiate the emissions from the different types of housing and to evaluate the performance of the models. Using the Box Model, a total dairy herd $PM_{10}$ emission factor of 6.8 kg/1000-head-day (2.17 lb/head-yr) was reported. The report indicates that

using the ISC model resulted in a total dairy herd $PM_{10}$ emission factor of 2.39 lb/head-yr, and that the $PM_{10}$ emission factors broken down by the types of housing were 1.7 kg/1000-head-day (1.37 lb/head-yr) from the freestalls and 6.8 kg/1000-head-day (5.46 lb/head-yr) from the open corrals.

4. Texas A&M University (2006): In the year 2006, District staff member Sheraz Gill spoke with Mr. Lee Barry Goodrich, one of the researchers for the 2002 and 2003 Texas A&M University dairy $PM_{10}$ emission studies (studies listed under #2 and #3 above) in order to better understand the studies. Mr. Goodrich stated the Box Model was not the best method to calculate emissions from dairies and that the data obtained in the 2002 study were re-run using the Industrial Source Complex - Short Term (version 3) (ISC-STv3) dispersion model. Mr. Goodrich provided Sheraz Gill with his draft revised emission factors that he said would be included in his report. The draft revised emission factors indicated that 3.77 lb/head-yr was attributed to milk cows housed in freestalls and 7.1 lb/head-yr was attributed to milk cows housed in open corrals. Mr. Goodrich also mentioned that these numbers remained uncorrected for the unpaved road and silage harvesting emissions (from the factors highlighted in the 2002 Texas A&M study).

5. Texas A&M University (ASAE/CSAE 2004): This study was performed by Texas A&M on a Texas cattle feedlot during a four-day period in the Spring of 2004 and the results of the study were presented at the 2004 ASAE/Canadian Society of Agricultural Engineering (CSAE) Annual International Meeting in Ottawa, Ontario, Canada. The analysis was performed using the ISC-STv3 dispersion model. This study included emissions from the unpaved roads adjacent to the feedyard. It was reported that these roads were heavily traveled during the daytime by passenger vehicles, feed trucks, large machinery, and other maintenance vehicles. This created a sizeable dust plume. In order to calculate PM emission factors for the feedlot, the unpaved road emissions were subtracted from the average daily emission factor. The differences in the daytime and nighttime emission factors were all attributed to road dust emissions. The $PM_{10}$ emission factors presented in the report are as follows:
   - Time weighted daytime average = 29 kg/1000-head-day (23.4 lb/head-yr)
   - Time weighted nighttime average = 3 kg/1000-head-day (2.4 lb/head-yr)
   - 24 hour weighted average = 19 kg/1000-head-day (15.3 lb/head-yr), including unpaved road dust emissions

   From this, 16 kg/1000-head-day (12.9 lb/head-yr) was attributed to road dust emissions and 3 kg/1000-head-day (2.4 lb/head-yr) was attributed to emissions from the corrals.

   As a note, the pen surface conditions at the feed yard were moist due to a rain event that occurred seven days before the first test. The pen surfaces remained moist during the four-day sampling period. However, the unpaved roads were reported as being dry throughout.

6. ARB Livestock Emissions Inventory $PM_{10}$ Emission Factors for Cattle: The California Air Resources Board (ARB) uses the following $PM_{10}$ emission factors for purposes of the ARB livestock emissions inventory: 6.7 lb/1000-head-day (2.45 lb/head-yr) for all dairy

cattle (this includes milk cows and support stock) and 28.9 lb/1000-head-day (10.55 lb/head-yr) for feedlot cattle. The dairy emission factor was developed using the 2002 ASAE Texas A&M study and multiplying that number by a scaling factor. The scaling factor was used to try to make the results more consistent with California geographic conditions. The USDA reported dairy emission factor of 32.85 lb/head-yr was excluded by ARB since it did not seem reasonable to have higher PM emissions from a dairy when compared to the reported emission factor for feedlots. The feedlot emission factor was developed using data from the USDA report (discussed in item #1).

## IV. Analysis of Data

### Dairy $PM_{10}$ Emission Factors:

$PM_{10}$ Emission Factors for Mature Cows (Milk Cows and Dry Cows)

The study performed by Texas A&M in 2003 appears to do a better job at refining the dairy $PM_{10}$ emission factors when compared to the other sources of data that were evaluated. No contamination from any other source was reported during measurement of the PM emissions from the freestalls and corrals. The study was also designed to evaluate emissions from the different types of housing. The study reported the following $PM_{10}$ emission factors the dairy:

- Milk Cows in Freestalls with Exercise Pens: 1.37 lb/head-yr
- Mature Cows in Open Corrals: 5.46 lb/head-yr.

Another source for dairy $PM_{10}$ emission factors was based on a phone conversation between Mr. Lee Barry Goodrich, one of the researchers for the 2002 and 2003 Texas A&M studies, and Mr. Sheraz Gill, a member of the District staff. Mr. Goodrich stated that significantly more work had gone into this research since the 2002 and 2003 Texas A&M studies had been completed. The subsequent work found that the Box Model used in 2002 and 2003 was inadequate for complicated source configurations, such as on the dairy. Therefore, all samples were consequently analyzed using ISC-STv3. The preliminary $PM_{10}$ emission factors provided to Mr. Sheraz Gill over the phone (3.77 lb/head-yr for freestalls and 7.1 lb/head-yr from open corrals) were a result of the analysis of all the results from both the 2002 and 2003 studies using ISC-STv3 and not the results from the Box Model.

The results of this analysis were included in Mr. Goodrich's master's thesis that was published in 2006. This paper must be carefully evaluated before the data from the paper can be used to establish $PM_{10}$ emission factors for dairies. The emission factors included in the paper are not consistent with the values reported in the 2002 and 2003 Texas A&M studies. District staff has begun the process of evaluating the information contained in the report. The master's thesis does not contain an explanation of the differences between the PM values reported therein and the previous reported values and does not contain sufficient details to resolve the differences between these values. Some of the differences may be related to the samplers that were chosen to represent the different sources, but this still does not explain the differences in the reported emission factor values that appear to be from the same PM sampler at the same time. It is possible that different calculation methods were used in the master's thesis compared to the previous published papers, but District staff were not able to locate

sufficient details on the calculations to determine this definitively. In addition, based on Mr. Sheraz Gill's phone conversation with Mr. Goodrich, these values also include emissions from silage harvesting and unpaved roads. It would be valuable to know the specific samples that may have been affected by these emissions to determine if the resulting values are representative of from the dairy cattle; however, the master's thesis does not mention the emissions from harvesting and unpaved roads. The PM emission factors included in the paper will not be used for the development of dairy $PM_{10}$ emission factors until a thorough evaluation of this paper and other information relevant to the study has been completed.

As mentioned above, the study performed by Texas A&M appears to do a better job at differentiating the dairy $PM_{10}$ emission factors from when compared to the other sources of data that were evaluated because the design of the study allowed for the $PM_{10}$ emissions from cattle housed in freestalls and open corrals to be distinguished. The review of the study also resulted in fewer questions related to the dairy $PM_{10}$ emissions factors reported than the other sources of data that were reviewed. Therefore, until better data becomes available or further analysis of the data has been completed, the San Joaquin Valley Air Pollution Control District will use the following $PM_{10}$ emission factors from the 2003 Texas A&M study to permit cattle housed in freestalls and mature cows in open corrals:

- Cattle in Freestalls with Exercise Pens: 1.37 lb/head-yr
- Mature Cows in Open Corrals: 5.46 lb/head-yr.

$PM_{10}$ Emission Factors for Heifers

For District permitting purposes, heifers at cattle facilities may be divided into the following categories: small heifers (age 3 to 6 months), medium heifers (age 7 to 14 months), and large heifers (age 15 to 24 months). In this memo it is assumed that the younger small and medium heifers at a dairy are as active as feedlot cattle and will therefore have the same $PM_{10}$ emission factor for District permitting purposes – 10.55 lb-$PM_{10}$/head-yr (see below). However, this assumption would not be accurate for large heifers at cattle facilities. Beef cattle are generally raised for some time at other facilities until they are ready to be moved to a feedlot. Beef cattle at a feedlot are then raised to a weight of 1,050 to 1,150 pounds and an age of 18 to 24 months, at which time they are marketed.[10] Beef cattle may continue to be active throughout their time at a feedlot. This is different than large heifers, which have generally been bred with the goal of having them deliver their first calf at around 24 months of age.[11] During the age of 15-24 months, bred heifers become increasingly heavy with the calves they are carrying and become progressively less active. By around 24 months of age large heifers are ready to deliver their first calves and have activity levels that are basically identical to mature cows. During the age of 15-24 months, heifers are transitioning from young active heifers to mature cows, which are not as active; this results in a lower $PM_{10}$ emission factor for mature cows (milk and dry cows) as described above.

[10] http://www.calcattlemen.org/cattle_101/how_cattle_are_raised.aspx

[11] Stull, C., Berry, S., and DePeters, E., editors (1998) Animal Care Series: Dairy Care Practices, Second Edition. University of California Cooperative Extension Dairy Workgroup, University of California, Davis, June 1998. Available at: http://www.dairyweb.ca/Resources/USWebDocs/Welfare2.pdf

Although, no study was located that specifically measured PM emissions from large heifers, observations and experience reported by dairy representatives support that large heifers are less active and appear to generate less dust than younger cattle at dairies. Therefore, the $PM_{10}$ emission factor for large heifers should reflect this.

As explained above, large heifers (age 15-24 months) are being prepared to deliver their first calf and are transitioning from young active heifers to mature cows that are not as active and generate less dust. Therefore, this memo presents a specific uncontrolled $PM_{10}$ emission factor for use to calculate $PM_{10}$ emissions from large heifers (age 15-24 months) in corrals/pens. Because no study was located that specifically measured PM emissions from large heifers, the specific uncontrolled $PM_{10}$ emission factor for use to calculate $PM_{10}$ emissions from large heifers (age 15-24 months) in corrals/pens will be based on the average of the $PM_{10}$ emission factors for milk and dry cows in corrals (5.46 lb-$PM_{10}$/head-year) and heifers in corrals (10.55 lb-$PM_{10}$/head-year) as presented above. As shown below, this results in a $PM_{10}$ emission factor 8.01 lb-$PM_{10}$/head-year for large heifers in corrals/pens.

(10.55 lb-$PM_{10}$/head-yr + 5.46 lb-$PM_{10}$/head-yr)/2 = 8.01 lb-$PM_{10}$/head-yr

<u>$PM_{10}$ Emission Factors for Calves in Corrals/Pens</u>

Currently, there is no emission factor established for calves, nor have there been any studies undertaken to develop one. Therefore, this memo will attempt to establish a calf emission factor using the best available data from the studies evaluated in this memo. This memo will develop a worst-case $PM_{10}$ emission factor based on the type of housing that has the potential of creating the most $PM_{10}$ emissions. A control efficiency can be applied to this emission factor if better calf housing are used.

Calves weigh less than 200 pounds, are generally fed a liquid diet, and are generally housed in hutches or small individual pens. Hutches are usually small-enclosed houses with an opening in the front and large enough for calves to lie down. There are several types of hutches/individual pens at a dairy. Individual pens are similar to an open corral type housing, with the exception of the size and that amount of cows held per pen. Calve hutches can either be placed directly on the ground with bedding or on grates, where the manure falls onto a concrete lane so that it can be flushed.

Based on the type of housing discussed above, it would appear that the worst-case emissions would likely be generated from individual pens, which are open to the elements. Due to the type of confinement of these calves, the emissions would resemble an emissions profile similar to cows housed in freestalls (1.37 lb/head-yr). Keeping in mind that the emissions would likely be lower for calves due to the difference in weight and activity between milk cows and calves, an emission factor of 1.37 lb/head-yr would be far better than the current factor of 2.46 lb/head-yr used by ARB and would be considered a conservative estimate considering no data is available. As mentioned earlier, further reductions can be obtained by using different types of calve housing systems (Refer to the draft SJVAPCD Memo *Dairy/Feedlot $PM_{10}$ Mitigation Practices and their Control Efficiencies*). Therefore, in order to be conservative, an uncontrolled emission factor of 1.37 lb/head-yr will be used for calves.

The following table outlines the uncontrolled $PM_{10}$ emission factors that the San Joaquin Valley Air Pollution Control District will use for permitting dairy cattle in the San Joaquin Valley:

| Uncontrolled Dairy $PM_{10}$ Emission Factors | | | |
|---|---|---|---|
| **Type of Housing** | **Type of Cattle** | **Emission Factor (lb/head-yr)** | **Source** |
| Freestalls with Exercise Pens | Milk Cows, Dry Cows, Heifers, & Calves[12] | **1.37** | 2003 Texas A&M (ASAE 2003) |
| Open Corrals/Pens with no shade structures | Milk Cows & Dry Cows | **5.46** | 2003 Texas A&M (ASAE 2003) |
| | Large Heifers (15-24 months) | **8.01** | SJVAPCD |
| | Small Heifers (3-6 months) and Medium Heifers (7-14 months)[13] | **10.55** | 2001 USDA Report – UC Davis |
| | Calves | **1.37** | SJVAPCD |

$PM_{10}$ Emission Factors for Calves in Calf Hutches

The uncontrolled $PM_{10}$ emission factor given for calves above is for calves that are housed in individual pens that are similar to open corral housing, with the exception of the size and the number of cattle per pen. However, calves are commonly housed in calf hutches to shelter them from the elements and reduce transmission of infectious diseases. Calf hutches may be placed directly on the ground with bedding or on grates, where the manure falls onto a concrete lane so that it can be removed by scraping or flushing. Calf hutches that are on the ground use some type bedding (e.g. hay) below the calves, which may create a potential for PM emissions; however, because calves don't move much and are confined to very a small area, calf hutches still will reduce potential $PM_{10}$ emissions compared to the uncontrolled baseline $PM_{10}$ emission factor for calves given above. In accordance with the draft SJVAPCD Memo *Dairy/Feedlot $PM_{10}$ Mitigation Practices and their Control Efficiencies*, housing calves in calf hutches will be assumed to reduce $PM_{10}$ emissions from calves by 75%-95%. Housing calves in on-ground calf hutches will be assumed to reduce $PM_{10}$ emissions from calves by 75% and housing calves in aboveground calf hutches with manure removed by scraping will be assumed to reduce $PM_{10}$ emissions from calves by 85%. $PM_{10}$ emissions from aboveground calve hutches on grates with manure removed by flushing could be considered negligible because of very low potential for PM emissions; however, to be conservative, a 95% control will be applied to aboveground calve hutches that use a flush system to remove manure.

The following table outlines the $PM_{10}$ emission factors that the San Joaquin Valley Air Pollution Control District will use for permitting calves housed in calf hutches:

[12] It is assumed that $PM_{10}$ emissions from heifers and calves kept in freestalls are the same as mature cows.
[13] It is assumed that the young heifers at a dairy are as active as feedlot cattle.

| $PM_{10}$ Emission Factors for Calves in Calf Hutches | | |
|---|---|---|
| **Type of Housing** | **Emission Factor (lb/head-yr)** | **Source** |
| Calf Hutches, On-Ground | **0.343** | SJVAPCD |
| Calf Hutches – Aboveground, Scraped | **0.206** | SJVAPCD |
| Calf Hutches – Aboveground, Flushed | **0.069** | SJVAPCD |

ARB Emissions Inventory Dairy $PM_{10}$ Emission Factor

As mentioned above, the ARB uses a $PM_{10}$ emission factor of 2.46 lb/head-yr for all dairy cattle for purposes of the ARB livestock emissions inventory. This $PM_{10}$ emission factor was derived from the 2002 Texas A&M study (discussed on above) and multiplying by a scaling factor that was based on the ratio of the California Feedlot $PM_{10}$ emission factor to a Texas feedlot $PM_{10}$ emission factor. This feedlot $PM_{10}$ emission factor was referenced in the 2002 Texas A&M study. The scaling factor was applied to adjust for climate conditions in California.

There are some concerns with the use of this emission factor to calculate Pm10 emissions from dairy cattle, as follows:

- The 2.46 lb/head-yr EF cannot be applied to all dairy cattle, since the only cows tested during the study were milk cows.
- This emission factor does not differentiate between emissions from open corral housing and freestall housing even though there is a significant difference in emissions from the two types of housing.
- This emission factor includes emissions from silage harvesting and unpaved road emissions.
- There is no reason to assume a scaling factor in developing this emission factor. The climates in Texas and California are fairly similar in the summer months would be expected to result in similar emissions. Additionally, a direct correlation between the various geographic conditions cannot be established. Therefore, the scaling factor will be considered arbitrary, further raising doubt about this emission factor.

**Feedlot $PM_{10}$ Emission Factor**

ARB uses an emission factor of 10.55 lb/head-yr for feedlot cattle, which was based on the 2001 USDA study (listed in item #1). The only other study that evaluated a feedlot emission factor was the 2004 Texas A&M study (#5). This study raises questions about the reported feedlot emission factor due to some externalities at the feedlot. A rain event occurred at the feed yard seven days prior to the test, which kept the pen surfaces moist during the 4-day sampling period. The unpaved roads, however, were dry throughout the entire period. These roads were heavily traveled during the daytime by passenger vehicles, feed trucks, large machinery, and other maintenance vehicles, which created a sizeable dust plume. All of the emissions generated during the daytime beyond the amount created by the cattle at night were attributed to the unpaved roads. Cattle generally tend to be more active in the daytime hours, resulting in higher emissions. However, this was not considered in developing the emission

factor outlined in this study. Therefore, until better data becomes available, the emission factor of 10.55 lb/head-yr, currently used by ARB, will be used for feedlot cattle operations.

The following table gives the uncontrolled $PM_{10}$ emissions factor that will be used for permitting feedlot cattle in the San Joaquin Valley:

| **Feedlot $PM_{10}$ Emission Factor** | | | |
|---|---|---|---|
| **Type of Cattle** | **Type of Housing** | **Emission Factor (lb/head-yr)** | **Source** |
| Feedlot Cattle | Open Corral | **10.55**[14] | 2001 USDA – ARB |

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[14] This emission factor takes an average of March samples (when ground surface was relatively wet) and during July. In July, water trucks were used for dust control in all of the animal enclosures and on the unpaved portions of roads surrounding the feedlot.

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