

**Field Survey of Ambient Concentrations of Hydrogen Sulfide
(H₂S) Associated with Feedyards in the Texas Panhandle**

FINAL REPORT

**Research project funded and submitted to the
Texas Cattle Feeders Association**

November 14, 2003

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SUMMARY

Concentrations of hydrogen sulfide (H_2S) in ambient air were semicontinuously measured at Feedyard C in northwestern Texas in three seasons: Fall 2002 (10 days), Winter 2003 (14 days), and Spring 2003 (15 days). Air sampling was conducted at the western fence line of cattle pens. Measured concentrations were measured when this location was upwind or downwind of the feedyard pens depending on the wind direction. Sampling port was located 5 feet above the ground. Hydrogen sulfide concentrations were measured using a continuous H_2S analyzer housed in an onsite instrument shelter. It was assumed that H_2S represents a major fraction of the total reduced sulfur concentration measured, i.e., the ambient air concentrations of other sulfur-containing gases were assured negligible. The experimental setup worked well and proved itself to be reliable in widely different weather conditions and operational for unattended and automated measurements.

Hourly averages of measured H_2S concentrations were always lower than the ambient air ground level concentration maximums for the State of Texas defined as 80 ppbv (30 min average) on residential, business or commercial property and 120 ppbv (30 min average) for other property for the State of Texas (Title 30 TAC 112.31-112.32). Also, the hourly average of measured H_2S concentrations were negligible compared to the thresholds for workplace exposures defined as (1) "OSHA General Industry PEL: 20 ppmv ceiling for 10 min once only if no other measurable exposure occurs and 50 ppmv peak", (2) OSHA Construction Industry PEL: 10 ppmv (15 mg/m^3) TWA, (3) ACGIH TLV: 10 ppmv (14 mg/m^3) TWA; 15 ppmv (21 mg/m^3) STEL, and (4) NIOSH REL: 10 ppmv ceiling 10 min. The average of the fall, winter, and spring hourly-averaged concentrations was 6.85 ppbv, 0.62 ppbv, and 2.19 ppbv, respectively. The highest hourly average of 34.9 ppbv was measured in the Spring 2003, followed by the 29.6 ppbv in the Fall 2002. The H_2S concentrations had a characteristic daily pattern with two local maximums in the early afternoon and early evening hours. The lowest concentrations were always measured during the night.

METHODOLOGY

Site selection and sampling time. Concentrations of hydrogen sulfide (H_2S) in ambient air were semicontinuously measured at Feedyard C in northwestern Texas in three seasons: Fall 2002 (10 days), Winter 2003 (14 days), and Spring 2003 (15 days). Air sampling was conducted at the western fence line of cattle pens. **Figure 1** shows the approximate location of sampling points for each season. Measured concentrations were measured when this location was upwind or downwind of the feedyard pens depending on the wind direction. Sampling port was located 5 feet above the ground. **Figure 2** and **Figure 3** show the actual photo of the instrument shelter at Feedyard C and a close-up of an H_2S sampling port.

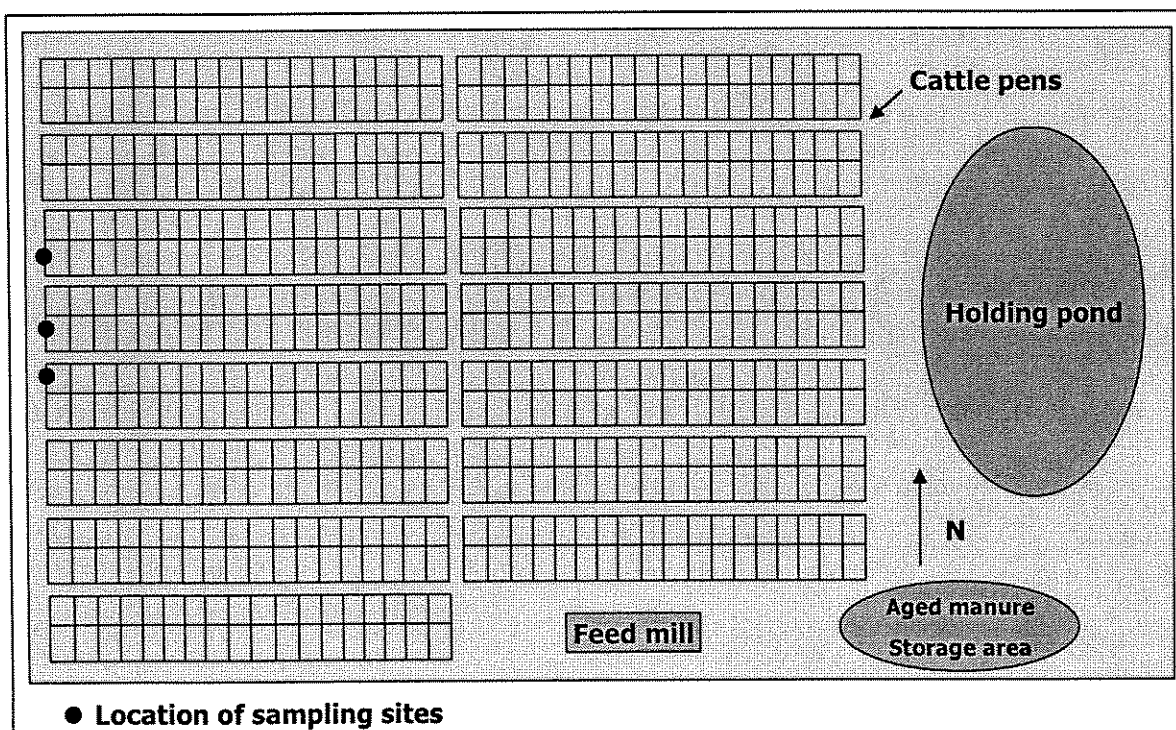


Figure 1. Schematic of sampling locations for semi-continuous measurements of ambient air H_2S concentrations at Feedyard C.

Hydrogen sulfide analyzer. Hydrogen sulfide concentrations were measured using a continuous H_2S analyzer (model 45 C, from Thermo Environmental Instruments, Franklin, MA) housed in an onsite instrument shelter. The analyzer was calibrated daily using UHP-grade air, certified standard H_2S gas in N_2 (2 ppmv) and SO_2 in N_2 (1 ppmv) (AirGas Southwest, Amarillo, TX).

Data acquisition and data analysis. A Campbell Scientific data logger CR23X was used as an automated data acquisition system. The system recorded 60 sec rolling average concentration measurements. Concentrations of H_2S were measured during three, 10 min intervals in each hour. However, only the last 3 min of each 10 min interval were

used for data analysis due to the minimum time required to obtain a stable measurement reading. Data were downloaded daily. Average 3 min concentrations were averaged on 1 hr basis.

It was assumed that H_2S represents a major fraction of the total reduced sulfur concentration measured, i.e., the ambient air concentrations of other sulfur-containing gases were assured negligible. The experimental setup worked well and proved itself to be reliable in widely different weather conditions and operational for unattended and automated measurements.

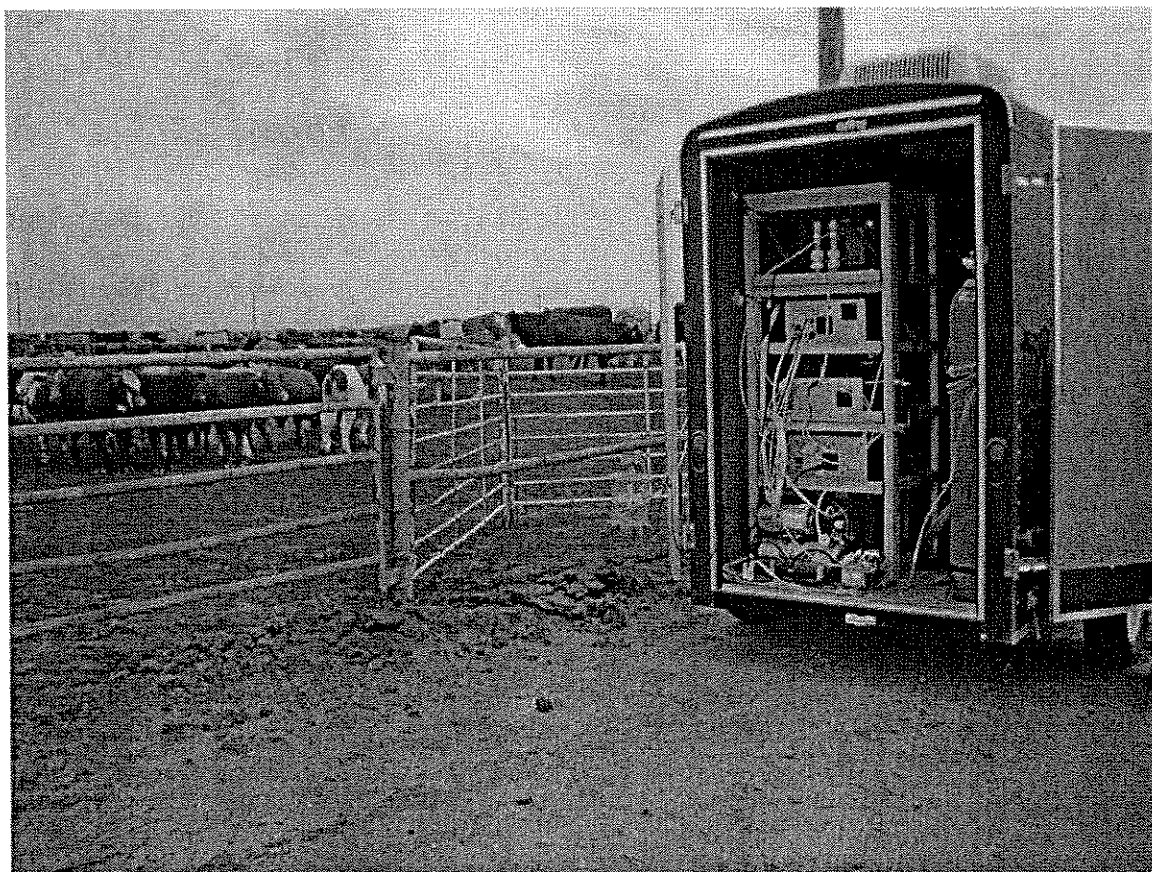


Figure 2. Semi-continuous measurements of ambient air H_2S concentrations at Feedyard C using an instrument shelter with continuous H_2S analyzer.



Figure 3. Location of gas sampling port for semi-continuous measurements of ambient air H₂S concentrations at Feedyard C.

RESULTS

Table 1 summarizes the hourly averaged concentrations of H₂S measured at Feedyard C.

Table 1. Summary of hourly averages, hourly minimums, and hourly maximums of H₂S concentrations in ambient air measured at beef cattle “Feedyard C” in the Fall 2002, Winter 2003, and Spring 2003.

Season	Number of Measurement Days	Average	Hourly Averaged H ₂ S concentrations (ppbv)		
			Standard Deviation	Minimum	Maximum
Fall 2002	10	6.85	4.36	0.00	29.6
Winter 2003	14	0.62	0.63	0.00	3.50
Spring 2003	15	2.19	3.18	0.00	34.9

Tables 2, 3, and 4 summarize the daily average, minimum, and maximum measured concentrations in the Fall 2002, Winter 2003, and Spring 2003, respectively.

Table 2. Summary of daily average, minimum, and maximum H₂S concentrations in ambient air measured at beef cattle “Feedyard C” in the Fall 2002.

Day	Date	H ₂ S concentrations (ppbv)		
		Daily Average	Daily Minimum	Daily Maximum
1	11/04/2002	1.95	0.00	12.3
2	11/05/2002	2.99	2.52	5.12
3	11/06/2002	3.84	2.19	14.1
4	11/07/2002	4.25	0.00	7.64
5	11/08/2002	4.70	0.00	13.0
6	11/09/2002	6.97	0.00	13.0
7	11/10/2002	11.4	8.52	21.7
8	11/11/2002	13.7	8.53	29.6
9	11/12/2002	9.55	8.50	12.4
10	11/13/2002	9.51	8.49	10.6
Average		8.22		

Note: Each entry in “Daily Average” column represents an average of hourly averages. The entries in minimum and maximum columns represent the minimum and maximum of hourly averages, respectively. The “Average entry represents the average of “Daily Averages”.

Table 3. Summary of daily average, minimum, and maximum H₂S concentrations in ambient air measured at beef cattle “Feedyard C” in the Winter 2003.

Day	Date	H ₂ S concentrations (ppbv)		
		Daily Average	Daily Minimum	Daily Maximum
1	1/09/2003	0.03	0.00	0.14
2	1/10/2003	0.12	0.00	0.14
3	1/11/2003	0.18	0.13	0.61
4	1/12/2003	0.14	0.13	0.15
5	1/13/2003	0.14	0.00	0.64
6	1/14/2003	0.19	0.00	0.64
7	1/15/2003	0.13	0.00	0.33
8	1/16/2003	0.74	0.00	3.50
9	1/17/2003	1.28	0.00	1.45
10	1/18/2003	1.36	0.00	2.15
11	1/19/2003	1.35	0.00	1.66
12	1/20/2003	1.33	0.00	1.68
13	1/21/2003	1.18	0.00	1.41
14	1/22/2003	0.52	0.00	1.30
Average		0.62		

Note: Each entry in “Daily Average” column represents an average of hourly averages. The entries in minimum and maximum columns represent the minimum and maximum of hourly averages, respectively. The “Average entry represents the average of “Daily Averages”.

Table 4. Summary of daily average, minimum, and maximum H₂S concentrations in ambient air measured at beef cattle “Feedyard C” in the Spring 2003.

Day	Date	H ₂ S concentrations (ppbv)		
		Daily Average	Daily Minimum	Daily Maximum
1	4/25/2003	0.16	0.00	1.09
2	4/26/2003	1.08	0.30	4.22
3	4/27/2003	1.20	0.15	3.81
4	4/28/2003	2.71	0.00	10.0
5	4/29/2003	2.91	0.00	1.99
6	4/30/2003	1.10	0.00	1.99
7	5/01/2003	3.34	0.00	17.8
8	5/02/2003	7.46	0.00	34.9
9	5/03/2003	2.99	1.38	6.33
10	5/04/2003	2.23	1.25	3.89
11	5/05/2003	1.35	0.00	2.58
12	5/06/2003	2.03	0.37	5.21
13	5/07/2003	1.89	0.00	3.21
14	5/08/2003	1.04	0.00	3.23
15	5/09/2003	0.30	0.25	0.48
Average		2.12		

Note: Each entry in “Daily Average” column represents an average of hourly averages. The entries in minimum and maximum columns represent the minimum and maximum of hourly averages, respectively. The “Average entry represents the average of “Daily Averages”.

Figures 4, 5, and 6 summarize the hourly averages of H₂S concentrations in ambient air measured in Feedyard C in the Fall 2002, Winter 2003, and Spring 2003, respectively. Each data point in **Figures 4, 5, and 6** represents the average of all hourly averages for a given hour within the same season. The error bars represent one standard deviation around the average of hourly averages. The H₂S concentrations had a characteristic daily pattern with two local maximums in the early afternoon and early evening hours shown in the fall and spring seasons. The winter season had only one local maximum in the early afternoon hours. The lowest concentrations were always measured during the night.

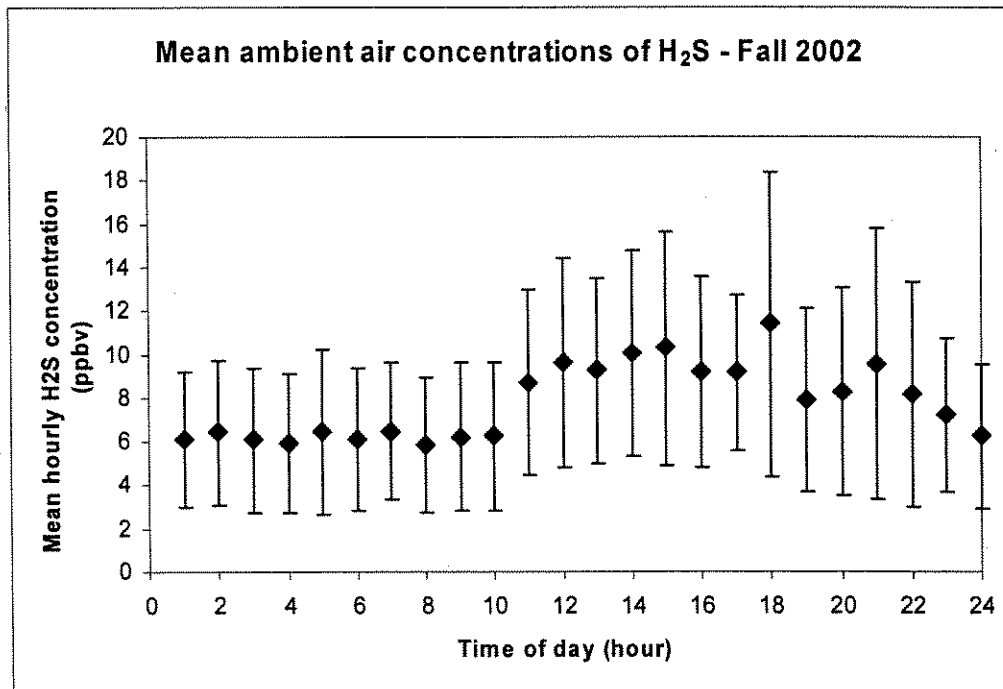


Figure 4. Summary of hourly averages of H₂S concentrations in ambient air measured in Feedyard C in the Fall 2002.

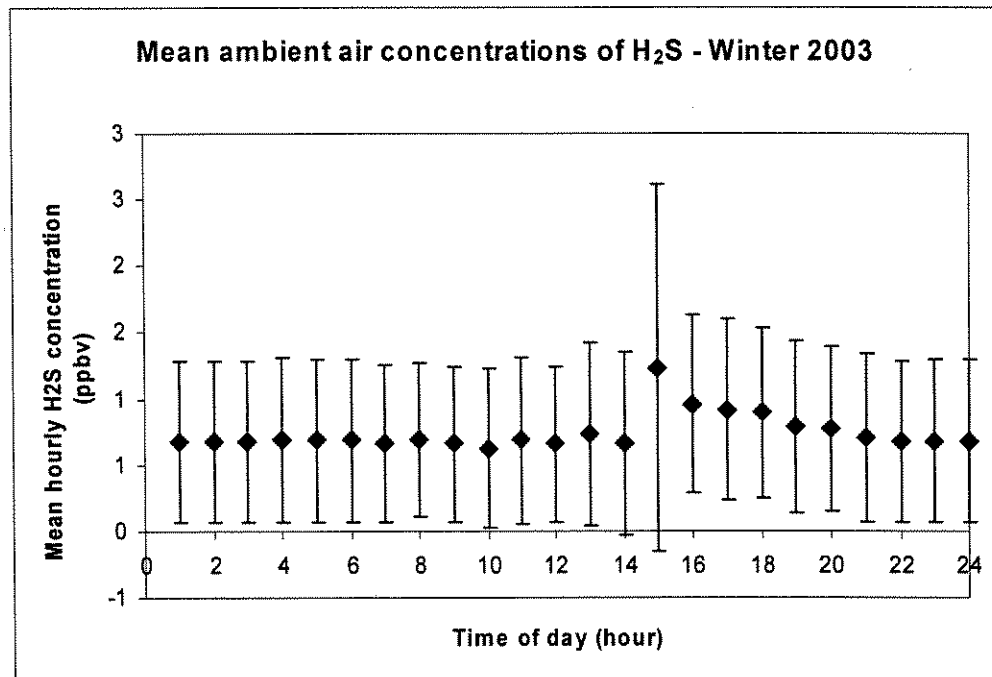


Figure 5. Summary of hourly averages of H₂S concentrations in ambient air measured in Feedyard C in the Winter 2003.

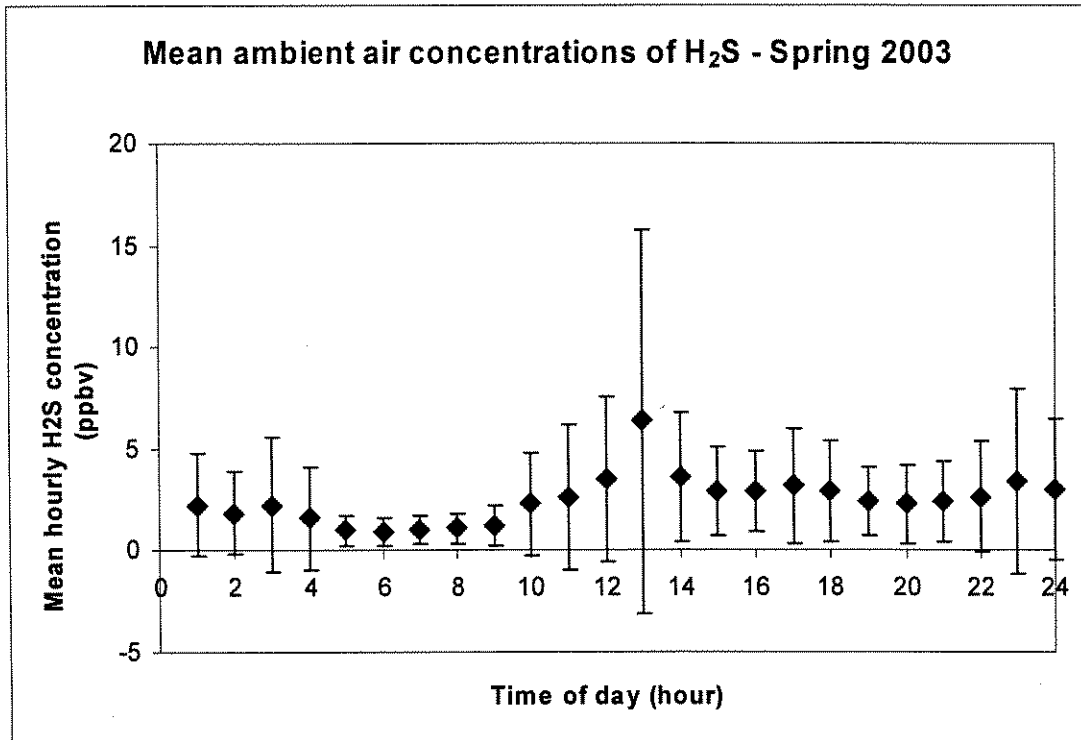


Figure 6. Summary of hourly averages of H₂S concentrations in ambient air measured in Feedyard C in the Spring 2003.

CONCLUSIONS

Measured concentrations could be compared with the threshold values established for regulatory purposes. However, it is important to emphasize that the data averaging time used in this project is 1 hr. This averaging time is longer than those used in regulations (10 min, 15 min, and 30 min). Hourly averages of measured H₂S concentrations were always lower than the ambient air ground level concentration maximums for the State of Texas defined as 80 ppbv (30 min average) on residential, business or commercial property and 120 ppbv (30 min average) for other property for the State of Texas (Title 30 TAC 112.31-112.32). Also, the hourly average of measured H₂S concentrations were negligible compared to the thresholds for workplace exposures defined as (1) “OSHA General Industry PEL: 20 ppmv ceiling for 10 min once only if no other measurable exposure occurs and 50 ppmv peak”, (2) OSHA Construction Industry PEL: 10 ppmv (15 mg/m³) TWA, (3) ACGIH TLV: 10 ppmv (14 mg/m³) TWA; 15 ppmv (21 mg/m³) STEL, and (4) NIOSH REL: 10 ppmv ceiling 10 min.

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