

AG HEALTH 101

UNIT 5

Air Quality & Gas Exposures

On the Farm



CHAPTER

DISCUSSION QUESTIONS



Chapter 1. Introduction

Have you personally heard of anything in the media about hazardous gases that have injured workers on the farm? Where on the farm and what was the exposure?



Chapter 2. Carbon Monoxide

What areas/equipment in your home might generate CO if it wasn't operating correctly? Do you have a CO monitor nearby this source?



Chapter 3. Carbon Dioxide

Think about times you were in a public building and "felt tired." Describe the event, including what season this happened in. Do you think CO₂ was the issue? How could you assess this?



Chapter 4. Nitrogen Dioxide

Exposures to NO₂ are rare outside of industry. Think about how you would determine if an agricultural worker was possibly exposed to this risk. What questions would you ask?



Chapter 5. Ammonia

Discuss your use of ammonia products (look at various cleaning supplies for the compound) and describe the unique smell of ammonia. How would you ask workers about their exposure to these gases at work?



Chapter 6. Methane

When walking into a livestock building, you want to know whether there are any ignition sources near the ceiling, particularly if there is the condition of "foaming manure." What types of things would you look for near the ceiling that might "ignite" methane?



Chapter 7. Hydrogen Sulfide

Have you ever smelled a "rotten egg" smell in your home? Think about and describe your plan of action if you come across a smell of hydrogen sulfide in your home.

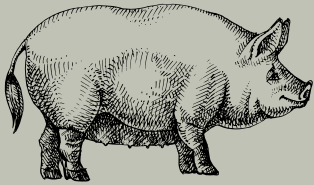


Chapter 8. Organic Dusts

If you live by a gravel road, you can see a difference in dust during the dry season walking by the road with a flashlight at night. Describe a time when you thought it was dusty, and how did you know? I challenge you to, with the lights off (or dim), take a flashlight or laser pen and shine it in the area. Can you see all the particles moving?

Chapter 1 INTRODUCTION

Gas Sources in Livestock Production



Manure Storage

Under slatted floor
Outside lagoon, pit, or tank

Manure pumping

Under slatted floor
Outside lagoon, pit, or tank

Foaming Manure

If foaming is present, significant methane risk

Gas-Fired Heaters

Combustion byproducts

Animal

Exhaled breath

Hydrogen Sulfide (H₂S)

Methane (CH₄, LEL)

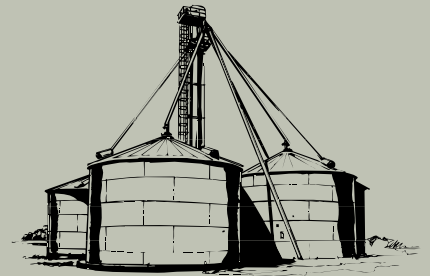
Ammonia (NH₃)

Carbon Monoxide (CO)

Carbon Dioxide (CO₂)

Nitrogen Dioxide (NO₂)

Gas Sources in Grain Bins



Inside Bins

Out-of-condition grain
Gas-fired dryers

Equipment

Overheated equipment
Smoldering product

Silos

Naturally-fermenting silage

Non-gas hazards include dust and endotoxin exposures and other animal handling risks.

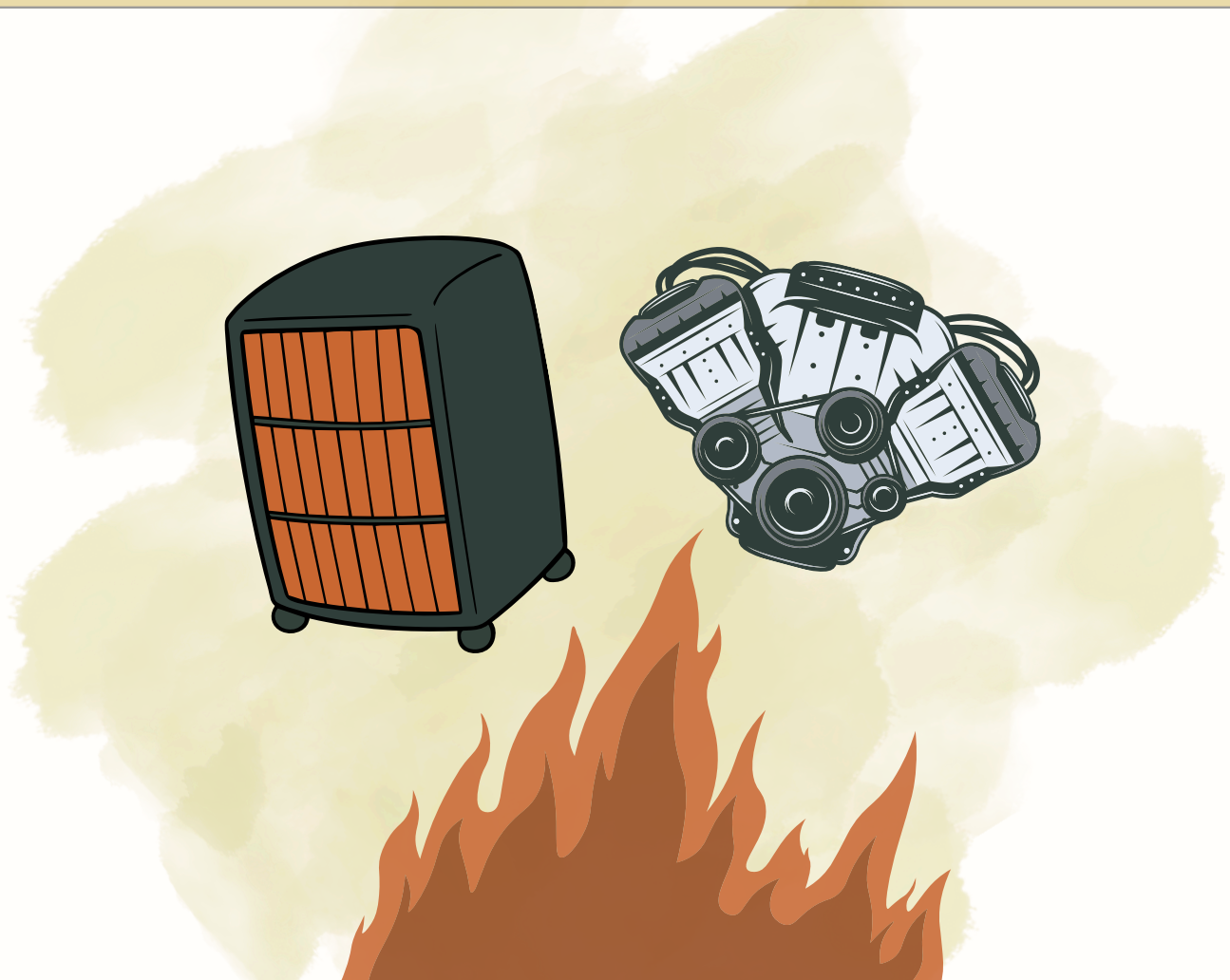
Non-gas hazards include dust explosions and engulfment in grain.

Chapter 2

CARBON MONOXIDE (CO)

Hazard: High levels of CO in the blood reduces blood oxygen concentration

Sources: Any combustion process has the possibility of creating CO



Low

<9 ppm: Comfortable living concentration
(35 ppm = 8-hr allowable)



Medium

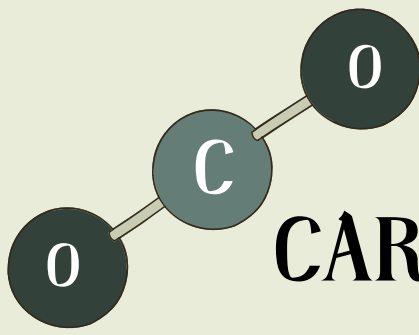
200 ppm: Headache, dizziness, nausea in 2 hours



High

400 ppm: Life threatening in 3 hours

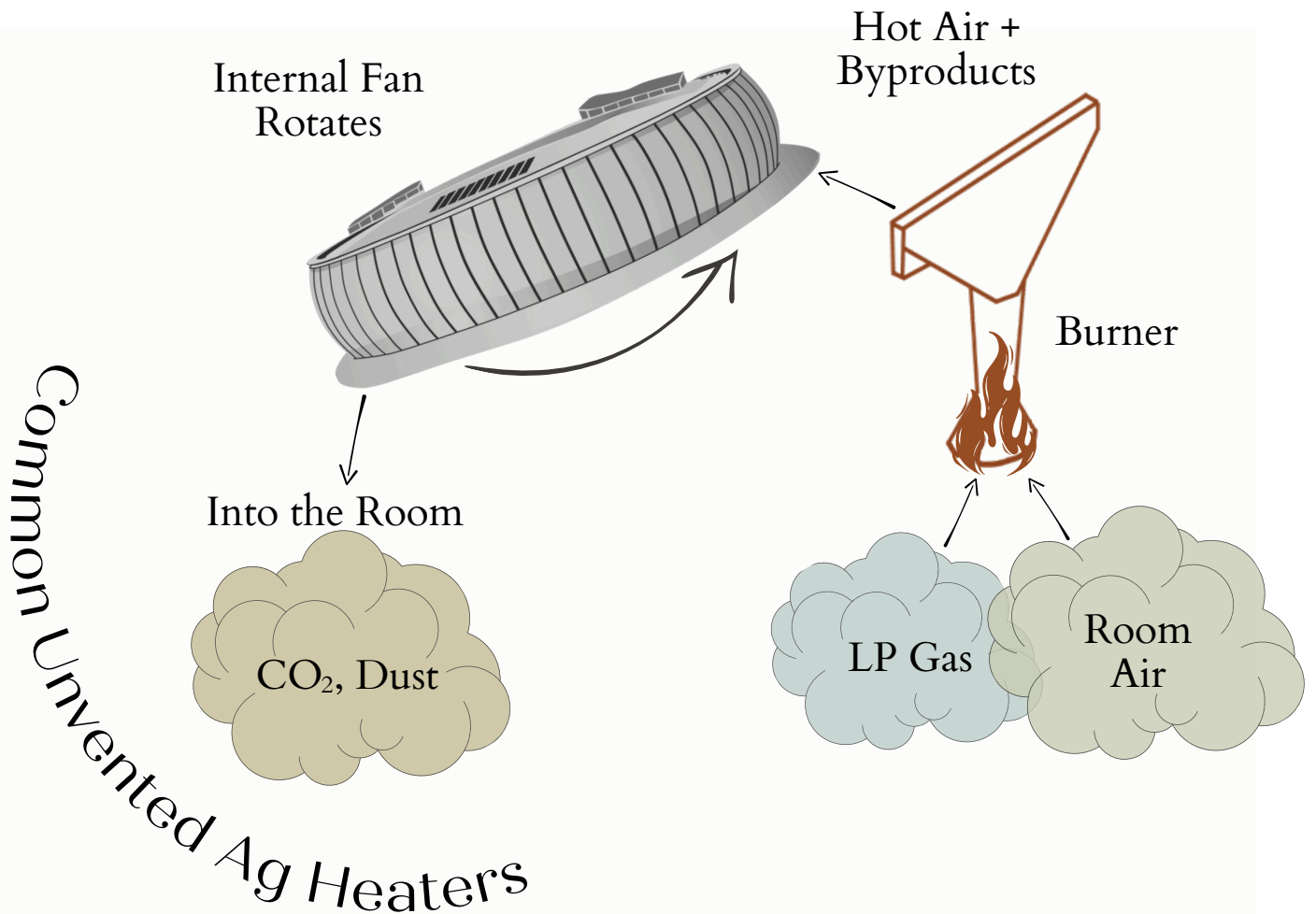
Children, elderly, pregnant women, etc. are at risk at lower CO concentrations. The concentrations are relevant only at "sea level."

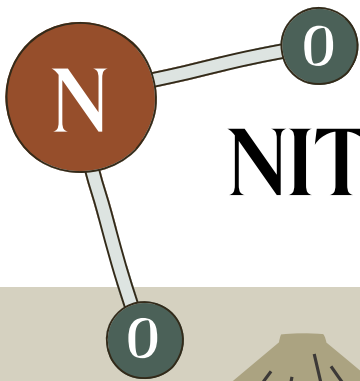


Chapter 3

CARBON DIOXIDE (CO₂)

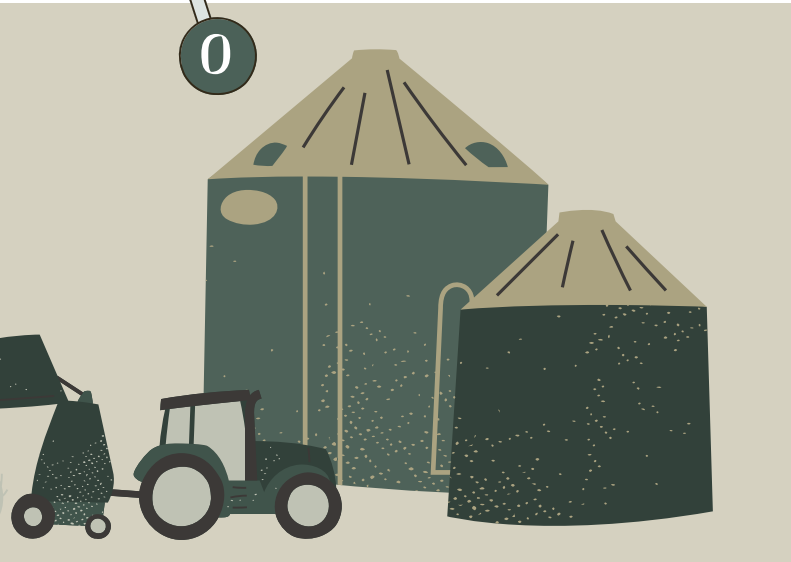
Low	600-1000 ppm: Odor, muscle stiffness
Medium	1000-2500 ppm: General drowsiness
	5000 ppm: 8-hr maximum
High	30,000 ppm (3%): Increased pulse rate, nausea, impairment





Chapter 4

NITROGEN DIOXIDE (NO₂)



Grain Bins

- Some dry grains like corn, soybeans, and wheat
- Found on grain farms and at grain elevator sites
- Wide, made of corrugated steel (shiny metal color)

Carbon Monoxide (CO) + Carbon Dioxide (CO₂)

Silos

- Stored silage or fermented pasture grasses used for animal feed
- Found on farms with livestock (usually cattle)
- Tall and narrow
- Airtight; made of concrete (brown/gray) or glass-fused steel (often blue)

Carbon Dioxide (CO₂) + Nitrogen Dioxide (NO₂)

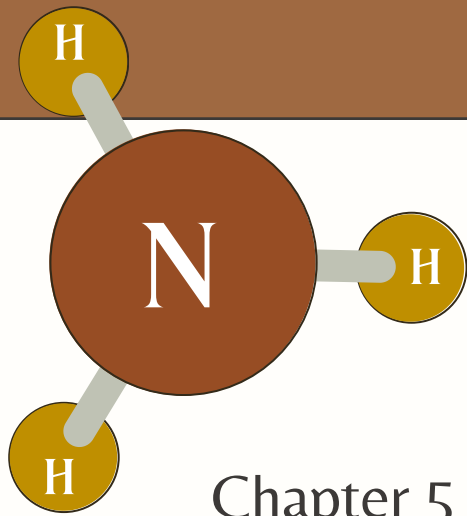


- 0.2 ppm:** Few symptoms, irreversible effects
- 1-4 ppm:** Reversible changes in respiratory function and pulmonary pathology
- 50 ppm:** Progressive respiratory injury; possible death

Signs of NO₂ Presence in Silo:
Yellow-reddish color to the air inside & often stained on silo structure.

Fermentation process takes about 10 days - 3 weeks to complete. Peak levels of NO₂ around day 3. NO₂ tends to be dissipated around day 10.

Do NOT permit entry into a silo until after day 10.



Chapter 5

AMMONIA



Precautions

Maintain good manure management practices, including minimizing manure levels in underfloor storage pits, and ventilating buildings when ammonia concentrations reach 25 ppm.

Low

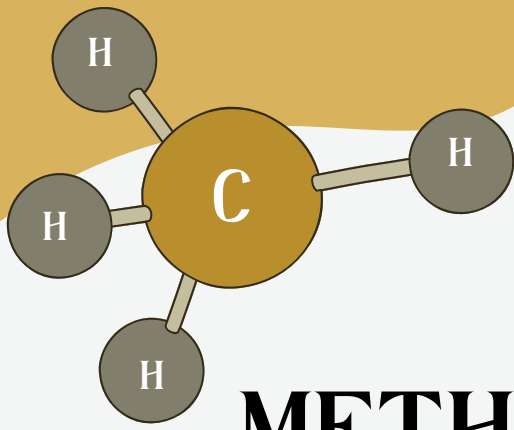
5–20 ppm: Odor, eye irritation

Medium

20–50 ppm: Moderate eye and upper respiratory tract irritation

High

2500 ppm: Chemical pneumonitis, edema, cyanosis, death



Chapter 6

METHANE (CH₄, LEL)

Manure Gases

Low

< 0.1% (1000 ppm):
Not harmful

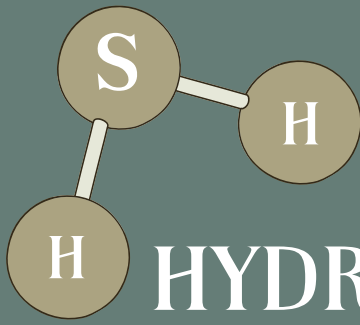
Medium

< 1% (10,000 ppm):
No known toxicity

High

< 5% (50,000 ppm):
Explosive





Chapter 7

HYDROGEN SULFIDE (H₂S)

Manure Gases

Low

2-20 ppm:

Nausea, headache,
dizziness

Medium

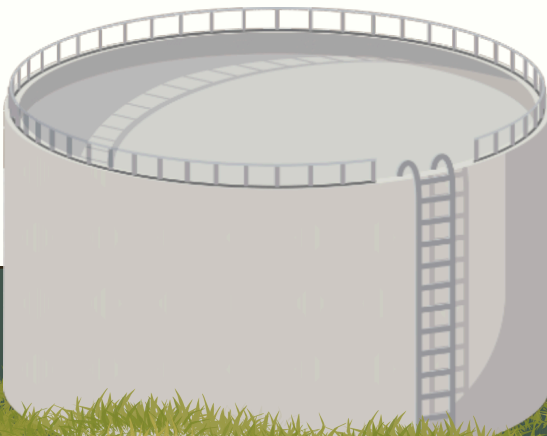
100-300 ppm:

Altered breathing,
fluid in lung

High

500-700 ppm:

Collapse, death



Prevention

For outside manure storage:

- 1 Know the direction of the wind and do not stand downwind of the pumping equipment.
- 2 Do not pump if there is an atmospheric inversion (including low ground fog early in the morning/late at night) - any H₂S will be trapped low to the ground and pool in high concentrations.

Wear gas monitors in livestock operations that are known to generate high concentrations of H₂S.

These operations include:

- Pressure washing inside a building
- Working outside around manure pumping operations
- Manure transport
- Land application tasks

Chapter 8 ORGANIC DUSTS

Personal Dust Exposure Limits

	Swine Production	OEL - Other
Dust: Respirable	0.23 - 0.28 mg/m ³	3 mg/m ³
Dust: Total	2.8 - 3.8 mg/m ³	5 mg/m ³
Endotoxin	0.2 - 0.9 ug/m ³	

Above 0.2 ug/m³, see decreases in lung function

Higher values from 1995 study, lower values from 1999 study

Grain Dusts & Farmer's Lung

Farmer's lung is an allergic disease caused by inhaling mold spores from moldy hay, straw or grain.

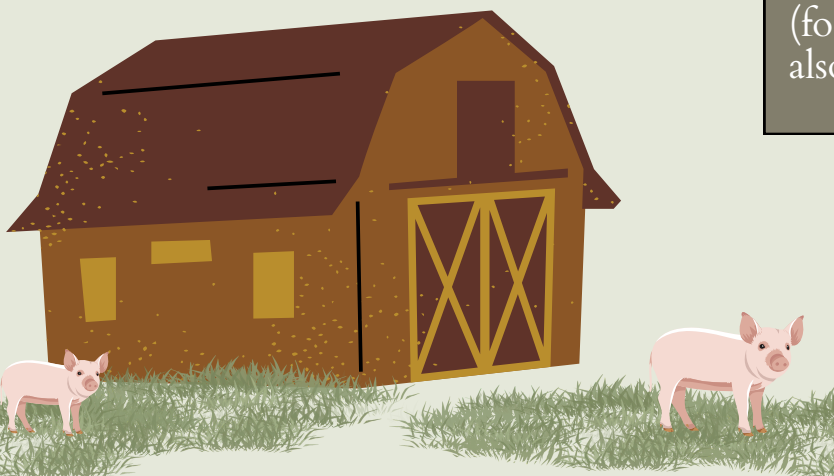
Acute symptoms of exposure after handling a moldy crop include:

- Developing a sudden flu-like illness, generally within a few hours after the exposure
- A chronic cough
- Feeling tired



Swine Barn Dusts

Swine barn dust is a complex mixture of materials, which includes organic materials (food, animal dander, and feces), and can also contain viruses and bacteria.



AIR QUALITY

Resources

View these links for additional resources on the information presented in this unit.

CHAPTER 1. INTRODUCTION

Respiratory Protection for Dusty Operations:

- https://en.wikipedia.org/wiki/Organic_dust_toxic_syndrome
- <https://www.ncbi.nlm.nih.gov/books/NBK557580/>

CHAPTER 2. CARBON MONOXIDE

- See *Bin Fires Can Create CO Danger*, January 2016: <https://icash.public-health.uiowa.edu/publications/news-releases-and-columns/>

CHAPTER 3. CARBON DIOXIDE

- <https://www.worksafebc.com/en/health-safety/hazards-exposures/carbon-dioxide>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4892924/>
- Effect on Cognitive Function: <https://www.hsph.harvard.edu/healthybuildings/2021/09/09/impacts-of-indoor-air-quality-on-cognitive-function/>

CHAPTER 4. NITROGEN DIOXIDE

- <https://www.ncbi.nlm.nih.gov/books/NBK554539/>
- <https://extension.psu.edu/silo-gases-the-hidden-danger>
- Fermentation: <https://afs.ca.uky.edu/dairy/important-steps-during-silage-fermentation-process>

CHAPTER 5. AMMONIA

- NIOSH Overview of Exposures & Hazards: <https://www.cdc.gov/niosh/topics/ammonia/default.html>
- Ammonia Emissions from Agriculture: <https://www.sciencedirect.com/science/article/pii/S0301479722018588>

CHAPTER 6. METHANE

- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3617131/>
- https://www.ccohs.ca/oshanswers/chemicals/chem_profiles/methane.html
- <https://nasdonline.org/48/d001616/manure-gas-dangers.html>

CHAPTER 7. HYDROGEN SULFIDE

- <https://www.cdc.gov/niosh/docs/90-103/>
- https://www.osha.gov/sites/default/files/2018-12/fy15_sh-27664-sh5_Confined_Space_Handout_Effects_of_H2S.pdf

CHAPTER 8. ORGANIC DUSTS

- https://en.wikipedia.org/wiki/Organic_dust_toxic_syndrome
- <https://www.ncbi.nlm.nih.gov/books/NBK557580/>
- <https://nasdonline.org/1623/d001504/dusts-from-decayed-grain-hay-and-silage.html>