STATE OF NORTH DAKOTA
PUBLIC SERVICE COMMISSION

IN THE MATTER OF THE APPLICATION OF SCS CARBON TRANSPORT LLC FOR A CERTIFICATE OF CORRIDOR COMPATIBILITY AND ROUTE PERMIT FOR THE MIDWEST CARBON EXPRESS PROJECT IN BURLEIGH, CASS, DICKEY, EMMONS, LOGAN, MCINTOSH, MORTON, OLIVER, RICHLAND AND SARGENT COUNTIES, NORTH DAKOTA	)))))))))	Case No. PU-22-391

DIRECT TESTIMONY OF DR. TED SCHETTLER

ON BEHALF OF

LANDOWNER INTERVENORS

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Q: Please state your name and purpose for providing testimony in these proceedings.

A: My name is Dr. Ted Schettler. The purpose of my testimony is to provide the North Dakota Public Service Commission (PSC) information helpful when considering the current proposed carbon capture pipeline of applicant Summit. Specifically, my research and opinions relate to the hazards and risks of unintended exposure to carbon dioxide during capture and pipeline transport of carbon dioxide.

Q: What experience, education, training, or background qualify you to provide opinions and your concerns as you have herein?

A: Please see a summary of my education and experience in Attachment No. 1.

Q: What happens when a person is exposed to an abnormally high level of carbon dioxide?

A: Carbon dioxide in abnormally high levels is an asphyxiant and is toxic. As an asphyxiant, carbon dioxide at high levels displaces ambient air so that oxygen levels can fall to dangerously low levels and a person exposed is deprived of sufficient oxygen to support life. Carbon dioxide also has toxic properties independent of oxygen deprivation. Inhalation of high concentrations of carbon dioxide can overwhelm compensatory responses, lowering the pH of blood and tissues, causing acute effects on the respiratory, cardiovascular, and central nervous systems.

\Q: What are the health risks from the rupture of a carbon dioxide pipeline?

A: Carbon dioxide is colorless, odorless and heavier than air. It tends to hug the ground and displaces oxygen, thus increasing the risk of asphyxiation for anyone in a carbon dioxide cloud as it disperses. Because carbon dioxide is colorless and odorless, people are often unaware of exposures, even when concentrations become dangerously high. In addition to being an asphyxiant, carbon dioxide has toxic properties independent of oxygen deprivation. As blood levels rise, carbon dioxide combines with water in the blood to form carbonic acid and as the blood acidifies, a number or organs are adversely affected, including the brain.

The National Institute for Occupational Safety and Health (NIOSH) considers 4% carbon dioxide (40,000 ppm) concentration in the ambient air to be "immediately dangerous to life and health." (IDLH) This is because at that level, the increased rate and depth of respiration becomes distressing and at that level, confusion can occur because of the impact of elevated levels on the brain. People breathing that concentration may not be able to realize that they are in danger and get to a safer place.

NIOSH defines IDHL and IDLH values as follows:[1]:

"Immediately Dangerous to Life or Health (IDLH) condition: A situation that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment [NIOSH 2004].

IDLH value: A maximum (airborne concentration) level above which only a highly reliable breathing apparatus providing maximum worker protection is permitted [NIOSH 2004]. IDLH values are based on a 30-minute exposure duration."

According to NIOSH, the conclusion that 4% CO2 is "immediately dangerous to life and health" is "based on acute inhalation toxicity data in humans". NIOSH also says: "Signs of intoxication have been produced by a 30-minute exposure at 50,000 ppm [Aero 1953], and a few minutes exposure at 70,000 to 100,000 ppm produces unconsciousness [Flury and Zernik 1931]." [2] For conversion purposes, 50,000 ppm carbon dioxide is the same as 5% carbon dioxide.

A 2007 report from a committee of the National Research Council (NRC) reviewed exposure guidance levels for selected submarine contaminants.[3] Among them was CO2 since identifying air levels that are safe or unsafe over various time periods in the confined environment of a submarine is essential. The committee reviewed available experimental

[1] Current Intelligence Bulletin 66: Derivation of Immediately Dangerous to Life or Health (IDLH) Values (cdc.gov) ; pg. xviii
[2] See CDC - Immediately Dangerous to Life or Health Concentrations (IDLH): Carbon dioxide - NIOSH Publications and Products] CDC - Immediately Dangerous to Life or Health Concentrations (IDLH): Carbon dioxide - NIOSH Publications and Products
[3] National Research Council. 2007. Emergency and Continuous Exposure Guidance Levels for Selected Submarine Contaminants: Volume 1. Washington, DC: The National Academies Press. https://doi.org/10.17226/11170 .

human and animal data as well as epidemiologic and occupational studies. Although many studies involved CO2 exposures over extended time periods of hours or days, some reported on impacts after exposures measured in minutes. With regard to neurobehavioral impacts, the report says:

> "It is well established that CO2 acutely impairs vision and hearing at concentrations exceeding about 50,000 ppm (Yang et al. 1997). Exposures to CO2 at 61,000-63,000 ppm for 6 min led to 3-8% increases in the hearing threshold for six subjects (Gellhorn and Spiesman 1935). The same authors noted slight impairment after 5-22 min of exposure at 30,000-40,000 ppm and identified a NOAEL [no observed adverse effect level] of 25,000 ppm (Gellhorn and Spiesman 1934, 1935)" (pg. 53)
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> "Based on the work of Storm and Giannetta (1974) and Glatte et al. (1967), a NOAEL of 30,000 ppm for general CNS effects could be proposed. However, the subcommittee considers the subtler, if less relevant visual effects reported by Sun et al. (1996) and Yang et al. (1997) at 25,000 ppm to be a minimal LOAEL" (lowest observed adverse effect level) (pg. 54-55)

Risks to health from carbon dioxide releases will depend on the volume of carbon dioxide released, the dynamic concentration of carbon dioxide in the ambient air as it disperses, a receptor's (human or animal) proximity to the release, and concentration and duration of exposure. A person's age and underlying health status largely account for considerable variability in carbon dioxide tolerance in the general population, with older people less tolerant of exposures, as has been described in various studies.[4] [5] [6]

Breathing 5% carbon dioxide can cause dimmed sight, impaired hearing, sweating, tremor, increased heart rate and blood pressure. Breathing 10% carbon dioxide can cause unconsciousness within a few minutes; a concentration of 30% can cause unconsciousness within seconds. More than 10% can cause death within 10 minutes. A concentration of 20-30% can cause death within one minute. Carbon dioxide transported by pipeline is typically at least 95% carbon dioxide and relatively free of impurities such as water,

[4] Many earlier studies summarized here: Occupational exposure to carbon dioxide (cdc.gov)
[5] Effects of elevated oxygen and carbon dioxide partial pressures on respiratory function and cognitive performance - PubMed (nih.gov)
[6] Carbon Dioxide (usda.gov)

hydrogen sulfide, and nitrogen, among others, because impurities can interfere with transport and cause pipeline corrosion. Thus, a pipeline rupture would be expected to release a cloud of nearly pure carbon dioxide, with perhaps small amounts of impurities that may not have been removed prior to compression for transport.

Dispersion of a carbon dioxide cloud will depend on the volume released, wind speed and direction, and local topography. The volume of carbon dioxide released will depend on the nature of the pipeline failure (e.g., leaky valve, full girth fracture, running ductile fracture, horizontal or vertical), soil cover, distance between shutoff valves and response time. Dispersion modeling is commonly used to predict carbon dioxide concentrations at increasing distances from an unintended release so that people or populations potentially at risk can be identified. A number of different models have been used for prediction purposes. They vary in sophistication and the number of variables they will accommodate. In the event of an unintended release or pipeline rupture it will be important to recognize it immediately and notify anyone who could be located where unsafe carbon dioxide levels could accumulate so that they can get to safety. This will require an emergency notification system to be in place and used. First responders to the scene of a carbon dioxide release will need an independent air supply and vehicles that can operate in reduced oxygen environments. First responders will triage the scene. All people, including unprotected rescuers, should be immediately removed from the environment where carbon dioxide levels are potentially elevated. People who are unconscious or obviously in severe distress should be given oxygen and transported to the nearest medical facility.

Q: Does <u>Attachment No. 2</u> to your testimony include research you have done related to CO2 and your opinions and concerns that you want the PSC to be aware of relative to the proposed CO2 pipeline in question?

A: Yes, it does. It is a fact sheet I prepared based on a literature review regarding hazards and risks of CO2 exposure. I stand by my positions and opinions discussed and am competent to testify about them as necessary. I urge the PSC to carefully consider this testimony during the Hearing in this matter and in your deliberations.

I further reserve the right to amend or modify these opinions upon presentation of any additional information that may justify such a change.

Q: Are all of your statements and opinions rendered here and in the incorporated materials attached given to a reasonable degree of professional certainty and based upon your education, experience, background, and training?

A: Yes.

/s/ Dr. Ted Schettler, MD, MPH
Dr. Ted Schettler, MD, MPH

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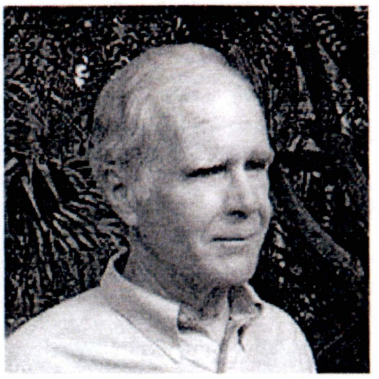
Attachment 1

Ted Schettler, MD, MPH

Science Director, Science and Environmental Health Network



Ted Schettler received his MD from Case-Western Reserve University and a master's degree in public health from the Harvard School of Public Health. He practiced emergency medicine as well as occupational medicine for many years in New England.

Ted has worked extensively with community groups and non- governmental organizations throughout the US and internationally, addressing many aspects of human health and the environment. He has served on advisory committees of the US EPA and National Academy of Sciences.

Ted is co-author of Generations at Risk: Reproductive Health and the Environment, which examines reproductive and developmental health effects of exposure to a variety of environmental toxicants. He is also co-author of In Harm's Way: Toxic Threats to Child Development, which discusses the impact of environmental exposures on neurological development in children, and Environmental Threats to Healthy Aging: With a Closer Look at Alzheimer' and Parkinson's Diseases. Ted has published numerous articles in the medical literature.

Among others, Ted's current projects include serving as an advisor for the Collaborative for Health and Environment (CHE) and science advisor for Health Care Without Harm, contributing to its international campaign to improve the environmental performance of hospitals and other healthcare institutions.

CARBON DIOXIDE (CO_2)

NORMAL PHYSIOLOGY & HAZARDS AND RISKS

by Ted Schettler, MD, MPH, Science Director, Science and Environmental Network (SEHN)

CO_2 IN NORMAL PHYSIOLOGY

In humans, carbon dioxide (CO_2) is produced in cells as a byproduct of metabolism.[1] Then it circulates through the bloodstream, mostly within red blood cells, to be exhaled from the lungs as CO_2 and excreted from kidneys as bicarbonate (HCO_3^-).

CO_2 levels:[2]

- play a major role in regulating blood and tissue pH (acid-base balance)
- largely determine respiratory drive (rate and depth of breathing)
- influence oxygen attachment to hemoglobin

Internal physiologic processes tightly regulate CO_2 levels in the blood; abnormally high concentrations cause a variety of signs and symptoms. (See CO_2 toxicity below.)

Maintaining blood pH within a narrow range is essential for normal functioning of virtually all organs and physiologic systems. CO_2 plays a central role via these reactions:

$$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow HCO_3^- + H+$$

where H_2O is water, H_2CO_3 is carbonic acid; HCO_3^- is bicarbonate; H+ is hydrogen ion.

Humans and virtually every living organism (plants and animals) have evolved to produce an enzyme, carbonic anhydrase[3], which dramatically increases the speed of the first part of the above reaction, ($CO_2 + H_2O \leftrightarrow H_2CO_3$), making this an ideal system for very rapidly fine-tuning the regulation of CO_2 levels and blood pH through changes in the rate and depth of respiration.

CO_2 also reacts with water to form carbonic acid in a CO_2 pipeline, even in the absence of carbonic anhydrase, albeit much more slowly. Carbonic acid is highly corrosive to carbon steel.

The main drivers of respiratory rate and depth are normally bloodstream CO_2 levels and associated pH changes. These are maintained within healthy limits by chemoreceptors located in the medulla at the base of the brain (central chemoreceptors) and in the aorta and carotid arteries (peripheral chemoreceptors). Brain receptors detect changes in the CO_2 and pH, aorta receptors detect changes in CO_2 and oxygen, and carotid receptors detect changes in all three. Respiratory rate and depth increase primarily in response to an increase in CO_2/decrease in pH to reduce CO_2 and maintain pH within normal limits.

CO_2: AN ASPHYXIANT AND TOXICANT

CO_2 is colorless, odorless, non-flammable, and heavier than air. As a gas in air, concentrations will be higher near the floor or ground. It can be compressed at high pressures into a liquid or frozen at very low temperatures into a solid (dry ice).

CO_2 is classified as a hazardous substance by the Occupational Safety and Health Administration (OSHA) and National Institute for Occupational Safety and Health (NIOSH)[4]

Workplace exposure limits:

OSHA: Airborne permissible exposure limit (PEL) is 5000 ppm (0.5%) averaged over 8 hours.

NIOSH: Recommended airborne exposure limit (REL) is 5000 ppm averaged over 10 hours and not to exceed 30,000 ppm (3%) over any 15 minute period.

Ambient air contains about 0.04% (400 ppm) CO_2, 20% O_2, 79% nitrogen, and small amounts of other gases.

This air level of CO_2 has no direct adverse health effects in humans. As a potent greenhouse gas, however, this steadily-increasing atmospheric concentration is a major driver of climate change, which has wide-ranging direct and indirect health impacts globally.

Inhalation exposures to concentrations of CO_2 higher than OSHA and NIOSH exposure limits are hazardous in two ways, both of which contribute to signs and symptoms (see also table next page):

- Gaseous CO_2 is heavier than air and when released in concentrated amounts it flows downhill, collects in low-lying areas—indoors or outdoors—or confined, poorly-ventilated spaces such as basements, storage tanks, dry-ice refrigeration systems, fermentation areas, or mines. It displaces ambient air so that oxygen levels can fall to dangerously low levels. For that reason, CO_2 is well-known as an asphyxiant.

- CO_2 also has toxic properties in addition to causing oxygen-deprivation. Inhalation of high concentrations of CO_2 can sharply lower the pH of blood and tissues (acidosis) causing acute effects on the respiratory, cardiovascular, and central nervous systems.

The response to excessive CO_2 inhalation varies even among healthy individuals[5] so that the timing of onset of signs and symptoms of toxicity can vary from one person to another. This may be due to underlying health status, age, or variability in chemoreceptor sensitivity and respiratory response to acute CO_2 exposures.

Symptoms depend in large part on the concentration of inhaled CO_2 and the length of time a person is exposed. Since CO_2 is odorless and does not cause irritation, unlike some other gases, it gives no warning and people may be unaware of excessive exposures until they experience troubling, dangerous symptoms.

CO_2 TOXICITY [6]

CO_2 Concentration	Health Effect	Timing
2% (20,000 ppm)	Respiratory center stimulated causing increases in breathing (tidal) volume	Rapid
4% (40,000 ppm)	Increase in breathing rate becomes distressing; development of respiratory acidosis	Immediately dangerous to life and health (IDLH) [NIOSH] *
5-10%	Dimmed sight, sweating, tremor, increased heart rate and blood pressure; can →unconsciousness**	Within a few minutes
More than 10%	Can cause convulsions; coma (less than one minute)	Death within 10 minutes
20-30%	Loss of consciousness; death	Within one minute

* NIOSH considers this level to be immediately dangerous to life and health because it can cause confusion and impair ability to respond and get to safety. Signs and symptoms resulting from low to moderate exposures are generally reversible when a person is removed from a high CO_2 environment.

** Symptoms are due to a combination of lower oxygen levels and CO_2 toxicity.[7]

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3. At least seven families of carbonic anhydrase enzymes have been identified, coded by distinct gene families, and at least one family is present in virtually every living organism. See Rossana Occhipinti and Walter F. Boron, "Role of Carbonic Anhydrases and Inhibitors in Acid-Base Physiology: Insights from Mathematical Modeling," *International Journal of Molecular Sciences* Vol. 20 (2019), 30 pgs. http://bit.ly/3JEk2us
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6. Wouter ter Burg and Peter M.J. Bos, *Evaluation of the acute toxicity of CO2.* (Bilthoven, The Netherlands: National Institute for Public Health and the Environment [RIVM], July, 2009); https://bit.ly/3txCj76. And: Kris Permentier and others, "Carbon dioxide poisoning: a literature review of an often forgotten cause of intoxication in the emergency department," *International Journal of Emergency Medicine* Vol. 10, No. 14 (2017), 4 pgs.; https://bit.ly/3umxqNv. And: Food Safety and Inspection Service Environmental, Safety and Health Group, *Carbon Dioxide Health Hazard Information Sheet [ESGH-Health-02.00]* (Washington, D.C.: U.S. Department of Agriculture, no date; retrieved Mar. 23, 2022.); https://bit.ly/2VCrjqC And: "Carbon Dioxide," in *NIOSH Pocket Guide to Chemical Hazards* (Atlanta, Georgia: Centers for Disease Control and Prevention, Oct. 30, 2019); https://bit.ly/3tyCGON
7. Richard E. Fairfax, "Clarification of OSHA's requirement for breathing air to have at least 19.5 percent oxygen content" in correspondence to William Costello April 2, 2007. Washington, D.C.: Occupational Safety and Health Administration, United States Department of Labor, April 2, 2007; https://bit.ly/3IsWoQo

State of California)
) ss.
County of Marin)

I, Dr. Ted Schettler, being first duly sworn on oath, depose and state that I am the person identified in the above Pre-Filed Direct Testimony that I have caused to be prepared and I am familiar with the contents therein and competent to testify on these matters. My Pre-Filed Direct Testimony found in the foregoing pages is true and correct to the best of my knowledge.

Ted Schettler

Subscribed and sworn to before me, a Notary Public in and for said County and State this 9 day of May, 2024

Notary Public Commission expires: 03/16/2026

See Attached Notarial Certificate

See Attached Notarial Certificate

ACKNOWLEDGMENT

A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document to which this certificate is attached, and not the truthfulness, accuracy, or validity of that document.

State of California
County of marin)

On 05/09/2024 before me, Clinton Dean Jones Notary Public
(insert name and title of the officer)

personally appeared Theodore Schettler,
who proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

I certify under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct.

WITNESS my hand and official seal.

Signature _____ (Seal)

THE GREAT SEAL OF THE STATE OF CALIFORNIA EUREKA
CLINTON DEAN JONES
COMM # 2397155
MARIN County
California Notary Public
Comm Exp Mar. 16, 2026