

# A Review of Health Effects of Compressor Stations

Joanne M. Belovich, Ph.D.

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## Overview

Numerous hazardous substances are released into the atmosphere during the normal operation of natural gas pipeline compressor stations. While EPA regulations tend to limit the annual output per year of each class of chemical to the environment, the potential human health impacts are more directly a function of chemical concentrations in the local atmosphere of nearby residents. This report will summarize the emissions projected by Nexus for the Wadsworth compressor station (CS) and the data available on concentrations of selected hazardous compounds associated with shale gas from similar CSs around the country, and compare these to EPA limits. The data show that the potential exists for serious negative health effects due to the CS emissions at distances up to one mile from the CS. Before permits are granted for new CSs, it is recommended that more detailed studies be conducted at existing CSs, including monitoring of average and peak concentrations of hazardous substances, and investigation of adverse health effects in residents in proximity to CSs.

## Results

**Annual emissions estimates (by Nexus) for each of the four compressor stations exceed EPA limits.** According to the Nexus permit application, the following are the estimated annual emissions in tons per year (tpy), compared to the EPA limits<sup>1</sup>. While it is unclear as to whether the EPA limit applies to a single CS, or to the entire pipeline, the table indicates that the predicted emissions from the single Wadsworth compressor will equal or exceed the EPA limit for NO<sub>x</sub>, CO, particulates, SO<sub>2</sub>, and VOCs.

Emissions, in tons per year→	NO <sub>x</sub>	CO	PM	SO <sub>2</sub>	VOC	HAP
Wadsworth	33	10	6	3	32	4
Total of 4 stations	164	49	31	15	141	17
EPA limit <sup>1</sup>	31.2	7.8	6.2	3.2	29.3	n/a

**Formaldehyde concentrations in the atmosphere of nearby residents (1/4 mi) may cause nasal irritation, increased risk of asthma and allergies, and slight risk of cancer (1/100,000).**

The Chronic Minimal Risk to Human Level (MRL) has been set to 20 ppb by the Center for Disease Control (CDC)<sup>2</sup>, while the California Office of Environmental Health Hazard Assessment has set the chronic Reference Exposure Levels (RELs) to 7 ppb<sup>6</sup>. Indoor air levels of formaldehyde range from 20-4,000 ppb (formaldehyde is released by carpets and furniture and

building material), while outdoor, rural area levels are 0.2-6 ppb<sup>2</sup>. According to the CDC, “Nasal and eye irritation, neurological effects, and increased risk of asthma and/or allergy have been observed in humans breathing 100 to 500 ppb.”<sup>2</sup> The U.S. Department of Housing and Urban Development has set maximum concentrations in manufactured housing of 400 ppb<sup>2</sup>. Formaldehyde is considered “probably human carcinogen” by the EPA, with a lifetime human cancer unit risk estimate of  $3.3 \times 10^{-7}$  per ppb formaldehyde<sup>4</sup>. Formaldehyde concentrations in air were measured at various distances from a CS in Susquehanna County, PA, yielding: 45 ppb at ½ mile (n=1); 6-44 ppb at ¼ mile (n=4); and 24 ppb at 1/7 mile (n=1)<sup>5</sup>. Similar results were reported for Arkansas<sup>5</sup>. Average formaldehyde concentrations around a CS have been calculated from weather models, estimated to be up to (depending on weather conditions) 26 ppb at ½ mile, 53 ppb at 1/5 mile, and 300 ppb at 100 yards from the CS.<sup>7</sup> Thus, residents at ¼ mile from the CS may experience nasal and eye irritations, and increased risk of asthma and allergy, with the risk decreasing with distance. Given the EPA’s risk assessment and a predicted level of 50 ppb, residents at ¼ mile have a cancer risk level of 1/100,000 from lifetime exposure to this expected formaldehyde level.

**Benzene concentrations in the atmosphere of nearby residents may be carcinogenic.**

Benzene is considered “known human carcinogen” by the EPA<sup>8</sup>, with a lifetime human cancer unit risk estimate of  $2.7 \times 10^{-5}$  per ppb benzene<sup>9</sup>. The EPA estimates that exposure to 0.4 ppb in air over a lifetime has a cancer risk of 1/100,000 (i.e. one additional cancer case for every 100,000 exposed persons)<sup>8</sup>. Benzene is released from gasoline filling stations and many industrial processes. Levels of benzene in outside air range from 0.02 – 34 ppb<sup>8</sup>.

Benzene concentrations in air were measured at various distances from equipment in CSs in Fremont County, WY and Park County, WY yielding benzene concentrations ranging from 7 – 640 ppb, at distances of 5 to 55 meters distance from a discharge canal or equipment such as a separator.<sup>5</sup> Benzene concentrations near equipment in Parker County TX ranged from 9-93 ppb<sup>10</sup>. Concentrations downwind of CSs in Denton County, TX were 1.6 ppb benzene.<sup>10</sup>

At the lower end of the above concentrations (1.6 ppb), the lifetime cancer risk is 4/100,000, while at the higher end (640 ppb), the lifetime cancer risk is very high (2/100), if this concentration is sustained at this high of a level over a lifetime. Benzene concentrations near the condensate tank of a CS (likely for liquid propane, not natural gas) in Wise County, TX was measured at 1,100 ppb<sup>10</sup>.

The data provided above are for locations in the very near vicinity of the CS. Concentrations near residents (1/4 mile away), are unknown, but are likely to be much less than these values. Weather models predicting benzene concentrations at this distance from a CS could not be found. Additional measurements and weather models on average benzene concentrations at the residences in proximity to CSs are needed to properly evaluate the carcinogenic risk.

**Fine particulate matter may cause increases in asthma and cardiopulmonary symptoms.**

Fine particulates (PM<sub>2.5</sub>) are particles that are 2.5 um in diameter or smaller. These particulates can be inhaled deep into the lungs. Scientific studies have linked the inhalation of fine

particulates to heart attacks, irregular heartbeat, aggravated asthma, decreased lung function, increased respiratory symptoms, and premature death in people with heart or lung disease.<sup>12</sup> The EPA has set particulate concentration limits at 12 ug/m<sup>3</sup> for average annual exposure, and 35 ug/m<sup>3</sup> for 24 h limit<sup>11</sup>.

In a permit application for a 7700 hp CS by Spectra Energy, their models for PM<sub>2.5</sub> predict a 4.6 ug/m<sup>3</sup> particulate concentration, in addition to a background concentration of 16.4 ug/m<sup>3</sup> for a total of 21 ug/m<sup>3</sup>. Given that the background concentration was already in excess of the EPA limit, the 25% increase due to the CS further increases the health risks. Note that the Wadsworth combustion turbine is rated at 26,000 hp (Nexus permit application), so it is likely that particulate concentrations will greatly exceed those shown above.

Average PM<sub>2.5</sub> concentrations around a CS have been calculated from weather models, estimated to be up to (depending on weather conditions) 56 ug/m<sup>3</sup> at 1.2 mile, 100 ug/m<sup>3</sup> at ½ mile, 225 ug/m<sup>3</sup> at 1/5 mile, and 1400 ug/m<sup>3</sup> at 100 yards from the CS.<sup>7</sup> These high levels far exceed the EPA limit and are likely to cause serious health problems.

Some of the hazardous air pollutants may adsorb to the surface of the particulates, increasing their concentration in the lungs of the residents who inhale the particulates and thus increasing the potential for toxicity of the chemicals.

**Epidemiological surveys show increase of illnesses in proportion to proximity to shale gas infrastructure.** A peer-reviewed published paper correlated self-reporting of residents of various illnesses (throat irritation, sinus problems, severe headaches, nosebleeds) with distance from shale gas facilities. Frequency of symptoms increased significantly as distance from the facility (gas well, CS, and/or impoundment pit) decreased, from 4000 ft to 500 ft.<sup>13</sup> While this type of study is not conclusive, these symptoms are consistent with exposure to air pollutants such as VOCs.

## References

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Notes:

"Estimates of exposure levels posing minimal risk to humans (MRLs) are also presented in the figure. An MRL is an estimate of the daily human exposure that is likely to be safe over a certain period of exposure. MRLs are not intended to define clean-up or action levels, but are intended only to serve as a screening tool to help public health professionals decide where to look more closely. Therefore, MRLs are set at levels well below where effects have been observed."

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