COMPRESSOR STATIONS

Health, Environmental, & Community Impacts

Compressor Stations are a necessary but dangerous part of natural gas pipeline infrastructure. As natural gas loses pressure through friction in the pipeline, transmission compressors "pump," or re-pressurize, and often filter, the gas in order to advance its flow through a pipeline. Compressor stations are installed at regular intervals, usually 40 to 100 miles apart, along the course of a pipeline and are designed to run continuously.[i,ii] These stations, which are generally unmanned and poorly regulated, have proven to create a host of serious environmental, health, and safety hazards for surrounding communities.

While it is important to note that more comprehensive data and analysis of compressor station impacts are greatly needed in order to fully understand the associated risks and properly regulate their operations—this paper provides an overview of the known impacts from compressor stations, including unsafe air and water contamination, greenhouse gas emissions, radioactive waste, fires and explosions, noise pollution, habitat destruction, seizure of private property, aesthetic loss and decreased property value. The associated health impacts from compressor station emissions are notably understudied and concerning—including chronic respiratory issues, cardiovascular issues and heart attacks, neurological issues, cancer, and reproductive and development toxicity, among others.

Property loss: Compressor stations impose negative impacts on the surrounding environment and community from the first day of approval. Once a pipeline company's compressor station plan is approved by the Federal Energy Regulatory Commission (FERC), the company is given the power to take private land under eminent domain, with a court determining compensation to landowners.

Ecological footprint: Compressor stations vary widely in size and layout, depending largely on how many compressor units the facility contains.[iii] Gas companies have been known to purchase or acquire 10-80 acres of land for a compressor station,[iv,v] of which 5-20 acres are used for constructing the facility.[vi,vii] Access roads are required to accommodate large trucks and can greatly add to the stations footprint and fragmentation of surrounding habitat.

Compressor stations are built at strategic locations along a pipeline route—with sites ranging from densely populated residential areas, where they put communities at higher risk of toxic emissions, deadly explosions, noise pollution, and property value loss, to remote forested areas, resulting in significant land disturbance, forest loss, habitat destruction, increased wildfire risk, and ensuing air and water quality loss.

Construction: The construction of compressor stations creates both land disturbance and dangerous air emissions. Sites must be cleared, graded, and compacted for concrete foundations for buildings,

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equipment, and access roads.[viii] Construction activities can last for over a year and produce notable emissions.[ix] Construction machinery and trucks are often diesel powered and emit carbon dioxide, nitric oxide, sulfur dioxide, volatile organic compounds (VOCs), carbon monoxide, nitrous oxide, methane, other hydrocarbons and fine particulate matter. In the short-term, diesel emissions increase the level of respiratory particles and can irritate the eyes, nose, throat, and lungs, cause coughs and headaches, lightheadedness, nausea, and inflammation of the lungs. Long-term exposure can cause increased risk of lung cancer.[x] In addition, fugitive dust emissions from active surface disturbance increase nearby resident's risk for respiratory and cardiac illness.[xi]

Facilities: Compressor stations are generally large facilities, composed of several components including scrubbers and/or filters, compressor units, cooling facilities, and a computerized monitoring system.[xii] The size of the station depends greatly on the amount of horsepower and natural gas flow capacity required. Most compressor stations will filter out liquids and other contaminates that have accumulated in the natural gas stream throughout the pipeline as the natural gas enters the facility[xiii]. This process creates highly toxic waste, which is stored on-site in condensate tanks before being transported for treatment or disposal—leaving great opportunity for toxic and likely radioactive waste leaks, spills, or mishandling. Condensate tanks are also a source of VOC and HAP emissions from evaporation or flashing.[xiv] After being filtered, the natural gas is compressed and then run through cooling facilities before reentering the pipeline.

Compressor stations can be powered by either natural gas fired engines, turbines, or electric motors. Most are fueled by a portion of the natural gas flowing through the pipeline.[xv] The power source of compressor stations greatly effects their emissions.

Stations are generally operational 24 hours per day, 365 days a year and are unmanned, monitored by an off-site computerized system that manages and coordinates the operations of the several compressor stations within a natural gas pipeline system.[xvi, xvii] If an issue is detected at a compressor station, such as a drop in pressure or fire, an emergency shutdown system releases the natural gas in the pipeline into the atmosphere.[xviii ,xix]

Fires and explosions: The process of compressing natural gas to a highly pressurized state generates a huge amount of heat, which must be vented and dispersed through cooling facilities.[xx] This is not only a waste of energy, but also a serious safety hazard in a facility that is unmanned and processing flammable gas around the clock. As a result, gas leaks, glitches in the computer monitoring system, and other events regularly lead to fires and/or explosions of various magnitudes at compressor stations throughout the country. Such fires and explosions have resulted in evacuated homes, closed roads, wildfires, toxic emissions, complete destruction of homes and compressor stations, millions of dollars in damages, injuries, and deaths. Fires can last for hours or even days, putting a huge strain on local firefighters, hospitals, and other emergency responders. The natural gas industry typically relies on local fire departments for assistance during an emergency.[xxi] This is often a problem as localities are not always equipped with the resources to adequately contain a large natural gas fire or explosion or care for those injured. Injuries can include respiratory damage and serious burns and can require evacuation by medical helicopter.[xxii]

Noise pollution: Compressor stations emit noise and vibrations continuously, day and night. The noise emitted is often above allowable standards, especially during construction, emergency venting, and

blowdowns. At these peak noise events, the noise emitted is likened to a jet engine or a freight train, depending on residents' proximity.[xxiii] Events such as blowdowns can last for hours. Compressor stations also emit constant low frequency noise during normal operation. Residents living nearby have compared the noise of compressor stations to truck running in there driving at all hours.[xxiv]

Chronic exposure to low frequency noise can lead to Vibroacoustic Disease, which causes a range of serious health impacts, with symptoms worsening over time. Symptoms can include hypertension, thickening of cardiovascular structures, heart disease, infections, cognitive impairment in children, sleep disturbance, tinnitus, hearing loss, reduced performance, and aggressive behavior among others.[xxv,xxvi]

Similarly, the 24-hour operation of compressor stations often produces disturbing light pollution to the surrounding community.

Water quality impacts: In addition to the water quality impacts caused by deforestation, construction, resulting erosion and wetland disturbances, risks for hazardous waste spills, and climate change impacts—compressor station emissions can also contribute to ground level ozone, smog, and acid rain. Compressor stations regularly emit carbon monoxide, nitrogen oxides, volatile organic compounds, and sulfur dioxide during normal operation. In the presence of sunlight, these gases react, producing devastating impacts. Acid rain can be detrimental to aquatic ecosystems.[xxvii] Environmental degradation caused by compressor stations are particularly harmful to sensitive ecosystems and endangered species. Air and noise emissions that negatively affect humans can have similar, if not more devastating, impacts on wildlife**.**[xxviii]

Greenhouse gas emissions: Studies are clear that the high methane emissions from the natural gas industry and the associated global warming impact of methane negate the benefits of using natural gas as a so called "clean," transitional fuel.[xxix] Compressor stations are one of the largest sources of methane emissions within natural gas infrastructure.[xxx] Station facilities emit huge amounts of methane on a regular basis, through both intentional venting episodes and unintentional fugitive leaks.

Compressor station emissions: The exact composition of emissions and the amount of each of the toxins released is not adequately measured, reported, or regulated. Emission levels vary from station to station, depending on the size and power source—as well as throughout each day, depending on emission events such as blowdowns, fugitive emissions, and accidents. While there is incomplete information on the content of compressor emissions, many harmful chemicals are known to be released.

Operational emission pathways: *In addition to the emissions from construction activities, compressor stations also produce emissions during regular operation. These emissions pathways fall into four categories—power generation, blowdowns, fugitives, and accidents.*[xxxi]

1. **Power generation:** Compressor stations generate the power needed to operate through either natural gas-fired engines, turbines, or electric motors. Both natural gas engines and turbines burn a portion of the natural gas in the pipeline and thus continuously emit pollutants.[xxxii] While most compressor stations rely on natural gas, some run off of electric motors and do not produce

emissions from power generation. They do, however, emit pollutants through the other three emission pathways.

2. **Blowdowns (venting):** Natural gas is released through a blowdown vent, sometimes intentionally (to control flow and pressure) and sometimes accidentally, creating a plume of gas extending up to 200 feet in the air and lasting up to three hours. Whatever is in the pipeline at the time is released. Blowdowns are the largest single emission from compressor stations.[xxxiii]
3. **Fugitives (leaks):** Uncontrolled or under-controlled releases. This is often the result of equipment leaks but can also be from evaporative sources. Fugitive leaks can increase over time as equipment wares.[xxxiv] One study found an average of 265 fugitive emission points per compressor station over a four month period.[xxxv] Equipment leaks can also release lube oil and coolant liquids.[xxxvi] Evaporation of VOCs, HAPs, and other air pollutants from condensate storage tanks are considered fugitive emissions.
4. **Accidents:** Besides accidental blowdowns and fugitive emissions, accidental emissions can include the immeasurable emissions from fires and explosions, as well as spills of coolant liquids or other wastes.

Emission contents: *Different aspects of compressor station operations produce or release varying emissions.*

Power generation emissions: When compressor stations burn natural gas from the pipeline in order to generate power, they produce and emit nitrogen oxides, carbon monoxide, particulate matter, VOCs, sulfur dioxide, formaldehyde, and other Hazardous Air Pollutants (HAPs).[xxxvii]

Emissions from blowdowns, fugitives, and accidents: These compressor station emissions include whatever is in the pipeline at a given time. This can vary depending on the chemical content of the shale gas source, the hydraulic fracturing fluid used, and chemical reactions resulting from their combination at high heat and pressure. Because pipeline companies are not required to test or report on the contents of the pipeline and limited data is available, the exact composition and full range of possible toxins is not known. Methane, a potent greenhouse gas (GHG), is the primary component in a natural gas pipeline, along with other hydrocarbons and an extensive, variable list of other potential toxins, including **radioactive material**.[xxxviii] While levels vary depending on geology and other factors, Technically Enhanced Naturally Occurring Radioactive Material (TENORM) is an unavoidable byproduct of natural gas production. [xxxix] It can accumulate as sludge or as a film on gas processing equipment, or flow through the pipeline as gaseous radon. While radon has a relatively short half-life, it breaks down into polonium and lead, with half-lives of 138 days and 22.6 years, respectively.[xl]

Chemical interactions: The reactions between the many known chemicals within the pipeline, as well as between these chemicals and the environmental factors they are exposed to, make understanding and identifying emission compositions all the more difficult. Many new chemicals are thought to be created, with some research already beginning to illustrate this. For example, in addition to the formaldehyde known to be emitted from compressor station engines, new research suggests that formaldehyde is also produced when methane is exposed to sunlight. This would greatly increase the amount of formaldehyde that is emitted from compressor stations from what has been reported.[xli]

From the limited available research on compressor emissions, chemicals found at or near compressor stations include: benzene, carbon monoxide, nitrogen dioxide, carbon disulfide, toluene, ethyl benzene, acetone, fine particulate matter, and many other toxic VOCs and HAPs, many of which were found above potentially unsafe levels.[xlii]

Health effects of known emissions: *The following chemicals, while not an extensive list of those emitted, illustrate a portion of the known health effects from compressor station emissions:*

VOCs (Volatile Organic Compounds):[xliii]

- **Benzene**: Short-term exposure can cause drowsiness, dizziness, headaches, irritation of the eyes, skin, and respiratory tract, and unconsciousness. Long-term exposure is carcinogenic; linked to reproductive effects, leukemia and childhood leukemia, and various blood disorders.
- **Methylene chloride**: Short-term exposure can cause decreased nervous system function and long-term exposure can affect the central nervous system. It is potentially carcinogenic, with animal studies showing increased liver and lung cancer following inhalation.
- **Formaldehyde**: Carcinogenic. Short-term exposure can cause asthma-like symptoms, coughing, wheezing, and shortness of breath. It is linked to adverse pregnancy outcomes and reproductive and developmental toxicity. Considered a Hazardous Air Pollutant (HAP).
- **Styrene**: Carcinogenic.

Particulate matter: Particulate matter of 10 micrometers in diameter (PM10) or less is small enough to get into the lungs, causing serious health problems on their own and compounding the effects of other chemicals. The size of particles determines the depth of inhalation into the lung—with smaller particles more readily reaching the deep lung. PM2.5 and ultrafine particles (less than .1 micrometer in diameter) are of particular concern.[xliv]

- **PM2.5 and ultrafine particles**: Cause harm to respiratory and cardiovascular systems. For example, inhalation of PM2.5 can cause decreased lung function, aggravate asthma symptoms, cause heart attacks and high blood pressure, increase risk of cardiovascular disease and death, increase cardiopulmonary death, and increase the risk of lung cancer. In children, exposure to PM2.5 has been linked to increased asthma and hospitalizations for respiratory diseases such as pneumonia. Particulate pollution is also linked to low birth weights and preterm births for pregnant women.[xlv]

TENORM: Radon and the resulting polonium are known carcinogens, while all three materials, including lead, are highly toxic.[xlvi]

Chemical interactions in the body: When gas is emitted or leaked from compressor stations, a very large number of chemicals are released together. Health departments and associations have expressed frustration in their inability to properly evaluate the associated health impacts, as medical reference values are not able to take into consideration the complex nature of shale gas emissions and the resulting interactions.[xlvii] No other industry emits as many chemicals within as close a range to residences.[xlviii]

One of the known chemical reactions associated with compressor stations is that relationship between particulate matter and other water soluble chemicals. PM2.5 and smaller particulate matter absorb other airborne chemicals and carry them into the deep lung and blood stream. This causes airborne chemicals to be absorbed in the body at much higher concentrations than they would in the absence of particulate matter—essentially increasing the dosage of any soluble chemical in their midst.[xlix]

Vulnerable populations: The health risks that emissions and noise pose to the general population are even greater for vulnerable populations such as children, pregnant women, the elderly, and sensitive individuals.[l] Wildlife are also exposed to these toxins and vulnerable. In some cases, sensitive wildlife species, and threatened and endangered species are likely even more threatened than the human population.

Lack of data and regulations: Because the emissions from transmission compressor stations are so complex—with variation in pipeline contents, the resulting chemical interactions, fluctuations in intensity and frequency of emissions, and difficulties in directly measuring emissions data at the source—regulators have been unable to properly evaluate emissions. In 2013, the EPA Inspector General released a report stating that the lack of air emissions data for oil and gas production and processing has hampered the EPA's ability to assess their airborne risks and develop appropriate regulations needed to protect human health and the environment.[li] Current compressor emissions standards have been criticized as not being health protective at an individual or community level, as well as for masking peak exposure events, such as blowdowns. The EPA is in the process of reviewing emissions standards from transmission compressor stations.[lii]

Reported health effects of compressor stations: In the absence of complete emissions data from direct testing and measurement, the chronic and episodic disease demonstrated around compressor stations in health impact surveys can be seen as an indicator of emissions.[liii] These health effects reported in proximity to compressor stations include impacts on respiratory, neurological, and cardiovascular body systems and are correlated with many of the known chemicals emitted from compressor stations.[liv]

Anecdotally, people living near compressor stations report burning eyes and throat, skin irritation, and headaches associated with episodic strong odors or visible plumes.[lv]

Property value and economic impact: Property values surrounding compressor stations have been shown to drop, by as much as 50%.[lvi] Associated health impacts increase health care costs and even inability to work, putting additional strain on the community and local economy.

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