

Environmental Health Project
Shale Gas & Oil Health Impact Assessment
Template for Compressor Station

The Shale Health Impact Assessment (HIA) Template is designed to give you a structured way to bring together data on your community, the expected emissions from shale gas or oil development, and the potential health risks posed to residents in the immediate area. It can provide decision-makers with a comprehensive perspective on the siting, expanding, or maintaining of a shale gas or oil compressor station.

The Health Impact Assessment revolves around one central question: Do you have enough information to determine that it is safe to have the compressor station in your community?

For introduction to compressor stations see Penn State Extension
<https://extension.psu.edu/understanding-natural-gas-compressor-stations>

Points to keep in mind:

- Emissions from shale gas and oil sites are significant.
- Exposures to emissions do not occur evenly over time, but spike in intensity periodically.
- The extent to which people are exposed to toxics is determined by the concentrations of emissions vented and leaked, along with weather conditions.
- There is now an abundance of information about shale gas site emissions and their potential to do harm.

Medical and Public Health professionals understand that:

- Certain types of particles and chemicals have well known health effects.
- Chemical toxicity in the human body can occur within minutes or hours of exposure.
- Repeated episodic exposures can increase the potential and degree of harm.
- High exposures to chemicals and mixtures of chemicals can increase the seriousness of the damage.
- Understanding the changes in exposures is essential to understanding the health risks.

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Compressor Station Health Impact Assessment Checklist

Have you been provided the information you need (from, for instance, the company or public officials)? This is best filled out once you've gone through the whole assessment.

	NOT PROVIDED	INCOMPLETELY ADDRESSED	ADDRESSED WELL*
Attention to concerns of residents			
Listing of chemicals emitted and at what concentrations			
How often emissions will occur and at what times of day			
Projected exposure within a mile of site – daytime and nighttime and at peak levels			
Radioactive material present			
Air monitoring plan specified			
Warning system in place for planned or unplanned high releases			
Blowdown emissions estimated			
Emissions from flares estimated			
Sufficient distance from schools, day cares and other sensitive locations			
HEALTH IMPACTS			
Chronic and episodic exposure effects on children addressed			
Health risks to fetal development addressed			
Health effects of PM2.5 addressed			
Health effects of VOCs addressed			

* By adequately, we mean you have been given concrete information and the company or public officials tell you how confident they are that it is accurate. Or you may have other standards.

QUESTIONS OFFICIALS OUGHT TO CONSIDER BEFORE MAKING SHALE GAS/OIL DECISIONS

A public agency – at the federal, state or local level – should address the concerns raised in this report. To protect public health, it is necessary to know whether dangerous baseline or spikes in pollutants will occur at this compressor station, how often, and what health effects may occur in the short- and the long-term. The Compressor Station Health Impact Assessment can help you organize the information which will shape informed decision-making.

Completing the Assessment will allow you to start answering three critical questions:

- 1) What is being emitted or leaked?
- 2) Are people being exposed to emissions?
- 3) What are the health effects from exposures?

I. INTRODUCTION

1. WHAT IS THE PRIMARY ISSUE?

New compressor station being built _____
Existing compressor station being expanded _____
Concerned about existing compressor station _____

2. WHY DOES THIS CALL FOR AN HIA?

Here you might list community concerns, especially health or safety concerns, nearby sensitive sites like schools, day care centers, or nursing homes. If you know of them, you might talk about changes in regulations or ordinances that might be up for discussion or that should (or should not) be up for discussion.

3. WHO IS RAISING THE HEALTH IMPACT CONCERN? WHO IS PREPARING OR COMMISSIONING THE HIA?

(Health department, other public officials, community members, local, regional, or national organization)

4. WHO WILL BE AFFECTED BY A DECISION ON THE COMPRESSOR STATION?

Consider benefits as well as risks.

Could be

- Families in the immediate area
- Individuals
- School children
- Advocates for the environment
- Local businesses
- The company seeking a permit
- Whole town/municipality (which would benefit from influx of funds/jobs)

FACILITY OR FACILITIES OF CONCERN

5. WHAT DO YOU KNOW ABOUT THE COMPRESSOR STATION?

Size or other description (amount of gas moved through, type of engines, horsepower of engines, at what pressure, diameter of pipeline)

6. IS THERE OTHER MACHINERY ON SITE?

(for instance, compressor stations sometimes have dehydrators and condensate tanks on or very near the site) Put down what you know:

CONCERNS OF RESIDENTS

7. Examples of concerns (you can rank them or not):

- Personal health and safety
- Soil contamination
- Loss of property values near shale sites
- Risks to wildlife and local habitat
- Concern about accidents, emergency response, compressor safety records and/or pipeline safety.
- Health and wellbeing of the local community
- _____
- _____

Resources for this section
 Community hearing,
 neighborhood meeting, formal
 or informal survey

II. COMMUNITY CONTEXT

8. WHAT IS IN THE IMMEDIATE AREA: ½ MILE RADIUS, 1 MILE, 2 MILES, 5 MILES

Land parcels within two miles of compressor station

Check the ones that describe the area around the site – you can also put numbers or notes in:

Parcel Category	1/2 Mile Radius	1 Mile Radius	2 Mile Radius
Agricultural Land			
Residential Year Round			
Publically-owned park			
Schools or day cares			
Hospital			
Water reservoir			
Others....			
Residents			
Total # of Adults			
Total # of Children (17 and younger)			
Total # of Elderly			

8a) The closest residence is _____ miles (or yards or feet) from the site.

8e) Anything else you want to say about the immediate community?

Resources for this section

Your town hall may be able to help with this section – maybe the taxing or zoning office. Google Earth can help to identify structures at the various distances from the site.

9. A COMPRESSOR STATION WILL ADD TO WHATEVER AIR POLLUTION IS ALREADY PRESENT. IT SHOULD BE EVALUATED BY WHAT IT ADDS TO YOUR AIR QUALITY, NOT ONLY WHAT IT PRODUCES ITSELF.

9a) Are there other polluters already in the area? Shale or non-shale?

9b) Are there plans for additional build-out of these sources?

9c) Is there anything you can say about your current air quality?

Examples include:

- *Attainment vs Non-attainment designation*
- *Lots of industry pollution already*
- *# of bad air quality days*
- *Summary of regional air quality*
- *Community members in a valley or other topographical feature that traps air contaminants*

Resources for this section

Go to www.airnow.gov to find the number of bad air days in your county over the last few years and how it could impact health. The National Environmental Public Health Tracking (<https://www.cdc.gov/nceh/tracking/>) is another good source for state and county level information.

10. ARE THERE ANY RELEVANT STATE OR LOCAL ENVIRONMENTAL OR PUBLIC HEALTH LAWS, REGULATIONS, ORDINANCES, THAT YOU KNOW ABOUT AND WOULD LIKE TO HIGHLIGHT?

COMMUNITY HEALTH

11. RELEVANT COMMUNITY HEALTH INFORMATION

For instance, many of the chemicals released at compressor stations can have respiratory effects. If you could locate asthma rates for adults and children that would be useful. Some chemicals emitted can affect reproduction, if you have data on births (even just the number of births), that would be useful.

Resources for community health information

Contact your local and state health departments to find out what kind of health data they have collected for your locality or county.

III. COMPRESSOR STATION EMISSIONS

Compressor station emissions fall into two categories: construction emissions and operational emissions. This section reviews company projections and provides perspective on the adequacy of the method of estimation and completeness of characterization of emissions. Discussion of the health risks produced by compressor station emissions will be presented in Section IV.

12. WHAT TO DO IF NO EMISSIONS WERE PROJECTED/AVAILABLE?

If no emissions estimates or measurements are provided, there is no way to determine the pollution the community will be subjected to and whether the compressor station is safe. In this situation, it is useful to draw on emissions documented at other compressor stations and the research on compressor station emissions. See Section VI. It would be reasonable to stop activity on the project until the site-specific information is provided.

13. DO YOU HAVE INFORMATION ABOUT CONSTRUCTION EMISSIONS?

Construction emissions are time-limited but generate pollution which will affect residents. *For information on construction emissions, see Section VI.*

OPERATIONAL EMISSIONS

14. OPERATIONAL EMISSIONS IF KNOWN (OR ESTIMATED).

1. Example: Operational emissions (include the metric – tons/year or micrograms/meter³ or whatever)

NOx	
CO	
PM10	
PM	
VOCs	
SO2	
Formaldehyde	
Other pollutants	
Total pollutants	

Resource for this section
State agency that permits oil & gas – often the Department of Environmental Protection. FERC is the federal agency that makes decisions concerning most compressor stations.

15. ARE POTENTIAL BLOWDOWNS ADDRESSED TO YOUR SATISFACITON?

Are they included in overall operating emissions? What, if anything, was identified about blowdowns?

16. FLARES CONSIDERED TO YOUR SATISFACTION?

17. ACCIDENTS CONSIDERED TO YOUR SATISFACTION?

18. FUGITIVES OR LEAKS TO YOUR SATISFACTION?

19. NOISE TO YOUR SATISFACTION?

20. WERE EMISSIONS PROVIDED WITH RESPECT TO NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS) OR OTHER STANDARDS?

SUMMARY AND PERSPECTIVE ABOUT EMISSIONS FROM YOUR SITE.

21. THIS IS AN AREA WHERE YOU COULD TALK ABOUT THE COMPRESSOR STATION BUT ALSO OTHER NEARBY SITES.

If you have final thoughts about the emissions, they can go here. Other pollution sites will raise the exposure to people nearby; that could be addressed here as well.

IV. HEALTH RISKS FROM AIR CONTAMINANTS

CHILDREN, BIRTH OUTCOMES AND EXPOSURE TO SHALE GAS DEVELOPMENT

Children and pregnant women are especially sensitive to pollution and highly at risk. Exposing them to compressor station emissions puts them at risk for both short- and potentially long-term health effects. Six large, well-conducted studies have been published on the effects of shale development activity and birth outcomes. The studies found a range of overlapping outcomes as well as associated with proximity to well pads, including low birth weight, low APGAR scores, prematurity, and neural tube defects. Well pads and compressor stations emit many of the same chemical emissions.

Children do not respond to emissions as though they are little adults. Instead:

- Children have higher respiratory rates and as a result children exposed to air contaminants breathe in more toxics per pound of body weight than adults.
- Children accumulate more toxics in their bodies than adults. Their bodies are still maturing and they cannot metabolize some toxicants as well as adults. They don't detoxify as efficiently.
- Children spend more time engaged in vigorous activity outside, increasing their air and potentially soil exposures.
- Children's brains are still developing. Many toxic agents are known to interfere with developmental processes within the brain.

These characteristics make children especially vulnerable.

HEALTH EFFECTS FROM EXPOSURES TO VOLATILE ORGANIC COMPOUNDS (VOCs)

VOCs, present at compressor stations, are a varied group of compounds which can range from having no known health effects to being highly toxic. Short-term exposure can cause eye and

respiratory tract irritation, headaches, dizziness, visual disorders, fatigue, loss of coordination, allergic skin reaction, nausea, and memory impairment. Long-term effects include loss of coordination and damage to the liver, kidney, and central nervous system. For more information, see National Institutes of Health:

https://toxtown.nlm.nih.gov/text_version/chemicals.php?id=31

HEALTH EFFECTS FROM EXPOSURES TO PARTICULATE MATTER

Particulate Matter (PM), is the term for a mixture of particles and liquid droplets. PM_{2.5} are very fine particles; thirty times smaller than the diameter of a single hair. Because it is composed of such tiny components, it can reach deep into the lungs. Exposure to PM_{2.5} can also affect the heart. Health effects include: heart attacks, irregular heartbeat, asthma attacks; and respiratory symptoms such as irritation of airways, coughing, and difficulty breathing. See the EPA's website for additional information on PM: <https://www.epa.gov/pm-pollution>

NOISE-RELATED HEALTH EFFECTS

Research has demonstrated that chronic noise exposure can cause a wide array of health effects, including sleep disturbance, annoyance, noise-induced hearing loss, cardiovascular disease and endocrine effects. The cardiovascular and endocrine effects appear to be associated with the sleep disruption and psychosocial stress of the chronic noise.¹ For additional information on noise, go to <https://ehp.niehs.nih.gov/1307272/>

22. SUMMARY AND ASSESSMENT OF AIR CONTAMINANTS AND HEALTH

This is a place where you can address the connections between the compressor station and potential health risks posed to your community. It is also a place where you can put any final comments.

V. RECOMMENDATIONS/REQUESTS FROM THE COMMUNITY IF A COMPRESSOR (OR EXPANSION) IS PROPOSED

RECOMMENDATIONS AND MITIGATION (IF PERMIT GRANTED)

If the project is permitted by the Federal Energy Regulatory Commission (FERC), or is already on line, you could make any or all of the following recommendations so that public health can be adequately addressed. Other recommendations you have should be spelled out in this section as well.

- ◆ Perform a baseline health study to establish population health status before the compressor station is built.
- ◆ Require best practices to ensure that effective emissions control measures are kept up to date.
- ◆ Establish an alert system for blowdowns or other large emissions and/or noise events.
- ◆ Put emergency plans in place.
- ◆ Institute a monitoring strategy at the compressor station and surrounding locations and make the data public.
- ◆ Note times when it's just too dangerous to emit; for instance, when air is still and the sky is overcast, and children are likely to be outside.

VI. ADDITIONAL INFORMATION

This section is here to provide additional material that you might be interested in; others receiving the HIA might be interested in; or you might want to insert into the main HIA sections.

DOCUMENTED COMPRESSOR STATION EMISSIONS AT OTHER SITES

Over the past 10 years, research on air contaminants around compressor stations has grown. Scores of chemicals have been measured at compressor stations and many are known to be harmful. Chemicals from different categories act on different receptors in the body. The most prevalent emissions from compressor stations are: Nitrogen Oxides, Carbon Monoxide, Volatile Organic Compounds (VOCs), Formaldehyde, PM₁₀ and PM_{2.5}. **Emissions are the result of combustion from the engines as well as venting and leaking of the gas and other substances from the pipeline.**

THREE THINGS TO KNOW ABOUT COMPRESSOR STATION EMISSIONS:

- **FLUCTUATIONS**
- **MIXTURES**
- **INADEQUATE STANDARDS**

Exposures from compressor stations are not constant. There are several variable contributors to exposure:

- 1) Emissions at any given time – Refers to the fact that there will be more emissions during a time when a large amount of gas is going through the pipeline as compared to when little or even no gas is traveling through the pipeline.
- 2) Content of the pipeline – The content of the pipeline also varies by the area of shale that the gas was released from. For instance, some gas may have more Hydrogen Sulfide than others; other sources may have more Radon or Radium.
- 3) Weather conditions – The weather (temperature, wind, and cloud cover) will affect whether the compressor station's emissions will disperse quickly away from nearby buildings or whether it will stay in close proximity.
- 4) Topography.
- 5) Other factors such as season and time of day.

FLUCTUATIONS IN EMISSIONS AND EXPOSURES

High vs Average Periods of Exposure

Exposures vary over time; even varying from one half-hour to the next. If you average the exposure level over the year or month or day, you will miss the high (and more dangerous) periods of exposure. For instance, over 24-hours the average particulate exposure might be 15 ug/m³ but there was a period just before dawn that was 75 ug/m³ which was high enough to cause an asthma attack.

Table: Variation in Ambient Air Measurements of Five VOCs Near a Compressor Station in Hickory, PA, Reported in ug/m³ *2

Chemical	May 18		May 19		May 20	
	morning	evening	morning	evening	morning	evening
Ethylbenzene	No detect	No detect	964	2015	10,553	27,088
n-Butane	385	490	326	696	12,925	915
n-Hexane	No detect	536	832	11,502	33,607	No detect
2-Methyl Butane	No detect	230	251	5137	14,271	No detect
Iso-butane	397	90	No detect	1481	3,817	425

*The PA DEP collected data on many more chemicals than those listed above; the authors of this paper have chosen these chemicals specifically to highlight variation in emissions.

BLOWDOWNS

The largest single concentration of emissions at a compressor station occurs when the compressor has a blowdown.³ A blowdown is the release of the gas and other constituents of the pipeline or within the compressor equipment. A blowdown can be scheduled or can be an unplanned response to a problem. As the natural gas rushes through the blowdown valve, a gas plume extends upward of 30 to 60 meters.⁴ Blowdown emissions must be understood in order to gauge the health risks. Averaging over a year such extreme emission events or including them in operating emissions will underestimate the risks posed by them. An intense exposure to blowdown levels of contaminants would have more serious health implications than a long-term lower level exposure (i.e. yearly average) to the same contaminants when the compressor is online and operating “normally.”

MIXTURES AND SEQUENTIAL/CUMULATIVE EXPOSURES

Mixtures of pollutants are a critically important topic in addressing the public health implications of compressor stations. A large number of chemicals are released together at the site. A single chemical may not reach levels deemed dangerous by regulatory standards. Looking at chemicals independently will not address the complex shale environment and natural gas infrastructure, its multiple emissions and interactions.⁵

Two or more compounds may show additive, antagonistic, or synergistic interactions in that the two together give much greater response than the sum of either alone. This is further complicated because “a single compound may have multiple sites of action and these may be mediated by totally different mechanisms. Second, many substances, including metals are changed to metabolites or conjugates in the body, and these new products may also have biologic activity that may or may not be similar to the parent compound.” Third, there may be different effects of a single environmental contaminant.”⁶

Writing about the risk posed by interactions at a Superfund site -- but applicable here -- researchers assert, “When confronted by patients or communities that are potentially affected by hazards such as metal mixtures..., clinicians need to be able to access and interpret a diverse array of informational sources on exposures, potential toxicity, methods of environmental and

medical monitoring, and best practices.”⁷ Currently, clinicians do not have complete information to work with when health concerns arise in natural gas areas, and specifically around compressor stations.

AIR STANDARDS USED TO IDENTIFY SAFE LEVELS OF EMISSIONS

The Federal Energy Regulatory Commission (FERC) is the federal organization that reviews and approves applications for new compressor stations or significant modifications of existing compressor stations. A significant portion of federal environmental regulations (including the Clean Air Act and Safe Drinking Water Act) do not apply to most shale oil and gas activities. Generally, however, applications concerning compressor stations include projected emissions and comparisons to the National Ambient Air Quality Standards (NAAQS). While important, NAAQS levels are not necessarily health protective. First, there is accepted research showing health impacts to individuals from pollution levels below NAAQS standards. The World Health Organization and some state governments set more protective standards. Second, NAAQS bases its safety levels on averages over a certain period of time. Averages make it difficult to impossible to know how high a short-term exposure may be.

CONSTRUCTION EMISSIONS

The construction phase of the compressor station is time-limited. Nevertheless, a significant amount of air pollution is generated during construction; much of it due to diesel engines. Diesel emissions include: NO_x, CO, PM, Formaldehyde, BTEX. According to the EPA, Short-term exposure (episodic) “can cause acute irritation (e.g., eye, throat, bronchial), neurophysiological symptoms (lightheadedness, nausea), and respiratory symptoms (cough, phlegm). There also is evidence for an immunologic effect – the exacerbation of allergenic responses to known allergens and asthma-like symptoms.”⁸ Infants, children, pregnant women, the elderly, and anyone at risk for cardiac and respiratory disease is most at risk.

NOISE

Outdoor noise pollution above 55 decibels and indoor noise pollution above 45 decibels may interfere with activities and lead to annoyance, according to the U.S. Environmental Protection Agency. The World Health Organization recommends nighttime noise levels below 40 decibels to reduce the risk of sleep disturbance, insomnia, and use of drugs for sleeping.

A pilot study of noise around a compressor station found that homes located in close proximity (<300 m) to a compressor station have higher average noise levels, both indoors and outdoors, compared to homes located further away. The researchers also found that residents in homes located <300 m from the nearest compressor station may be exposed to low frequency noise. Overall, the researchers argue that there is chronic noise exposure that community members could potentially experience for the lifetime of the compressor station.⁹

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- ¹ Hammer MS, Swinburn TK, Neitzel RL, Environmental noise pollution in the United States: Developing an effective public health response. *Environmental Health Perspectives* 2014; 122(2): 115-119. DOI:10.1289/ehp.1307272
- ² Carpenter DO, Arcaro KF, Bush B, Niemi WD, Pang S, Vakharia DD, Human health and chemical mixtures: an overview. *Environmental Health Perspectives* 1998; 106(Suppl 6, Appendix A): 1263-70.
- ³ Harrison MR, Galloway K E, Hendler A, Shires TM, Natural Gas Industry Methane Emission Factor Improvement Study Final Report Cooperative Agreement No. XA-83376101.
- ⁴ Personal communication with staff at SWPA-EHP.
- ⁵ For additional information see, for instance, EPA's Integrated Risk Information System database, <https://www.epa.gov/iris>.
- ⁶ Carpenter, 1998
- ⁷ Hu H, Shine J, and Wright RJ. The Challenge Posed to Children's Health by Mixtures of Toxic Waste: The Tar Creek Superfund Site as a Case-Study. *Pediatric Clinics of North America* 2007; 54(1):155–175, doi:10.1016/j.pcl.2006.11.009.
- ⁸ EPA, Health Assessment Document for Diesel Engine Exhaust, 2002; <https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=29060>
- ⁹ Boyle MD, Soneja S, Quirós-Alcalá L, Dalemarre L, Sapkota AR, Sangaramoorthy T, Wilson S, Milton D, and Sapkota A, A pilot study to assess residential noise exposure near natural gas compressor stations. *PLOS ONE* 2017; 12(4), <https://doi.org/10.1371/journal.pone.0174310>.
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