Potential Health Effects Due to Inhalation of Low-level Environmental Air Contaminants Generated by Unconventional Natural Gas Development (UNGD) Related Activities

Chemical	Sources	Short term Exposures, Acute Health Symptoms	Long term Exposures, Chronic Health Effects
Volatile Organic Chemicals (VOC's)	Well pads Compressor Stations Processing Facilities	Varies with individual chemical. See following examples: Benzene, Ethyl Benzene, Toluene, Xylene	Varies with individual chemical. See following examples.
*Benzene	Same as above	Headache, dizziness	Aplastic anemia, leukemia
*Ethyl benzene	Same as above	Eye and throat irritation	Possible carcinogen
*Toluene	Same as above	Headaches, sleepiness, confusion	Possible permanent neurological problems
*Xylenes	Same as above	Eye, nose, throat , and skin irritation	Possible permanent neurological effects.
Methylene Chloride	Well pads	Decreased attentiveness and decreased hand-eye coordination	Cancer
Formaldehyde	Well pads Compressor Stations Processing Facilities	Nose and eye irritation, impaired short term memory, asthma attacks	Asthma, eczema, nasal and throat cancer
Diesel Exhaust (contains VOC's and PM2.5)	Well pads Compressor Stations Truck traffic	Eye, nose, throat and lung irritation. Headaches, dizziness, nausea	Worsening respiratory disease, lung cancer
Hydrogen sulfide	Well pad	Eye, nose, and throat irritation. Asthma attacks.	Eye, nose, and throat irritation. Worsening asthma.
Polycyclic Aromatic Hydrocarbons	Well pads Compressor Stations Processing Facilities	Eye and skin irritation, asthma attacks, acute cardiac events, adverse effects on developing fetus.	Contribute to the development or worsening of pulmonary or cardiac disease. Lung, skin, bladder cancer.
Particulate Matter 2.5 (PM2.5)	Well pads Compressor Stations Processing Facilities	Asthma attacks, acute bronchitis, heart attacks in individuals with cardiac disease	Reduced lung function, chronic bronchitis
Ozone	Created by chemical reactions between NOx and VOC'S in the presence of sunlight.	Chest pain, coughing, throat irritation, congestion. Increased symptoms in bronchitis, emphysema, and asthma.	Contributes to development of chronic lung disease and worsens pre-existing bronchitis, emphysema, and asthma.
Radon	Naturally occurring in shale. Contained in produced gas	None	Lung cancer
Carbon monoxide (CO)	Well pads Compressor Stations Processing Facilities	Decreased exercise tolerance, decreased vigilance, increased risk for cardiac ischemia in individuals with heart disease.	Decreased exercise tolerance, decreased vigilance, increased risk for cardiac ischemia in individuals with heart disease.
Nitrogen oxides (NOx)	Well pads Compressor Stations Processing Facilities	Respiratory symptoms, worsening asthma	Respiratory disease, worsening heart disease

* Chart does not include additional health effects occurring with higher level occupational exposures.
Health information is primarily derived from EPA and ATSDR sources.

Sources

Well-pad: *Includes well head, flaring, diesel powered equipment, produced water storage pits and tanks, vehicles.*
Compressor Stations: *Located along natural gas pipelines to compress gas to a sufficient pressure to keep the gas moving within the pipeline.*
Processing Facilities: *Clean raw natural gas by removing impurities and separating out non-methane hydrocarbons and fluids.*

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Activities associated with unconventional natural gas development (UNGD) and transport consistently produce air emissions known to cause both acute and chronic health effects. Emissions from some sources occur at a relatively steady rate, while those from other sources occur in episodic peaks. Some sources are only temporary. Weather conditions and wind direction may affect an individual's actual exposure. As a result of these factors, acute health symptoms related to air emissions may be persistent, episodic or temporary.

The episodic intense peak exposures produced from some UNGD activities, which may last for minutes to several hours, can precipitate acute health symptoms, even though the total exposure averaged over a 24 hour or longer period appears acceptable.

Exposure to the air contaminants associated with unconventional natural gas drilling increase an individual's risk for the development of or worsening of pre-existing respiratory or cardio-vascular disease. In addition, some of the contaminants have adverse neurologic effects, others are carcinogenic.

As with other air pollution, some individuals are at greater risk for health impacts. Children, developing fetuses, the elderly, and individuals with chronic respiratory or cardiovascular disease are most susceptible.

Although the accompanying chart describes the recognized health effects of some of the individual compounds identified as air contaminants originating from unconventional natural gas production and transport, actual exposures occur to mixtures of these compounds. The health effects of exposures to chemical mixtures are incompletely studied and defined.

The performance of blood or urine tests to identify the specific chemicals to which an individual has been exposed often produces misleading results. Most of the chemicals of concern have short half-lives in the body and have other potential exposure sources. In addition, for some chemicals, the measured metabolites may also originate from more benign parent compounds. As a consequence, both false positives and false negative results occur, causing either unwarranted concern or inappropriate reassurance. Thus, as with most poisonings, treatment should be supportive and guided by symptoms.

Contamination of well water as a result of accidental spills, leaks, and well casing failures occurs more sporadically and less predictably than air contamination.

The most common new or worsening physical symptoms reported by individuals evaluated by EHP following the onset of nearby UNGD activities include:

- **Respiratory (cough, shortness of breath, wheezing, throat soreness or irritation, sinus problems, or nosebleeds)**
- **Dermal (rash, pruritus, or irritation)**
- **Neurological (headache or dizziness)**
- **Gastrointestinal (nausea or abdominal pain)**
- **Constitutional (sleep disruption or fatigue)**
- **Eye symptoms (pruritic, painful, or dry)**

Residents living in proximity to shale gas activities also frequently reported the development of additional symptoms that interfere with normal functioning, including anxiety, depression, difficulty focusing and feeling a loss of control. It is important to recognize and to address these disabling symptoms as they may be attributed to a wide range of social factors associated with shale drilling.

Reducing exposures:

Air contamination: Individuals should avoid exercising at times and places with increased air pollution present. Although the Air Quality Index provides useful guidance regarding regional air quality, it does not accurately portray the air quality in microenvironments where local sources, such as proximity to major roadways or UNGD activity, impact the air quality. Portable monitors are available which provide real time information regarding local pollution levels which can help to guide levels of activity. In addition, an individual's perception of air quality, e.g. the experience of odor or irritation, should also guide activity levels.

Indoor air quality is determined both by indoor sources of pollutants and infiltration of outdoor sources of air pollutants. Indoor sources of air contaminants should always be reduced to the extent feasible. The impact of outdoor sources on indoor air quality can be reduced with air conditioning, as well as with the installation of filters in the ducts of HVAC systems and the use of portable filter-based air cleaners.

Water contamination: Comprehensive water testing should be performed prior to any local gas drilling activity and then periodically after the onset of activity. Low cost tests for water conductivity are available for frequent monitoring of changes in water. Individuals should switch to drinking and cooking with bottled water if any changes in water are noted while awaiting comprehensive testing results. Shower and laundry locations should be ventilated, since some contaminants may volatilize from water resulting in inhalation exposures.

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