POTENTIAL HEALTH IMPACTS OF GAS INFRASTRUCTURE

The entire gas extraction and production process, including gas delivery, is an intense industrial activity which has the potential to pose significant health risks. Following are some of the potential health impacts of the gas infrastructure, including compressor stations, metering and regulating stations, and pipelines.

ACCIDENTS

Accidents can occur at any point of gas production, from transport of gear and chemicals to the site, to construction and operation of the facility, to the processing of the gas and to the delivery of it via pipelines, and especially via tractor-trailers on rural roads, and at any of those points, explosions are possible, as well as accidental releases of air toxins.

Several references on worker safety[1] [2] [3], and specific incidents are listed here:
Louisiana Compressor Station Fire[4]
Wyoming Compressor Station Fire[5]
Texas Compressor station venting incident[6]
March 29, 2012, Springville, PA[7]
November, 2011, Artemas, PA[8].

A cornerstone of this industrialization is the truck traffic.[9] Accidents are common.[10] Loopholes in highway safety rules allow truck drivers in the oil and gas industry to work longer hours than drivers in most other industries.[11]

---

[1] http://www.ktbs.com/news/24753381/detail.html http://www.mcclatchydc.com/2010/06/10/95701/oil-gas-worker-safety-record-weak.html
http://www.osha.gov/pls/oshaweb/searchresults.relevance?p_text=gas%20workers%20safety&p_status=CURRENT&p_title

[2] http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=NEWS_RELEASES&p_id=19776

[3] http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=NEWS_RELEASES&p_id=19575

[4] http://www.ktbs.com/news/24753381/detail.html

[5] http://trib.com/news/state-and-regional/article_9de82058-2e6b-5e3d-8e19- 2744fafd49b4.html?mode=story

[6] http://www.star-telegram.com/2011/05/14/3075603/delayed-response-to-gas-release.html
http://en.wikipedia.org/wiki/List_of_pipeline_accidents

[7] http://thetimes-tribune.com/news/explosion-rocks-natural-gas-compressor-station-1.1292502

[8] http://times-news.com/local/x459214584/Gas-explosion-fire-forces- evacuations

[9] "Drilling trucks have caused an estimated $2 billion in damage to Texas roads", access at http://www.star-telegram.com/2012/07/02/4075195/drilling-trucks-have-caused-an.html#storylink=cpy

AIR POLLUTION and CHEMICALS

The infrastructure, including compressor stations, processing facilities, metering and regulating stations and diesel-powered trucks emit pollutants[12] [13] [14] [15]such as Nitrogen Oxides (NOx), Carbon Monoxide (CO), Volatile Organic Compounds (VOCs), Formaldehyde (H2CO), Particulate Matter (PM 10 and 2.5) and Sulfur Dioxide (SO2) and their impacts are not currently aggregated. Yet the exposure is cumulative[16] and costly[17].

Following are some of the health impacts associated with infrastructure and truck pollutants:

NOx is associated with respiratory disease.

VOCs are neurotoxins, hepatotoxins, reproductive toxins, fetotoxins, and dermatotoxins.

SO2 is associated with respiratory illness, and it is toxic.

Particulate matter contributes disproportionately to human health risks, and includes brain lesions resulting in neurobehavioral abnormalities.[18]

With small increases in airborne particulate matter exposure, human risks increase for the following:
• Cardiovascular disease
• Respiratory disease
• Fetal and neonatal illness.
• Childhood illnesses: Pediatric allergies, ear/nose/throat and respiratory infections early in life, impaired lung development in children that affects lung function in adulthood, asthma, bronchiolitis, exacerbation of existing asthma and exacerbation of cystic fibrosis.
• Geriatric illnesses: Including exacerbation of chronic obstructive pulmonary disease, congestive heart failure, heart conduction disorders, myocardial infarction and coronary artery disease, and diabetes in the elderly.

---

[10] "Traffic Accidents Increase as Texas Oil and Gas Industry Grows", access at http://www.texaslawfirm.com/CM/Custom/Traffic-Accidents-Increase-as-Texas-Oil-and-Gas-Industry-Grows.asp
[11] Amy Mall blog (NRDC), http://switchboard.nrdc.org/blogs/amall/another_loophole_for_the_oil_a_1.html
[12] http://www.iom.edu/~/media/Files/Activity%20Files/Environment/EnvironmentalHealthRT/2012-04-30/Robinson.pdf and http://www.iom.edu/Activities/Environment/EnvironmentalHealthRT/2012-APR-30/Day-1/Session-5/1-Robinson.aspx
[13] http://sape2016.files.wordpress.com/2013/10/algonquin_incremental_market_project.pd
[14] http://courses.washington.edu/envir300/papers/Steinzor_et_al_2013.pdf
[15] http://sape2016.files.wordpress.com/2013/10/air_quality_and_climate_impacts_of_shale_gas_operations.pdf
[16] http://www.post-gazette.com/news/state/2013/10/06/Marcellus-gas-facilities-near-to-one-another-or-even-linked-are-evaluated-individually-for-pollution/stories/201310060050
[17] Litovitz, Curtright, 2013, "Estimation of regional air-quality damages from Marcellus Shale natural gas extraction in Pennsylvania". Access at http://iopscience.iop.org/1748-9326/8/1/014017/pdf/1748-9326_8_1_014017.pdf and also http://iopscience.iop.org/1748-9326/8/1/014017
[18] http://www.usatoday.com/story/news/nation/2014/06/09/air-pollution-autism-study/10226445/

Formaldehyde causes cancer.[19]

Children and pregnant women are particularly affected in adverse ways by environmental toxins[20]. Children are especially vulnerable to air pollution because their lungs continue to grow and enlarge until about age 18. Plus they breathe faster and are closer to the ground.[21]

Air pollution has also been shown to be associated with birth problems[22], neurodevelopmental disorders, lower IQ in babies born to mothers with polycyclic aromatic hydrocarbon exposure during pregnancy[23] [24] and learning disorders in exposed children. A study in 2010 compared residential proximity to a freeway with the incidence of autism, and found that for those living within 300 meters of the freeway during the third trimester, the odds ratio of being born with autism was more than twice as great as controls.[25]

Neurodevelopmental disorders such as autism, attention deficit disorder, dyslexia, and cerebral palsy affect one in six children worldwide, and are increasing in frequency. Industrial chemicals that injure the developing brain are among the known causes for this rise in prevalence. Co-authors of a paper just published in Lancet Neurology, Grandjean and Landrigan, write: "Exposure to these chemicals during early development can cause brain injury at levels much lower than those affecting adults, and the real impact on children's health is just beginning to be uncovered."[26]

Metering and regulating stations are in essence small gas processing plants, some with heaters, separators, condensate tanks, and venting.[27] They work via:

- *Inlet and outlet ball valves to control gas flow*
- *Inlet and outlet pressure gauges for gas measurement*
- *Flow filters that isolate the gas and remove impurities*
- *Pressure regulators that reduce pressure when needed, and ensure gas is supplied at a constant pressure*

---

[19] http://ntp.niehs.nih.gov/ntp/roc/twelfth/profiles/formaldehyde.pdf
[20] CEH, 2013, http://www.ceh.org/legacy/storage/documents/Fracking/fracking_final-low-1.pdf
[21] World Health Organization http://www.who.int/ceh/capacity/Children_are_not_little_adults.pdf
[22] Wilhelm at UCLA report on air pollution and premature births
http://www.environment.ucla.edu/reportcard/article.asp?parentid=1700
[23] Perera, 2009 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2864932/
[24] Perera et al, 2006. Effect of prenatal exposure to airborne polycyclic aromatic hydrocarbons on neurodevelopment in the first 3 years of life among inner-city children. Environ Health Perspect. Doi:114(8):1287–1292.
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1551985/
[25] Volk, HE et al (2010) Residential Proximity to Freeways and Autism in the CHARGE study. Environmental Health Perspectives Dec 13 (Epub ahead of print)
[26] Grandjean and Landrigan, "Neurobehavioural effects of developmental toxicity",
Lancet Neurol 2014; 13: 330–38, doi:10.1016/S1474-4422(13)70278-3. Published Online February 15, 2014. Access online at
http://download.thelancet.com/pdfs/journals/laneur/PIIS1474442213702783.pdf?id=baaj7wRR-UTIz8M5y3Zqu
[27] http://www.pipelineandgasjournal.com/fundamentals-gas-pipeline-metering-stations?page=show

- *Shut-off and relief valves that stop or reduce the pressure in the system, and ensure safety of equipment*[28]

M&R stations release methane[29]; since a list of other chemicals flow with the methane (Nitrogen Oxides, Carbon Monoxide, Volatile Organic Compounds, Formaldehyde, Particulate Matter 10, 2.5, and smaller, Sulfur Dioxide, and Polychlorinated Biphenyls), these will be released as well during heating for pressure regulation, venting and blowdowns.

Polychlorinated Biphenyls (PCBs)

Pipelines have been found to contain PCBs which the EPA began regulating in the 1970s.[30] However, the EPA is in the process of re-assessing the rules, including PCBs in gas transmission. [31] Cases of illegal dumping have been reported, which is of concern since PCBs could lead to a variety of illness, including damage to the immune system and fetuses, liver disease and chloracne, an acute form of skin rash, as well as cancer.[32] An independent report found that there is no way to completely eliminate PCBs from pipelines and processing facilities.[33]

There should be a plan for monitoring since there is a good chance that PCBs may accumulate in the proposed infrastructure.[34] [35]

NOISE

Noise can cause Vibro-Acoustic Disease which can lead to heart disease, neurological and gastrointestinal problems, as well as psychological issues.[36] Noise pollution raises the risk of heart attack and high blood pressure and cognitive deficits in children, and it can interfere with the ability to learn in children, as reported by the World Health Organization.[37]

---

[28] https://www.honeywellprocess.com/en-US/explore/products/gas-measurement-and-regulation/gas-pressure-regulating-and-metering-stations/Pages/gas-pressure-regulating-and-metering-stations.aspx
[29] http://www.epa.gov/gasstar/documents/emissions_report/10_metering.pdf
[30] http://www.epa.gov/compliance/resources/publications/monitoring/tsca/manuals/pcbinspect/pcbinspectappg.pdf
[31] http://yosemite.epa.gov/opei/rulegate.nsf/byRIN/2070-AJ38#1
[32] http://www.nytimes.com/1987/02/26/us/pcb-dumping-by-4-pipelines-reported.html
[33] Papadopulos et al, 2010. PCBs in the Interstate Natural Gas Transmission System – Status and Trends. Access at http://www.ingaa.org/11885/Reports/10722.aspx and full report at http://www.ingaa.org/File.aspx?id=10753
[34] http://www.pca.state.mn.us/index.php/view-document.html?gid=17960
[35] http://www.ingaa.org/28.aspx?CFVreporttype=32
[36] http://www.citidep.pt/papers/articles/alvesper.htm and http://www.fastcompany.com/1744151/air-pollution-causes-europeans-to-lose-16-million-years-of-healthy-living-annually-study
[37] http://www.euro.who.int/__data/assets/pdf_file/0008/136466/e94888.pdf

There are adverse physical and mental effects from noise.[38] For example, prolonged periods of exposure to 65 dBA can cause mental and bodily fatigue. Noise can affect the quantity and quality of sleep; it can cause permanent hearing damage; and it can contribute to the development or aggravation of heart and circulatory diseases; and it can transform a person's initial annoyance into more extreme emotional responses and behavior.[39] One example of extreme and sometimes unexpected noise comes from blowdowns.[40]

According to the World Health Organization[41],
". . .apart from 'annoyance', people may feel a variety of negative emotions when exposed to community noise, and may report anger, disappointment, dissatisfaction, withdrawal, helplessness, depression, anxiety, distraction, agitation, or exhaustion.
. . . Social and behavioural effects include changes in overt everyday behaviour patterns (e.g. closing windows, not using balconies, turning TV and radio to louder levels, writing petitions, complaining to authorities); adverse changes in social behaviour (e.g., aggression, unfriendliness, disengagement, non-participation); adverse changes in social indicators (e.g. residential mobility, hospital admissions, drug consumption, accident rates); and changes in mood (e.g. less happy, more depressed)."

The World Health Organization also reports that "a large proportion of low-frequency components in noise may increase considerably the adverse effects on health."[42]

The loud short-term noises from flaring and the loud or low frequency noise from compressors or regulating stations are common complaints. Numerous citizens have reported disruption of sleep and increased anxiety caused by noise from oil and gas development.[43] For people who live in semi- rural or suburban areas, the arrival of a new, industrial noise source can greatly disturb the natural environmental soundscape.

RADIOACTIVITY

Radon, a gas, has a short half-life (3.8 days) but among its progeny are lead and polonium, and these are toxic and have relatively long half-lives of 22.6 years and 138 days respectively. Lead causes neurologic and hematologic toxicity, and death; polonium causes cancer and death.[44] Radon and its radioactive

---

[38] http://www.earthworksaction.org/noiseresources.cfm#GENERALNOISE
[39] Marsh, A. 1999. University of Western Australia, School of Architecture and Fine Arts. Cited in East of Huajatolla Citizens Alliance. *Noise*
[40] http://www.transcanada.com/docs/Our_Responsibility/Blowdown_Notification_Factsheet.pdf
[41] Berglund, B., Lindvall, T. and Schwela, D. 1999. *Guidelines for Community Noise*
[42] Report on low-frequency noise http://www.scotland.gov.uk/Publications/2002/02/10663/File-1
[43] Clarren, Rebecca. "Status quo reigns in New Mexico," ***High Country News***. Sept. 25, 2000. p. 10
[44] National Academy of Sciences 1988 report: Health Risks of Radon and Other Internally Deposited Alpha-Emitters: BEIR IV, page 5

decay products enter the body primarily through inhalation. Most of the radon is exhaled prior to radioactive decay but some of the solid radioactive polonium and lead remain in the lungs and may cause cancer.

The gas which flows through the pipeline carries gaseous radon with it, and as radon decays within the pipeline, the solid daughter elements, polonium and lead, accumulate along the interior of the pipes. There might be concern that the gas transiting, and being compressed and regulated, will have radioactivity levels which will be a risk not only to the workers at these stations and along the pipeline, but potentially also to the residents.

Following are several references, some from industry publications, on radon and its progeny in pipelines:

--A report from an industry publication, the Oil and Gas Journal, 1990, recognizing that radioactivity could pose problems.[45]
--A. Paschoa and F. Steinhäusler, Technologically Enhanced Natural Radiation[46]
--The recommendations from the IAEA of which the US is a member[47]
--ICRP recommendations[48]
--Steinhausler "RADIOLOGICAL IMPACT ON MAN AND THE ENVIRONMENT FROM THE OIL AND GAS INDUSTRY: RISK ASSESSMENT FOR THE CRITICAL GROUP" 2004[49]
--Van Netten et al "Radon-222 and Gamma Ray Levels Associated with the Collection, Processing, Transmission, and Utilization of Natural Gas"[50]
-- OGP, "Guidelines for the management of Naturally Occurring Radioactive Material (NORM) in the oil & gas industry" International Association of Oil & Gas Producers, Report No. 412, September 2008.[51]
--Godoy, José Marcus, et al. "210Pb content in natural gas pipeline residues ("black-powder") and its correlation with the chemical composition." Journal of environmental radioactivity 83.1 (2005): 101-111.[52]
--García-Tenorio, R. "210Po and 210Pb in NORM mineral processing industries." EU-NORM 1st International Symposium 5-8 June 2012, pp. 202 – 209.[53]
--IAEA, "Radiation Protection and the Management of Radioactive Waste in the Oil and Gas Industry" Training Course Series No. 40, International Atomic Energy Agency, Vienna, 2010.[54]
--Argonne National Laboratory, "Natural Decay Series: Uranium, Radium, and Thorium "EVS Human Health

---

[45] http://www.ogj.com/articles/print/volume-88/issue-26/in-this-issue/production/radioactive-materials- could-pose-problems-for-the-gas-industry.html

[46] Paschoa and Steinhäusler Radioactivity in the Environment, Volume 17, 2010

[47] http://www-pub.iaea.org/MTCD/publications/PDF/Pub1171_web.pdf

[48] http://www.icrp.org/docs/Michael%20Cowie%20Developemetn%20of%20a%20NORM%20Management%20Strategy%20Oil%20and%20Gas%20.pdf

[49] http://www.gasdrillingtechnotes.org/uploads/7/5/7/4/7574658/assembly_radioactivity_gas_workers_steinhaeusler2006.pdf

[50] Van Netten et al, Radon-222 and Gamma Ray Levels Associated with the Collection, Processing, Transmission, and Utilization of Natural Gas. American Industrial Hygiene Association Journal, DOI:10.1080/15428119891010794, Published online: 18 Jun 2010. Access at http://www.tandfonline.com/doi/abs/10.1080/15428119891010794#.U6oUNfldWSp

[51] http://www.ogp.org.uk/pubs/412.pdf

[52] http://www.sciencedirect.com/science/article/pii/S0265931X05000913

[53] http://digital.csic.es/bitstream/10261/75835/1/EstoniaProceedings.pdf

[54] http://www-pub.iaea.org/MTCD/Publications/PDF/TCS-40_web.pdf

Fact Sheet, August 2005.[55]

Pigging operations and worker risks

As radon decays within the pipeline, the solid daughter elements, polonium and lead, accumulate along the pipes. (PCBs and other contaminants such as black powder[56] and anaerobic microbials do as well [57] [58]). PIGs (Pipeline Inspection or Intervention Gauge/Gizmo/Gadget [59]) inspect or clean out the pipe, and become repositories of these toxins. These PIGs, with pipe film, black powder, bacteria, scale and sludge, must be removed from the pipeline, stored and eventually disposed.[60] [61] [62] [63] At each step, precautions must be taken to avoid contaminating workers and residents.

[55] http://gonuke.org/ComprehensiveTeachingToolkits/Radiation%20Protection/ChSCC_RP/Columbia%20Basin%20RPT-111/Supplementary%20materials/natural-decay-series.pdf

[56] Baldwin, Richard M. "Black powder problem will yield to understanding, planning." Pipeline and Gas Industry 82 (1999): 109-112. http://muellerenvironmental.com/Documents/100-056-Black%20Powder.pdf and Baldwin, Richard M. "Black powder control starts locally, works back to source." *Pipeline & Gas Industry* (1999): 81-87. http://www.muellerenvironmental.com/Documents/100-058%20Black%20Powder2.pdf

[57] Mueller, Fred, and Mark Null. "Impurities in the Gas Stream." Mueller Environmental Designs, Inc. Technical Document, 2005. http://www.muellerenvironmental.com/public/ProductDocuments.aspx

[58] Zhu, Xiang Y., John Lubeck, and John J. Kilbane. "Characterization of microbial communities in gas industry pipelines." Applied and environmental microbiology 69.9 (2003): 5354-5363. Access at http://aem.asm.org/content/69/9/5354.full.pdf

[59] http://en.wikipedia.org/wiki/Pigging)

[60] http://www.rigzone.com/training/insight.asp?insight_id=310&c_id=19

[61] http://www.pigtek.com/advanced_pipeline_cleaning.php

[62] Tsochatzidis, Nikolaos A., and Konstantinos E. Maroulis. "Methods help remove black powder from gas pipelines." Oil and Gas Journal 105.10 (2007): 52. http://www.desfa.gr/files/dimosieyseis/Tsochatzidis%26MaroulisOGJMar2007.pdf

[63] Lindner, Hubert. "A new cleaning approach for black powder removal." Pigging Products and Services Association, 2006. http://www.ppsa-online.com/papers/2006-Aberdeen-8-Lindner.Pdf

An industry video of cleaning (with PIGs) can be viewed here[64]
http://www.cleanharbors.com/assets/downloads/videos/video-popup-pipeline-coating.html .

Prepared by:
Larysa Dyrszka M.D., co-founder Concerned Health Professionals of NY
Paul Moskowitz Ph.D. (Physics), P.E.

July 8, 2014

[64] http://www.cleanharbors.com/assets/downloads/videos/video-popup-pipeline-coating.html