

Internalizing Externalities through Public Pressure: Transparency Regulation for Fracking, Drilling Activity and Water Quality

Background Information

This Appendix provides additional descriptive evidence along with background information.

BI.1 – Examples of the Demand for HF Transparency

BI.2 – Descriptive Information on the Disclosed Chemicals used in HF Fluids

BI.1 – Examples of the Demand for HF Transparency

Societal calls for more transparency about HF generally

Outlet	Date	Title / Quotes
Pennlive	September 5, 2010	<p>'Gasland,' a documentary about the natural gas industry in Pennsylvania, is a national hit</p> <p>The movie "Gasland" — about the environmental hazards of drilling and fracking shale for natural gas — has become a national sensation. The documentary has aired repeatedly on HBO in recent months. Critics, including some Pennsylvania government officials, say it's a shameless piece of propaganda riddled with inaccuracies. Fans say it opened their eyes to what really happens when drillers come to town. Either way, it has become a force to be reckoned with in the ongoing political debate over Marcellus Shale in Pennsylvania. (...) Q: The film focuses <u>on the secrecy surrounding the chemicals used in fracking</u>. Range Resources and several other companies have since begun publicly posting the fracking recipe for each of their wells in Pennsylvania. Your thoughts on that?</p> <p>A: <u>They're clearly afraid of federal regulation</u>. They're trying to get out ahead of the curve. The governor of Wyoming publicly stated (his state) passed this (fracking disclosure) law to keep the EPA out. <u>That Wyoming law requires the industry to disclose the chemicals to the state, but not to the people</u>. There has to be a federal standard in America. ... Right now, the gas industry is exempt from the Clean Water Act, the Safe Drinking Water Act, the Clean Air Act. ... We shouldn't be having any discussion of drilling until those exemptions are reversed.</p>
Science	August 11, 2012	<p>Federal Committee: Shale Gas Needs More Openness, Better Data</p> <p>(...) The subcommittee to the secretary's Energy Advisory Board was not asked who should be regulating shale gas, Zoback says. Regulation now lies primarily with the states. But "we're pointing out what can and should be done." <u>To regain public trust, the report says, much information about shale gas should become readily available to the public, starting with the chemical recipes for the fluids pumped at high pressure into shale to free up the gas</u>. Those fluids sometimes spill onto the surface and into waterways. And much more information should be gathered on the environment before, during, and after drilling. The debate over whether and how drilling and fracking contaminate groundwater with gas—the infamous flaming water faucet of the documentary Gasland—would benefit especially. "We feel very strongly that having good data will advance a lot of the issues," Zoback says.</p> <p>Some sort of national organization focused on shale gas should also be formed, the report says. <u>It could create a national database of all public information as well as disseminate best practices to industry as they evolve</u>. Added support for existing mechanisms that aid communication among state and federal regulators would also help.</p>
Huffington Post	November 21, 2012	<p>Fracking's Toxic Secret: Lack of Transparency Over Natural Gas Drilling Endangers Public Health, Advocates Say</p> <p>(...) <u>The disclosing of chemicals used by the industry remains seriously incomplete</u>. Couple that with the incomplete reports on water tests and it aggravates a situation where landowners don't have a full picture of what is going on," said Kate Sinding, a senior attorney with the Natural Resources Defence Council.</p> <p><u>David Headley, of Smithfield, Penn, is one of those that's been getting incomplete information about contaminants in his water</u>. In April 2010, four years after the first natural gas well was drilled near his home, the DEP tested Headley's drinking water and reported low levels of barium, strontium and manganese. "We were told the water was safe to drink," David Headley said. "But we had an infant in the house, and a pre-teen. We weren't about to let them drink it." (...)</p>

National Geographic	March, 2013	<p><i>The New Oil Landscape</i></p> <p>(...) <u>Of special concern are the hundreds of fracking components, some of which contain chemicals known to be or suspected of being carcinogenic or otherwise toxic.</u> Increasing the likelihood of unwanted environmental effects is the so-called Halliburton loophole, named after the company that patented an early version of hydraulic fracturing. Passed during the Bush-Cheney Administration, <u>the loophole exempts the oil and gas industry from the requirements of the Safe Drinking Water Act.</u> What's more, manufacturers and operators are not required to disclose all their ingredients, on the principle that trade secrets might be revealed. Even <u>George P. Mitchell, the Texas wildcatter who pioneered the use of fracking, has called for more transparency and tighter regulation.</u> In the absence of well-defined federal oversight, states are starting to assert control. In 2011 the North Dakota legislature passed a bill that said, in effect, fracking is safe, end of discussion. (...)</p>
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Demand from local communities, NGOs, and environmental activists for information about the HF fluids

Outlet	Date	Title / Quotes
Earth Justice	December 11, 2011	<p><i>Colorado Adopts New Fracking Disclosure Rule - Victory — Earthjustice instrumental in positive outcome</i></p> <p>The Colorado Oil and Gas Conservation Commission has announced a new state rule on hydraulic fracturing that requires full disclosure of the substances used in the fracking process. <u>The rule is one of the strongest in the country and Earthjustice's Denver office was actively involved in shaping the decision.</u></p> <p>"This rule is an important step forward that will provide Coloradans with information they need to ensure the safety of their drinking water, air and health, said Earthjustice staff attorney Michael Freeman. "While the conservation community did not get everything it wanted, <u>Colorado's disclosure rule provides a good foundation for ensuring that hydraulic fracturing is done safely in this state.</u>"</p> <p>(...) "We are pleased we could reach a reasonable compromise on protecting legitimate trade secrets while ensuring that all types of fracking chemicals and their concentrations are reported to the public," said Charlie Montgomery, Energy Organizer at Colorado Environmental Coalition.</p> <p>"Colorado has taken a strong first step to addressing public health and environmental concerns from fracking," said Matt Reed, public lands director of the High Country Citizens Alliance. "<u>The new disclosure rule, while not perfect, adds transparency to what has been a secretive process. The result will be a better-informed public, recourse for citizens to pursue violations of the rule, and ultimately a better understanding of what chemicals are going into the ground and where.</u>"</p>
The Bismarck Tribune	April 1, 2012	<p><i>Environmentalists sue over fracking fluids</i></p> <p>CHEYENNE, Wyo. (AP) – <u>Environmentalists are suing the Wyoming Oil and Gas Conservation Commission, saying the regulatory agency hasn't done enough to justify honoring requests by companies to keep the public from reviewing ingredients in hydraulic fracturing fluids.</u> The groups Powder River Basin Resource Council, Wyoming Outdoor Council, Earthworks and OMB Watch sued in Natrona County District Court on Monday. <u>They allege the commission denied their state open records requests to review fracking fluid ingredients.</u> Hydraulic fracturing involves pumping water, sand and chemicals into oil and gas wells to crack open fissures. Wyoming has required oilfield service companies to disclose to state officials the ingredients in their fracking fluids since 2010. Environmentalists have raised alarm for years that fracking could contaminate groundwater. Few if any such cases are confirmed although last year the U.S. Environmental Protection Agency theorized that fracking may have contaminated the groundwater near Pavillion, a small community in central Fremont County. <u>Testing groundwater for fracking-related pollution gets complicated because what goes into fracking fluids isn't generally known outside the companies that make it.</u> Wyoming's open records law provides an exception for public disclosure of trade secrets. The groups say the commission has repeatedly allowed companies to invoke the exception - on flimsy grounds - to keep fracking fluid ingredients out of the public realm. He pointed out that companies must also track fracking fluids after they've been used and account for their reuse, storage or disposal. Wyoming led the nation in its fracking disclosure regulations and other states are following suit, Gov. Matt Mead said in a statement. "Wyoming and the additional states requiring disclosure believe it is the states rather than the federal government that should regulate hydraulic fracturing," said Mead, who as governor is chairman of the commission. "We will watch this case closely to determine if either the rules or the administration of the rules need work. If improvements need to be made we will make them."</p>

Efforts by policy makers and regulators

The Obama Administration attempted to introduce federal legislation on HF fluid disclosures, but the effort eventually failed.

Outlet	Date	Title / Quotes
Gas Daily	May 4, 2011	<p><i>Maryland to sue Chesapeake over Pa. fluid spill</i></p> <p>The state of Maryland intends to sue Chesapeake Energy for allegedly violating federal environmental laws when hydraulic fracturing fluids from one of its Marcellus Shale gas wells spilled into a north-eastern Pennsylvania creek. "Companies cannot expose citizens to dangerous chemicals that pose serious health risks to the environment and to public health," Maryland Attorney General Douglas Gansler said late Monday. "We are using all resources available to hold Chesapeake Energy accountable for its actions." Gansler said in a letter to Oklahoma City-based Chesapeake that he plans to sue the company and its affiliates for violating the federal Resource Conservation and Recovery Act and the Clean Water Act. Federal law mandates that Gansler give the company 90 days notice of his intent. On April 19, thousands of gallons of fracking fluid were released from the Bradford County well into Towanda Creek, a tributary of the Susquehanna River, which supplies drinking water to about 6.2 million people in Pennsylvania, Delaware and Maryland (GD 4/20). <u>"Exposure to toxic and carcinogenic chemicals in unknown quantities creates a risk of imminent and substantial endangerment to humans using Maryland waterways for recreation and to the environment," Gansler said. "Although the precise mixture of these fracking fluids is not known, a recent congressional study found that they contain 750 chemicals and other components, including several extremely toxic compounds. High levels of these contaminants remain in the fracking fluid that returns to the surface as wastewater after a well has been hydrofracked."</u> He said radioactivity levels in Pennsylvania's fracking wastewater "have sometimes been thousands of times above the maximum allowed by federal standards for drinking water."</p>
Reuters	January 25, 2012	<p><i>Obama backs shale gas drilling</i></p> <p>Improvements in drilling techniques have transformed the U.S. energy landscape in recent years by unlocking the country's immense shale oil and gas reserves. But the drilling boom has raised concerns about the safety of natural gas extraction techniques like hydraulic fracturing, or fracking, which environmentalists say could pollute water supplies. <u>Still, with fracking mostly exempt from federal oversight and most shale gas production occurring on private lands, the Obama administration is limited in its authority over the practice.</u> Obama said the administration would move forward with rules that would require companies to disclose chemicals used during the fracking process on public lands. In wide-ranging comments about the energy industry, Obama also said he would direct his administration to open 75 percent of the country's potential offshore oil and gas resources to drilling. This proposal would be carried out in the latest offshore drilling plan released by the Interior Department in November.</p>
The Tampa Tribune	March 21, 2015	<p><i>Fracking chemicals must be disclosed; New rule requires drillers to be more transparent</i></p> <p><u>The Obama administration said Friday it is requiring companies that drill for oil and natural gas on federal lands to disclose chemicals used in hydraulic fracturing, the first major federal regulation of the controversial drilling technique that has sparked an ongoing boom in natural gas production but raised widespread concerns about possible groundwater contamination.</u> A rule to take effect in June also updates requirements for well construction and disposal of water and other fluids used in fracking, as the drilling method is more commonly known. The rule has been under consideration for more than three years, drawing criticism from the oil and gas industry and environmental groups alike. The industry fears federal regulation could duplicate efforts by states and hinder the drilling boom, while some environmental groups worry that lenient rules could allow unsafe drilling techniques to pollute groundwater.</p>

Reaction to the rule was immediate. An industry group announced it was filing a lawsuit to block the regulation and the Republican chairman of the Senate Environment and Public Works Committee announced legislation to keep fracking regulations under state management. The final rule hews closely to a draft that has lingered since the Obama administration proposed it in May 2013. The rule relies on an online database used by at least 16 states to track the chemicals used in fracking operations. The website, FracFocus.org, was formed by industry and intergovernmental groups in 2011 and allows users to gather well-specific data on tens of thousands of drilling sites across the country. Companies will have to disclose the chemicals they use within 30 days of the fracking operation. Interior Secretary Sally Jewell said the rule will allow for continued responsible development of federal oil and gas resources on millions of acres of public lands while assuring the public that transparent and effective safety and environmental protections are in place.

Jewell, who worked on fracking operations in Oklahoma long before joining the government in 2013, said decades-old federal regulations have failed to keep pace with modern technological advances. The League of Conservation Voters called the bill an important step forward to regulate fracking.

Demand from shareholders for information about HF fluids

Shareholders request information on HF to assess the potential for reputational risks and vulnerability to litigation, as illustrated below:

Outlet	Date	Title / Quotes
ExxonMobil - DEFINITIVE PROXY STATEMENT	April 13, 2010	<p><i>ExxonMobil shareholder proposal</i></p> <p>ITEM 10 – REPORT ON NATURAL GAS PRODUCTION</p> <p>This proposal was submitted by The Park Foundation, 311 California St., Suite 510, San Francisco, CA 94104, as lead proponent of a filing group.</p> <p><u>Fracturing operations can have significant impacts on surrounding communities including the potential for increased incidents of toxic spills, impacts to local water quantity and quality, and degradation of air quality. Government officials in Ohio, Pennsylvania and Colorado have documented methane gas linked to fracturing operations in drinking water. In Wyoming, the US Environmental Protection Agency (EPA) recently found a chemical known to be used in fracturing in at least three wells adjacent to drilling operations.</u></p> <p><u>There is virtually no public disclosure of chemicals used at fracturing locations.</u> The Energy Policy Act of 2005 stripped EPA of its authority to regulate fracturing under the Safe Drinking Water Act and state regulation is uneven and limited. But recently, some new federal and state regulations have been proposed. In June 2009, federal legislation to reinstate EPA authority to regulate fracturing was introduced. In September 2009, the New York State Department of Environmental Conservation released draft permit conditions that would require disclosure of chemicals used, specific well construction protocols, and baseline pre-testing of surrounding drinking water wells. New York sits above part of the Marcellus Shale, which some believe to be the largest onshore natural gas reserve.</p> <p>Media attention has increased exponentially. A search of the Nexis Mega-News library on November 11, 2009 found 1807 articles mentioning ‘hydraulic fracturing’ and environment in the last two years, a 265 percent increase over the prior three years.</p> <p>Because of public concern, in September 2009, some natural gas operators and drillers began advocating greater disclosure of the chemical constituents used in fracturing.</p> <p><u>In the proponents’ opinion, emerging technologies to track ‘chemical signatures’ from drilling activities increase the potential for reputational damage and vulnerability to litigation. Furthermore, we believe uneven regulatory controls and reported contamination incidents compel companies to protect their long-term financial interests by taking measures beyond regulatory requirements to reduce environmental hazards.</u></p> <p><u>Therefore, be it resolved, Shareholders request that the Board of Directors prepare a report by October 1, 2010, at reasonable cost and omitting proprietary information, summarizing 1. the environmental impact of fracturing operations of ExxonMobil; 2. potential policies for the company to adopt, above and beyond regulatory requirements, to reduce or eliminate hazards to air, water, and soil quality from fracturing.</u></p> <p>Supporting statement:</p> <p><u>Proponents believe the policies explored by the report should include, among other things, use of less toxic fracturing fluids, recycling or reuse of waste fluids, and other structural or procedural strategies to reduce fracturing hazards.”</u></p> <p>The Board recommends you vote AGAINST this proposal for the following reasons:</p> <p>ExxonMobil’s Environmental Policy states that we will comply with all applicable laws and regulations and apply responsible standards where laws do not exist, including precautions specific to hydraulic fracturing. The Board believes the minimal environmental impacts of hydraulic fracturing have been well-documented and regulatory protections are well-</p>

established; therefore, an additional report is not necessary. ExxonMobil supports the disclosure of the identity of the ingredients being used in fracturing fluids at each site. While we understand the intellectual property concerns of service companies when it comes to disclosing the proprietary formulations in their exact amounts, we believe the concerns of community members can be alleviated by the disclosure of all ingredients used in these fluids. We understand that some communities and homeowners new to drilling operations may have concerns. We are committed to working with them to demonstrate that we can address environmental concerns they may have, while providing good jobs and income associated with the safe and efficient production of natural gas.

Shareholder Proposals	Multiple dates	Several other companies are targeted by shareholder proposals related to HF disclosures			
		Company	Year	Outcome	Votes %
		ANADARKO PETROLEUM CORP.	2012	Withdrawn	
		CABOT OIL & GAS CORPORATION	2010	Voted	35.9
		CABOT OIL & GAS CORPORATION	2013	Withdrawn	
		CHESAPEAKE ENERGY CORP.	2012	Withdrawn	
		CHEVRON CORPORATION	2012	Voted	27.9
		CHEVRON CORPORATION	2013	Voted	30.2
		CHEVRON CORPORATION	2014	Voted	26.6
		EL PASO CORPORATION	2010	Withdrawn	
		ENERGEN CORPORATION	2010	Withdrawn	
		EOG RESOURCES, INC.	2010	Voted	30.9
		EOG RESOURCES, INC.	2012	Withdrawn	
		EOG RESOURCES, INC.	2013	Withdrawn	
		EOG RESOURCES, INC.	2014	Voted	28
		EQT CORPORATION	2010	Omitted	
		EQT CORPORATION	2014	Withdrawn	
		EXXON MOBIL CORPORATION	2010	Voted	26.3
		EXXON MOBIL CORPORATION	2011	Voted	28.2
		EXXON MOBIL CORPORATION	2012	Voted	29.6
		EXXON MOBIL CORPORATION	2013	Voted	30.2
		HESS CORPORATION	2010	Withdrawn	
		NOBLE ENERGY, INC.	2012	Withdrawn	
		OCCIDENTAL PETROLEUM CORP.	2014	Withdrawn	
		PIONEER NATURAL RESOURCES COMPANY	2013	Voted	41.7
		RANGE RESOURCES CORPORATION	2010	Withdrawn	

Withdrawn proposals are those for which the company has agreed to take action ahead of the vote at the annual general meeting. Omitted proposal are those for which the company has petitioned the SEC to be authorized to exclude the proposal from the proxy statement (see SEC rule 14a-8)

Demand from potential plaintiffs for information about HF disclosures

HF fluid information can help plaintiffs to prove contamination and establish causation. The following excerpts are from a local newspaper article explaining how landowners (in the proximity of HF wells) can use HF disclosures.

Outlet	Date	Title / Quotes
Great Falls Tribune	January 19, 2017	<p><i>Fracking chemicals focus of lawsuit seeking more disclosure</i></p> <p><u>Landowners are being denied information needed in order to test for the presence of fracking chemicals in their water before fracking occurs, which is essential to establish baseline information should contamination problems occur later, O'Brien said.</u></p> <p>Fracking chemicals are toxic or carcinogenic to humans, who may be exposed to the chemicals through surface spills of fracking fluids, groundwater contamination and chemical releases into the air, the lawsuit says. The plaintiffs argue the trade information should be disclosed to a state regulator, who could then make a determination whether trade secrets are involved. "The constitutional right-to-know provision does not mandate disclosure of bona fide de trade secrets, but it creates an express presumption in favor of public access to information and places the burden of establishing trade secret status on the entity seeking to withhold information from public disclosure," the lawsuit says.</p> <p>The first recorded hydraulic fracturing operation in Montana was in the 1950s, Halvorson said.</p> <p>"We are aware of no chemicals related to the hydraulic fracturing process being detected in groundwater," he said. A well hasn't been fracked in more than a year as the state has seen a decline in oil and gas production due to lower oil prices. It doesn't make sense for the public to wait until activity picks up to seek changes, O'Brien said. "It's hard to ask regulators to make changes in a boom," she said. <u>If chemicals are secret, O'Brien said, it's impossible to determine whether contamination, should it occur, is caused by hydraulic fracturing or something else.</u> Board members examined the evidence submitted in the rulemaking petition to the board seeking more disclosure including technical papers and concluded no evidence was presented that the rules were inadequate, Halvorson said.</p> <p><u>An incident in North Dakota in which chemicals were detected in the groundwater was presented in the petition, Halvorson said.</u> That incident occurred prior to the current hydraulic fracturing rule that the board adopted in 2011, he said. The incident that lead to that problem would have been addressed by the 2011 Montana rule, he said. The lawsuit calls the board's reasons for denying the rulemaking petition "factually erroneous, unsupported, and irrational." The board will discuss the MEIC filing and the request for rulemaking contained the filling at its Feb. 2 meeting, Halvorson said.</p>

BI.2 – Descriptive Information on the Disclosed Chemicals used in HF Fluids

The table below reports the most common hazardous chemicals reported in the disclosures for HF fluids. Chloride-related hazardous chemicals are reported in **bold**. Hazardous chemicals are those (i) regulated as primary contaminants by the Safe Drinking Water Act; (ii) regulated as Priority Toxic Pollutants for ecological toxicity under the Clean Water Act; or (iii) classified as diesel fuel under EPA guidance on HF operations (EPA, 2014).

Table ABI.1 – Most Common Hazardous Chemicals in the Disclosure for HF Fluids

Chemical name	Toxicology
1,4-dioxane	Dioxane is irritating to the eyes and respiratory tract. Exposure may cause damage to the central nervous system, liver and kidneys. Dioxane is classified by the National Toxicology Program as "reasonably anticipated to be a human carcinogen". It is also classified by the IARC as a Group 2B carcinogen: <i>possibly carcinogenic to humans</i> because it is a known carcinogen in other animals. The United States Environmental Protection Agency classifies dioxane as a probable human carcinogen, and a known irritant at concentrations significantly higher than those found in commercial product.
Acrylamide	Acrylamide is classified as an extremely hazardous substance in the United States as defined in Section 302 of the U.S. Emergency Planning and Community Right-to-Know Act (42 U.S.C. 11002) and is subject to strict reporting requirements by facilities which produce, store, or use it in significant quantities. Acrylamide is considered a potential occupational carcinogen by U.S. government agencies and classified as a Group 2A carcinogen by the IARC. The Occupational Safety and Health Administration and the National Institute for Occupational Safety and Health have set dermal occupational exposure limits at 0.03 mg/m ³ over an eight-hour workday.
Benzyl chloride	Benzyl chloride is an alkylating agent. Indicative of its high reactivity (relative to alkyl chlorides), benzyl chloride reacts with water in a hydrolysis reaction to form benzyl alcohol and hydrochloric acid. In contact with mucous membranes, hydrolysis produces hydrochloric acid. Thus, benzyl chloride is a lachrymator and has been used in chemical warfare. It is also very irritating to the skin. It is classified as an extremely hazardous substance in the United States as defined in Section 302 of the U.S. Emergency Planning and Community Right-to-Know Act (42 U.S.C. 11002) and is subject to strict reporting requirements by facilities which produce, store, or use it in significant quantities.
Calcium chloride anhydrous	Although non-toxic in small quantities when wet, the strongly hygroscopic properties of the non-hydrated salt present some hazards. Calcium chloride can act as an irritant by desiccating moist skin. Solid calcium chloride dissolves exothermically, and burns can result in the mouth and esophagus if it is ingested. Ingestion of concentrated solutions or solid products may cause gastrointestinal irritation or ulceration. Consumption of calcium chloride can lead to hypercalcemia.
Chlorine dioxide	Chlorine dioxide is toxic, and limits on human exposure are required to ensure its safe use. The United States Environmental Protection Agency has set a maximum level of 0.8 mg/L for chlorine dioxide in drinking water. The Occupational Safety and Health Administration (OSHA), an agency of the

Choline chloride	United States Department of Labor, has set an 8-hour permissible exposure limit of 0.1 ppm in air (0.3 mg/m ³) for people working with chlorine dioxide. Irritating to eyes, respiratory system and skin. Toxic to aquatic organisms. Accidental ingestion of the material may be damaging to the health of the individual. Nausea, vomiting, gastro-intestinal discomfort and diarrhea have been reported after large doses of choline.
Cupric chloride	Cupric chloride can be toxic. Only concentrations below 5 ppm are allowed in drinking water by the US Environmental Protection Agency.
Dazomet	Dazomet is irritating to the eyes and its degradation product, MITC, is a dermal sensitizer. Dazomet is very toxic to aquatic organisms, and acutely toxic to mammals. Exposure to dazomet can occur through several means; interaction with unincorporated granules, inhalation of its decomposition product, MITC, and/or water runoff.
Didecyl dimethyl ammonium chloride	In mice this disinfectant was found to cause infertility and birth defects when combined with Alkyl (60% C14, 25% C12, 15% C16) dimethyl benzyl ammonium chloride (ADBAC). These studies contradict the older toxicology data set on quaternary ammonia compounds which was reviewed by the U.S. Environmental Protection Agency (U.S. EPA) and the EU Commission.
Dimethylformamide (DMF)	Reactions including the use of sodium hydride in DMF as a solvent are somewhat hazardous; exothermic decompositions have been reported at temperatures as low as 26 °C. On a laboratory scale any thermal runaway is (usually) quickly noticed and brought under control with an ice bath and this remains a popular combination of reagents. https://en.wikipedia.org/wiki/Dimethylformamide
Ethylene glycol	Ethylene glycol has relatively high mammalian toxicity when ingested, roughly on par with methanol. Upon ingestion, ethylene glycol is oxidized to glycolic acid, which is, in turn, oxidized to oxalic acid, which is toxic. It and its toxic byproducts first affect the central nervous system, then the heart, and finally the kidneys. Ingestion of sufficient amounts is fatal if untreated. Several deaths are recorded annually in the U.S. alone. https://en.wikipedia.org/wiki/Ethylene_glycol
Ethylene glycol mono-n-butyl ether	2-Butoxyethanol has a low acute toxicity, with LD ₅₀ of 2.5 g/kg in rats. Laboratory tests by the U.S. National Toxicology Program have shown that only sustained exposure to high concentrations (100–500 ppm) of 2-butoxyethanol can cause adrenal tumors in animals. OSHA does not regulate 2-butoxyethanol as a carcinogen.
Ethylene oxide	Ethylene oxide causes acute poisoning, accompanied by a variety of symptoms. Central nervous system effects are frequently associated with human exposure to ethylene oxide in occupational settings. Headache, nausea, and vomiting have been reported. Peripheral neuropathy, impaired hand-eye coordination and memory loss have been reported in more recent case studies of chronically-exposed workers at estimated average exposure levels as low as 3 ppm (with possible short-term peaks as high as 700 ppm). The metabolism of ethylene oxide is not completely known. Data from animal studies indicate two possible pathways for the metabolism of ethylene oxide: hydrolysis to ethylene glycol and glutathione conjugation to form mercapturic acid and meththio-metabolites. Ethylene oxide easily penetrates through ordinary clothing and footwear, causing skin irritation and dermatitis with the formation of blisters, fever and leukocytosis.
Formaldehyde	In view of its widespread use, toxicity, and volatility, formaldehyde poses a significant danger to human health. In 2011, the US National Toxicology Program described formaldehyde as "known to be a human carcinogen". The CDC considers formaldehyde as a systemic poison. Formaldehyde poisoning can cause permanent changes in the nervous system's functions.

Formic acid	Formic acid has low toxicity (hence its use as a food additive), with an LD ₅₀ of 1.8 g/kg (tested orally on mice). The concentrated acid is corrosive to the skin. Formic acid is readily metabolized and eliminated by the body. Nonetheless, it has specific toxic effects; the formic acid and formaldehyde produced as metabolites of methanol are responsible for the optic nerve damage, causing blindness, seen in methanol poisoning. Chronic exposure in humans may cause kidney damage. Another possible effect of chronic exposure is development of a skin allergy that manifests upon re-exposure to the chemical. Concentrated formic acid slowly decomposes to carbon monoxide and water, leading to pressure buildup in the containing vessel. The hazards of solutions of formic acid depend on the concentration. The principal danger from formic acid is from skin or eye contact with the concentrated liquid or vapors. The U.S. OSHA Permissible Exposure Level (PEL) of formic acid vapor in the work environment is 5 parts per million parts of air (ppm).
Hydrochloric acid	Being a strong acid, hydrochloric acid is corrosive to living tissue and to many materials, but not to rubber. Typically, rubber protective gloves and related protective gear are used when handling concentrated solutions.
Isopropyl alcohol	Isopropyl alcohol vapor is denser than air and is flammable, with a flammability range of between 2 and 12.7% in air. Isopropyl alcohol causes eye irritation and is a potential allergen. Isopropyl alcohol, via its metabolites, is somewhat more toxic than ethanol, but considerably less toxic than ethylene glycol or methanol. Death from ingestion or absorption of even relatively large quantities is rare. Both isopropyl alcohol and its metabolite, acetone, act as central nervous system (CNS) depressants. Poisoning can occur from ingestion, inhalation, or skin absorption. Symptoms of isopropyl alcohol poisoning include flushing, headache, dizziness, CNS depression, nausea, vomiting, anesthesia, hypothermia, low blood pressure, shock, respiratory depression, and coma. Overdoses may cause a fruity odor on the breath as a result of its metabolism to acetone. Isopropyl alcohol does not cause an anion gap acidosis, but it produces an osmolal gap between the calculated and measured osmolalities of serum, as do the other alcohols. Isopropyl alcohol is oxidized to form acetone by alcohol dehydrogenase in the liver and has a biological half-life in humans between 2.5 and 8.0 hours.
Magnesium nitrate	May cause irritation of the digestive tract. May be harmful if swallowed. Ingestion of nitrate containing compounds can lead to methemoglobinemia. Inhalation: Causes respiratory tract irritation.
Methyl isobutyl ketone	Exposure to high concentrations can cause you to feel dizzy and lightheaded, and to pass out. Prolonged contact can cause a skin rash, dryness and redness. Methyl Isobutyl Ketone may damage the liver and kidneys.
Naphthalene	Exposure to large amounts of naphthalene may damage or destroy red blood cells, most commonly in people with the inherited condition known as glucose-6-phosphate dehydrogenase (G6PD) deficiency, which over 400 million people suffer from. Humans, in particular children, have developed the condition known as hemolytic anemia, after ingesting mothballs or deodorant blocks containing naphthalene. Symptoms include fatigue, lack of appetite, restlessness, and pale skin. Exposure to large amounts of naphthalene may cause confusion, nausea, vomiting, diarrhea, blood in the urine, and jaundice (yellow coloration of the skin due to dysfunction of the liver). The International Agency for Research on Cancer (IARC) classifies naphthalene as possibly carcinogenic to humans and animals (Group 2B). Under California's Proposition 65, naphthalene is listed as "known to the State to cause cancer". A probable mechanism for the carcinogenic effects of mothballs and some types of air fresheners containing naphthalene has

	<p>been identified. US government agencies have set occupational exposure limits to naphthalene exposure. The Occupational Safety and Health Administration has set a permissible exposure limit at 10 ppm (50 mg/m³) over an eight-hour time-weighted average. The National Institute for Occupational Safety and Health has set a recommended exposure limit at 10 ppm (50 mg/m³) over an eight-hour time-weighted average, as well as a short-term exposure limit at 15 ppm (75 mg/m³). Naphthalene's minimum odor threshold is 0.084 ppm for humans.</p>
Phosphoric acid	<p>Phosphoric acid is not a strong acid. However, at moderate concentrations phosphoric acid solutions are irritating to the skin. Contact with concentrated solutions can cause severe skin burns and permanent eye damage.</p>
Sulfuric acid	<p>A link has been shown between long-term regular cola intake and osteoporosis in later middle age in women (but not men).</p> <p>Sulfuric acid can cause very severe burns, especially when it is at high concentrations. In common with other corrosive acids and alkali, it readily decomposes proteins and lipids through amide and ester hydrolysis upon contact with living tissues, such as skin and flesh. In addition, it exhibits a strong dehydrating property on carbohydrates, liberating extra heat and causing secondary thermal burns. Accordingly, it rapidly attacks the cornea and can induce permanent blindness if splashed onto eyes. If ingested, it damages internal organs irreversibly and may even be fatal.</p>
Titanium dioxide	<p>Titanium dioxide dust, when inhaled, has been classified by the International Agency for Research on Cancer (IARC) as an IARC Group 2B carcinogen, meaning it is <i>possibly carcinogenic to humans</i>.</p>
Xylenes	<p>Xylene is flammable but of modest acute toxicity, with LD₅₀ ranges from 200 to 5000 mg/kg for animals. Oral LD₅₀ for rats is 4300 mg/kg. The principal mechanism of detoxification is oxidation to methylbenzoic acid and hydroxylation to hydroxylene. The main effect of inhaling xylene vapor is depression of the central nervous system (CNS), with symptoms such as headache, dizziness, nausea and vomiting. At an exposure of 100 ppm, one may experience nausea or a headache. At an exposure between 200 and 500 ppm, symptoms can include feeling "high", dizziness, weakness, irritability, vomiting, and slowed reaction time.</p>
