Oil Trains

volatile, toxic, radioactive

oil trains threaten our communities and first responders

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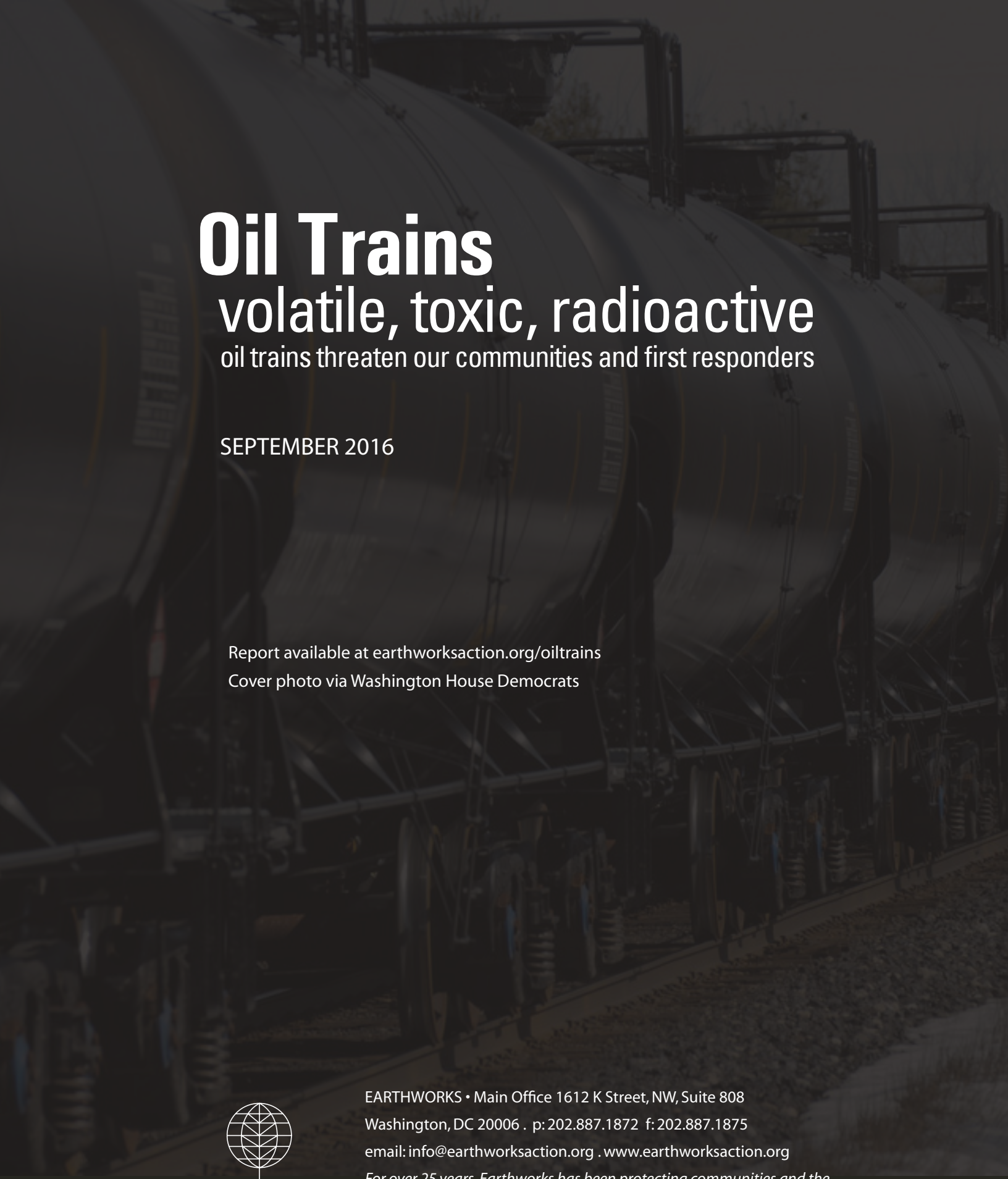

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Report available at earthworksaction.org/oiltrains

Cover photo via Washington House Democrats

EARTHWORKS™

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For over 25 years, Earthworks has been protecting communities and the environment from the impacts of irresponsible mineral and energy development while seeking sustainable solutions.

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Introduction

In 2016 the United States continues to produce oil hydraulically fractured from shale at a booming rate – averaging around 4.9 million barrels per day.[1] Pipeline infrastructure has not kept up with production volume, so producers have turned to railroads to move around this glut of oil. 50 million people live within 2 miles of tracks carrying these oil trains, placing them in danger of derailings, explosions, fires, and the loss of human lives.

The center of increased oil production in the United States is the Bakken Shale Formation, which extends for about 200,000 square miles under parts of Montana and North Dakota, and into Canada. Texas's Eagle Ford Shale is the second largest producer of shale oil crude, and although it shares many physical characteristics with Bakken crude, it is much closer to refineries and pipelines, and so the oil itself travels fewer rail miles in the production and distribution process.

How significant a threat are oil trains to our communities and first responders? **If a train transporting shale oil derails, it carries significantly greater risk to surrounding communities than other trains because:**

1. **Shale oil is volatile;**
2. **Shale oil is highly toxic;**
3. **Shale oil, particularly from the Bakken region, is radioactive;**
4. **The train cars and rails are not safe.**

Police helicopter view of Lac-Mégantic, the day of the derailment. Photo: Sûreté du Québec

1) Shale crude oil is volatile

Oil from the Bakken Shale is light crude. According to the American Fuel and Petrochemical Manufacturers, "Light crudes tend to have higher concentrations of 'light ends'; chemicals such as methane, ethane, propane, butanes and pentanes. The presence of increasing amounts of light ends, particularly pentanes, has the effect of increasing the crude oil's vapor pressure, lowering its flashpoint and lowering its initial boiling point."[2] This means it takes less energy to cause the oil to vaporize, which increases pressure in the tank.

The Wall Street Journal reports that shale crude oil is much more volatile than other crude oils around the world:

> *Oil from North Dakota and the Eagle Ford Shale in Texas had vapor-pressure readings of over 8 pounds per square inch (PSI), although Bakken readings reached as high as 9.7 PSI. U.S. refiner Tesoro Corp., a major transporter of Bakken crude to the West Coast, said it regularly has received oil from North Dakota with even more volatile pressure readings — up to 12 PSI. By comparison, Louisiana Light Sweet from the Gulf of Mexico, had vapor pressure of 3.33 PSI, according to the Capline data.*[3]
>
> *On average, North Dakota's Bakken shale oil had a volatility rating of 8.56 PSI. The next most volatile oil was Brent crude from the North Sea, with a volatility rating of 6.17 PSI. The third most volatile, 4.8 PSI, was Basrah Light oil from Iraq.*[4]

These unusually high numbers are reflected in North Dakota's Commission Order 25417 from December 2014 which sets the maximum pressure limit for the shipment of Bakken crude oil at 13.7 PSI.[5]

Bakken and Eagle Ford shale oil contain such high levels of volatile gases that the volatility can be visible to the naked eye. "Some oil from the Eagle Ford Shale in Texas brims with so much dissolved gas that it bubbles, giving the appearance of boiling at room temperature."[6] The gases contained within this light crude make it much more volatile than heavier crude.

This volatility means the oil has a greater potential to release vapors, thereby increasing pressure inside the rail cars and increasing the risk of rupture and explosion if a rail car derails.

In July 2014 the Department of Transportation announced that:

> *Given Bakken crude oil's volatility, there is an increased risk of a significant incident involving this material due to the significant volume that is transported, the routes and the extremely long distances it is moving by rail.*[7]

The PHMSA safety notices have done nothing to slow production or transportation of crude by rail, nor has it changed the way Bakken crude oil is handled prior to loading onto rail cars. A key difference between the Bakken region and the Eagle Ford region is that Eagle Ford crude is more likely to be "stabilized," a process by which the volatile gases are separated from the crude oil before it is loaded into the trains. "Measures to siphon NGLs from Bakken crude before it enters a railcar - would involve an infrastructure common in Texas but not seen so far in the Bakken region."[8]

2) Shale crude oil is toxic

It is not only the gases and increased volatility that makes fracked shale crude dangerous; it also contains hazardous chemical compounds, particularly benzene and hydrogen sulfide. Bakken oil also contains volatile organic compounds (VOCs) including toluene, xylene, benzene, and hexane, and according to one report consists of a maximum 15% by weight of these toxins (alternatively known as "Hazardous Air Pollutants").[9]

Benzene is a particularly dangerous compound that is acutely toxic to the liver, kidneys and nervous system at high concentration, and can interfere with the normal workings of cells, making it a known carcinogen.[10]

> *The National Institute for Occupational Safety and Health (NIOSH), a branch of the Center for Disease Control (CDC) has identified the recommended exposure level (REL) for benzene during a worker's shift as 0.1 parts per million.[11] As a result of its extreme toxicity, NIOSH has recommended comprehensive measures to limit workers' exposure to benzene.[12] However, in one study published in August 2014 in the Journal of Occupational and Environmental Hygiene, researchers sampling air emissions at frack sites in Colorado and Wyoming found that "Fifteen of the 17 samples met or exceeded the NIOSH REL of 0.1 ppm."[13]*

If oil field workers are considered to be at risk from benzene exposure, then the risk of benzene contamination to groundwater, soil and air as a result of a derailment is very real. In May 2014, a train derailment near LaSalle, Colorado polluted groundwater with high levels of benzene. Measurements taken by the Environmental Protection Agency two months after the spill showed benzene measurements as high as 144 parts per billion near the crash site.[14] The EPA has set the safe level for benzene in drinking water at five parts per billion. [15] As a result, monitoring wells were installed in the area surrounding the oil spill to monitor the ongoing issue of groundwater contamination.[16] At the tragic spill in Lac Mégantic in Quebec in 2013 when over six million liters of crude oil were spilled, precautions had to be taken to limit first responders' exposure to benzene.[17] During the first month, firefighters had to work in 15 minute shifts due to the extreme toxicity of the disaster site.[18]

Hydrogen sulfide, "a corrosive and extremely hazardous gas, . . . is present in high concentrations in some stocks of Bakken oil."[19] "Just a few breaths of air containing high levels of hydrogen sulfide can cause death. Lower, longer-term exposure can cause eye irritation, headache, and fatigue."[20] Moreover it is extremely flammable and may form explosive mixtures with air.[21]

One large threat posed by rail car transport of oil containing hydrogen sulfide is its explosive potential. OSHA notes that cylinders containing hydrogen sulfide exposed to fire may vent and release toxic and flammable gas through pressure relief devices; that containers may explode when heated, and that ruptured cylinders may rocket.[22]

Fracking Chemicals: Shale oil is obtained by hydraulic fracturing, a process in which huge amounts of water and chemical additives are forced under pressure into 1 to 2 mile deep wells, fracturing the underground shale rock, and forcing the oil trapped inside to the surface. Many different, undisclosed and often inconsistent chemicals are added to the water used in fracking, and some small amount of these chemicals ends up in the shale oil. The chemicals which contaminate the oil as a result of fracking may be explosive, corrosive and toxic.

Not all chemicals used in fracking can be identified because the oil industry has long protected their chemical blends as proprietary. In 2011, however, Democratic members of the House of Representatives Energy and Commerce Committee released a report finding that oil and gas companies used more than 2,500 hydraulic fracturing products containing 750 different chemicals and other components. These included "hydraulic fracturing products containing 29 chemicals that are **known or possible human carcinogens**, regulated under the Safe Drinking Water Act (SDWA) for their risks to human health, or listed as hazardous air pollutants under the Clean Air Act."[23]

These chemical contaminants cause three problems. First, many of them are inherently toxic. If burned and inhaled, they can cause fatal injuries. Second, many of the fracking chemicals used are volatile, and like the oil itself, may vaporize while the oil is in transit. This can serve to increase pressure inside the railcars, rendering them more vulnerable to explosion and fire in the event of a collision or derailment.

But there is a third problem, too: corrosivity. In a July 29, 2013 letter to the American Petroleum Institute, the Federal Railway Administration said it has found increasing cases of damage to tanker cars' interior surfaces. "A possible cause is contamination of the crude oil by materials used in the fracturing process that are corrosive to the tank car tank and service equipment."[24] The corrosive chemicals can corrode the metal of the rail cars, weakening and damaging seams and welds.

A 2013 joint effort by the Federal Railroad Administration (the FRA) and the Pipeline and Hazardous Materials Safety Administration (PHMSA) known as 'Operation Classification' showed that "crude oil taken from cargo tanks en route to rail loading facilities was not properly classified."[25]

Much of the oil transported by rail car contains unidentified and very dangerous chemicals; chemicals with the potential to explode, and cause severe or fatal injuries. The industry remains opposed to requiring disclosure of chemicals used in fracking.

SHALE CRUDE'S VOLATILITY MEANS ITS TOXICS POSE A GREATER THREAT

Derailment and rupture of rail cars containing shale oil exposes ecosystems, waterways, farmland and communities to all of these toxic chemicals carried along with the crude oil itself. Cleanup cost projections of $200 million after the Lac Megantic disaster drove the railroad company responsible for derailment into bankruptcy protection just two months after the crash.[26]

Shale oil's volatility means that its toxics also pose an explosive threat. When shale oil is underground at great pressure, the gases remain trapped within it, and when the oil is cold, its capacity to hold gases in solution is great.[27]

But when oil is extracted, and then transported by rail, it is under much less pressure and can be exposed to hot weather. This makes the gases and chemicals contained in the oil much more likely to vaporize. This situation is compounded as the oil travels across the country in miles-long trains, made up of 100 or more black tank cars absorbing thermal energy from the sun. As the oil heats, its capacity to keep the gas dissolved lessens, and more of these volatile and explosive gases come out of the liquid oil, and become vapors contained within the rail car. This raises the internal pressure in the oil rail cars, and creates an explosive mixture of oil and gas, a mixture than can explode if exposed to a heat source, such a spark during a derailment.

And sometimes, a spark is not even necessary. The "flashpoint"—the lowest temperature at which ignition can occur—is lower for Bakken oil than for lower grade crude oils, which means that Bakken crude is particularly flammable."[28] "Bakken shale oil vaporizes much more quickly than other crude oils. In fact, the oil has a "flash point" as low as 73°F. That means that the oil can spontaneously ignite at the temperature of a pleasant summer day."[29]

3) Shale oil, particularly from the Bakken, is radioactive

Naturally occurring radioactive material is common in "processes associated with the recovery of oil and gas."[30] In the Bakken shale, oil filters, which screen the oil as it comes up out of the ground, are becoming radioactive. The allowable threshold for radioactivity in North Dakota is 5 picocuries per gram, but as one expert has stated, "Everything we've tested in the Bakken, it all exceeds 5 pCi per gram, virtually every sample."[31]

It is not clear how radioactive the oil itself is. Likewise, we cannot assess the health risks associated with regular exposure to this oil, or the health risks associated with inhaling vapors from the oil if it burns in a derailment, because shale oil is not routinely tested before being loaded onto rail tanker cars.

The problem seems likely to worsen based on experience with oil field equipment;[32] as pipelines and oil storage tanks become increasingly radioactive the longer they are used, so too may the rail cars which transport the oil.

4) The rail cars and rails themselves are not safe enough for this volatile, toxic and radioactive product

Much of the oil from the Bakken and Eagle Ford shale is transported in DOT-111 rail cars, although the DOT released a ruling in May 2015 with a plan to phase out or retrofit these DOT-111 cars by 2018 (with some flexibility).[33] These cars, which have previously been criticized for their vulnerability to catastrophic failure,[34] are made of steel less than one half inch thick and have valves that are at risk of shearing off or puncturing if the car derails.[35] They have no head shields, which makes them even more vulnerable in the event of a pile-up, and no Pressure Relief Devices - a common sense necessity when transporting something as volatile as Bakken crude oil.[36]

The National Transportation Safety Board (NTSB) has been calling the DOT-111 cars unsafe for decades. In 1991 the NTSB wrote, "the inadequacy of the protection provided by DOT-111A tank cars for certain dangerous products has been evident for many years in accidents investigated by the Safety Board." [37] It took nearly seven years [38] for standards assessing the safety of hazardous material by rail in response to an accident in Montana and highlighted in the 1991 NTSB report to be written. The first standard to update or phase out these cars was not written until 2015.[39] The other tank cars carrying oil are built to standards known as CPC-1232 and were celebrated as a safer way to transport volatile fuels such as crude oil from the Bakken shale. These new standards were created by an industry group and in spite of all of the positive press they received these tanks too soon they too started exploding, in West Virginia,[40] Virginia,[41] Ontario,[42] Illinois[43], Oregon[44],and more. The retrofit deadline for these CPC-1232 cars in the May 2015 DOT ruling is 2025.

Trains carrying crude oil criss-cross the U.S. and Canada, putting millions at risk. Photo via Washington House Democrats.

The physical railroads themselves are another cause of rail disasters. According to a review of oil train crashes carrying crude oil between January 2013 and October 2015 there were 31 derailments. 57 percent of them were a result of track failure.[45] Another report from the University of Illinois at Urbana-Champaign ran an analysis of all train derailments reported to the DOT between 2001 and 2010 in the Midwest. Their report concludes that for all types of tracks, main lines, yard lines, and side lines, the number one reason for derailment is broken rails or welds.[46] Not only was this (by far) the number one cause of derailments, but also caused about 13 cars to derail on average, making the accidents themselves more severe than most other causes. A derailment caused by broken rails or welds means that the physical track structure itself gave way. Upkeep of tracks is vital, but logistically difficult with the resources of the DOT especially in respect to how many train tracks exist in the United States. As Sarah Feinberg, chief of the Federal Railroad Association told the *Los Angeles*

Times, "preventing accidents that result from defective track involves finding a needle in every haystack along thousands of miles of track."[47] If track upkeep is so difficult, and the physical track structures themselves responsible for most failures, why would this infrastructure be suitable to transport Bakken oil?

Furthermore, Investigations by the Transportation Safety Board of Canada speculate that "petroleum crude oil unit trains transporting heavily-loaded tank cars will tend to impart higher than usual forces to the track infrastructure during their operation. These higher forces expose any weaknesses that may be present in the track structure, making the track more susceptible to failure."[48] When the product of transport is as explosive and toxic as Bakken oil, the potential for disaster from track failure is enormous.

Legislative Safeguards?

On May 1st 2015, the US Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) released new safety regulations for the transport of flammable liquids (including crude oil) by railway. This final rule entitled " Enhanced Tank Car Standards and Operational Controls for High-Hazard Flammable Trains" defines "High-hazard flammable trains" as "a continuous block of 2- or more tank cars loaded with a flammable liquid or 35 or more tank cars loaded with a flammable liquid dispersed through a train."[49] These rules were formally codified in law when the "Fixing America's Surface Transportation Act" (or the "FAST Act") was passed by congress in it's final form early December 2015.[50]

This new set of rules and regulation calls for physical enhanced standards for new and existing tank cars. This includes the replacement of all DOT-111 cars by 2018, and the required retrofitting or replacement of all CPC-1232 cars by 2025. Cars constructed after October 2015, or being retrofitted, will have to meet standards of thickness for the tanks shell, jacket, and head shield, as well as improved pressure-relief and bottom outlet valves. The trains are also required to have an enhanced breaking system. The specific technologies are outlined in the rules and exist to mitigate damage in the event of a derailment.[51]

On the other side of the issue, the American Petroleum Institute (API) promptly filed a law suit against the timeline laid out for the retrofitting and replacement of railcars.[52] The new rule as it is currently written has a timeline already stretching to 2025 for the retrofitting of all cars (DOT-111 and CPC- 1232), and if the API wins its suit these tanks could stay on the tracks for even longer.

In regards to the movement of trains on the tracks, the rules propose a mandatory speed limit of 50 mph for all oil rails and a 40 mph speed limit for urban areas and trains who have not yet met the structural tank car requirements. Also, the rules call on the railroads to take a minimum of 27 safety and security factors into account when planning routes for trains. Furthermore, it is required of the railroads that they provide state, local, and tribal officials with contact information regarding hazardous transport through their area.[53]

Finally, the legislation calls for more frequent and accurate sampling of all unrefined petroleum-based products. This is both to ensure that the products are packaged properly, and so that the information can be available to the DOT upon request.[54]

Several citizens' groups wrote a two-page response the day the DOT released their new safety standards to express that these standards are not enough to address the threat of crude oil by rail. They say that the standards for new tank cars were largely already accepted by the industry, and that the retrofit rules allow for looser standards than the industry themselves would place. Additionally, the groups criticize the slow pace of the phase-outs, and cite the fact that "it does not apply to every tank car" since trains of blocks of 34 tank cars or fewer are exempt.[55]

Activists honor the 47 lives lost in Lac Mégantic two years after the disaster. Photo: Rick Rappaport.

Eric T. Schneiderman, Attorney General of New York wrote a 30-page proposal to PHMSA in response to their rules, essentially saying that without requiring rail road companies to stabilize the highly volatile Bakken shale crude, the safety standards are completely missing the mark. He proposes a 9.0 psi maximum as the standard for interstate shipments of crude oil.[56] Similarly, Congressman John Garamendi of California proposed a bill entitled "the Bakken Crude Stabilization Act" in August 2015. This bill calls to limit the pressure to 9.5 psi as this is this "maximum volatility permitted by the New York Mercantile Exchange for crude futures contracts."[57] No progress in committee of the bill has been reported.[58] Currently, no such standards exist on the federal level, and on the state level only North Dakota has implemented any limits and theirs sits at a lofty 13.7 psi.[59]

WHAT ABOUT LEGISLATION AT THE STATE AND LOCAL LEVELS?

In nearly all issues relating to railroads in the United States federal law holds virtually ubiquitous power to preempt legal action taken at the state or local level. This is a result of two pieces of legislation, the Interstate Commerce Commission Termination Act of 1995 (ICCTA), and the Federal Railroad Safety Act of 1970 which both give the federal law more weight when it comes to regulation of railroad operations. There are also measures that are explicitly outlawed for state or local authorities including rerouting trains and setting speed limits, but the courts have traditionally ruled in favor of the federal government even in cases that are not so specifically delineated.

The Surface Transportation Board, the federal agency tasked with regulating rail roads, provides a three-point framework for when to preempt state law. In order to pass this three-point test, state or local regulations must not conflict with federal regulation, interfere with federal authority, or unreasonably burden interstate commerce. Historically, state and local governments have only passed laws without being preempted by either making sure that their laws target non-railroad operations (meaning parties who do not operate rail cars). Overall, the amount of authority allotted to the state and local governments when it comes to rail roads is small in scope, and often loses in court.

Conclusion and Recommendations

There is little doubt that the mile-long trains carrying oil from the Bakken oil fields are hazardous. The oil itself is explosively volatile, and vaporizes at very low temperatures. It contains trapped gases that are also explosive and very volatile. Many of the fracking chemicals added to the oil are toxic and corrosive. And finally, there is the very high likelihood that the oil is, to some unknown extent, radioactive.

All of these characteristics inherent to crude oil from the Bakken region, combined with shipping the oil in outdated and unsafe cars, over hundreds or thousands of miles on rail tracks that are prone to failure, create very real risks to the communities through which they pass in the event of a crash, or derailment.

Although some consider pipelines to be an alternative for oil transport, they too carry inherent risks of spills and leaks. In fact, in a 2013 report based on PHMSA data analyzed by the International Energy Agency found that over a span of 8 years pipeline spills released 3 times as much oil as train spills.[60] Transporting oil through communities by any means is unsafe.

Each train traversing a community is just a derailment away from disaster. Far from alarmist, both experiences in Quebec, North Dakota and West Virginia, and decades-old recommendations by the U.S Department of Transportation, make clear this conclusion is well justified.

As long as this practice of shipping oil by rail continues, safety can never be guaranteed. There are, however, some sensible steps that can be taken to reduce excessive risk.

- Bakken Oil should be stabilized and natural gas liquids (NGL) should be removed prior to transport. This practice is common in the shale plays of Texas,[61] and is already required for international export.[62] Infrastructure needs to be built in the Bakken region to reduce the volatility of the oil.
- Fracking chemicals should disclosed, especially in the aftermath of a derailment, explosion, or spill. First responders, medical professionals, and affected community members deserve the right to know what toxins they are facing.
- Prior to transport, oil should be tested for radioactivity, and radioactivity should be disclosed.
- DOT-111 and CPC 1232 cars should be removed from service; retrofitting to looser standards should not be an option.
- Trains should be adequately staffed with a minimum of two workers per train.
- Finally, rails should have adequate funding for upkeep to avoid derailment, trains should be routed away from populated areas, and staffed with adequate crews.

The above recommendations should be taken as a minimum, as they cannot guarantee the safety of transporting oil by rail. **By far, the best policy solution to the risk of shale oil spills and explosions is to keep the oil in the ground.** By putting our policy incentives and investments behind petroleum-free transportation, renewables and conservation, we can avoid risky oil extraction, including the Bakken and Eagle Ford shales, tar sands, off shore oil, and oil-related conflict areas.

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- Oil Change International
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- The Center for Biological Diversity
- The Sierra Club
- The Sightline Institute
- And frontline grassroots activists across North America

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Activists gather in front of city hall in Baltimore, MD to say 'no' to oil trains.

Endnotes

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[11] "The National Institute for Occupational Safety and Health (NIOSH) recommends that benzene be controlled and handled as a potential human carcinogen in the workplace and that exposure be reduced to the lowest feasible limit. The NIOSH recommended exposure limit (REL) is 0.1 ppm [0.32 milligrams of benzene per cubic meter of air (mg/m3) as a ceiling in any 15-minute sampling period."

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For a list of those 29 chemicals, see http://www.conservation.ca.gov/dog/general_information/Documents/Hydraulic%20Fracturing%20Report%204%2018%2011.pdf In addition the report noted "Many of the hydraulic fracturing fluids contain chemical components that are listed as "proprietary" or "trade secret." The companies used 94 million gallons of 279 products that contained at least one chemical or component that the manufacturers deemed proprietary or a trade secret. In many instances, the oil and gas service companies were unable to identify these "proprietary" chemicals, suggesting that the companies are injecting fluids containing chemicals that they themselves cannot identify.

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Senator Charles Schumer, a New York Democrat, today called on U.S. regulators to phase out the older cars, known as DOT-111s, saying they've contributed to spills of hazardous materials.

'The DOT-111 tank car has proven particularly prone to spills, tears and fires in the event of a derailment, and it's simply unacceptable for New York's communities along the rail lines to face that risk when we know thicker, tougher cars could keep us safer,' Schumer said in an e-mailed statement."

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