Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

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Fact Sheet
Reduction of Sulfur Dioxide Emissions and Fuel Sulfur Content

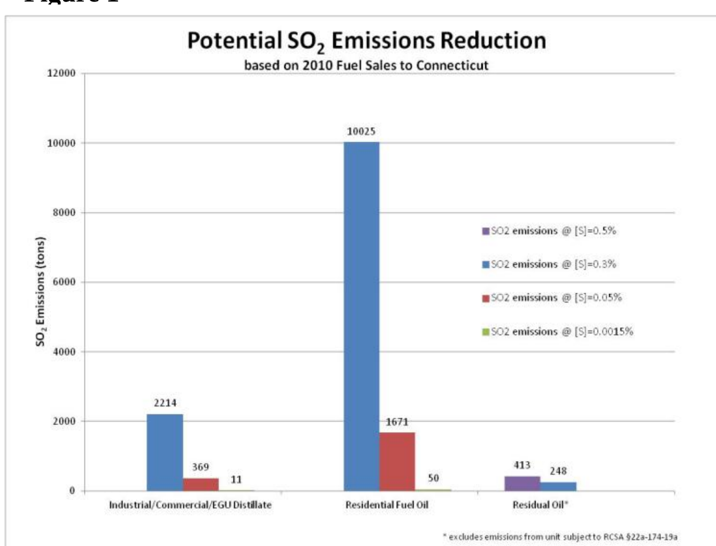
The Department of Energy & Environmental Protection (Department) is taking comment to better inform our decision making in amending the air quality regulations to reduce the sulfur content of distillate oil, residual oil and other non-transportation fuels sold or used in Connecticut. Adopting and implementing this proposal will result in significant reductions in sulfur dioxide (SO_2) emissions from fuel-burning sources in Connecticut, without requiring source owners to install pollution control equipment. The proposal is highly cost effective.

Benefits: Reducing SO_2 emissions will help the state attain and maintain the federal health-based national ambient air quality standards (NAAQS) for fine particles (particles smaller than 2.5 microns in diameter or $PM_{2.5}$) and SO_2. This proposal is also part of Connecticut's commitment to a regional effort to reduce regional haze and improve visibility as required under the federal Clean Air Act. Haze and reduced visibility are created when sunlight is scattered by particulates in the air, reducing color and clarity of a view. To mitigate visibility impairment, Connecticut and other MANE-VU[i] states have committed to coordinated actions that include the adoption and implementation of low sulfur fuel strategies to reduce haze throughout the MANE-VU region.[ii] New York State already requires the use of ultra-low sulfur heating oil ($\leq$ 15 ppm), and Maine, Massachusetts, New Jersey, Pennsylvania and Vermont now have rules in place that will require lower sulfur fuel oils by 2018 at the latest. Rhode Island is expected to adopt a fuel sulfur rule in 2013.

Lowering the sulfur content of fuel oil directly reduces SO_2 emissions and atmospheric $PM_{2.5}$ and sulfuric acid formation. Potential annual SO_2 emissions reductions from lowering the allowable fuel sulfur content (based on 2010 fuel consumption levels; *see* Figure 1) in 2018 are as follows:

- Distillate fuel oil $\approx$ 2,200 tons,
- Residual fuel > 150 tons, and
- Residential fuel oil $\approx$ 10,000 tons.

Figure 1



Under certain atmospheric conditions and in the presence of other pollutants, some SO_2 condenses to form sulfate particles, an important component of $PM_{2.5}$. Exposure to SO_2 and $PM_{2.5}$ is associated with negative health impacts. SO_2 exposure is linked to bronchoconstriction and increased asthma symptoms. $PM_{2.5}$ can penetrate deeply into sensitive parts of the lungs and can cause or worsen respiratory disease, such as emphysema and bronchitis, and can aggravate existing heart disease, leading to increased hospital admissions and premature death.

Sulfur oxide emissions may also react with water vapor to form sulfuric acid. Deposition of atmospheric acids causes acidification of lakes and streams, contributes to the damage of trees and many sensitive forest soils, and accelerates the decay of building materials and paints.

Reduction in nitrogen oxides (NO_x) emissions from fuel combustion is a secondary air quality benefit of reducing sulfur content. The hydro-treating process that removes sulfur from fuel also removes nitrogen. NO_x and volatile organic compounds react to form ozone in the presence of sunlight. Ozone is a strong oxidizer that irritates the respiratory system, aggravates chronic lung diseases like emphysema and bronchitis, reduces the immune system's ability to fight off bacterial infections in the respiratory system and can cause permanent lung damage. Nitrogen oxides also condense to form nitrate $PM_{2.5}$. Nitrogen deposited into Long Island Sound from the air can lead to lower oxygen levels in water, suffocating commercially important fish and other aquatic life.

In light of the health and environmental costs, reducing sulfur in fuel oils has significant economic benefits. The estimated avoided adverse health costs (*e.g.*, hospital admissions and medical treatments) are about $18,000 per ton of sulfur removed.[iii] This estimate does not include additional economic benefits from reducing the non-health impacts of higher sulfur fuel.

Proposal: The main requirement of the proposal is a reduction in the fuel sulfur content of fuels burned in stationary and area sources in Connecticut. The timing and fuel sulfur content limitations under consideration are as follows:

Effective July 1, 2014:

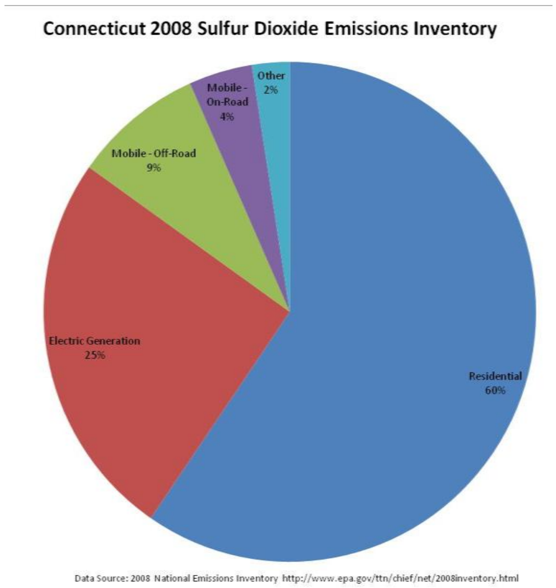
- #2 distillate oil sulfur content ≤ 500 ppm
- Coal sulfur content ≤ 3000ppm

Effective January 1, 2018:

- #2 distillate oil sulfur content ≤ 15 ppm
- Residual oil sulfur content ≤ 3000 ppm
- Aviation fuel (combusted in a stationary source) sulfur content ≤ 15ppm
- Kerosene sulfur content ≤ 400 ppm

The proposal applies to fuel oil burned in non-mobile sources in Connecticut. The proposal does not change the fuel sulfur requirements for large stationary sources and electric generating units subject to RCSA §22a-174-19a, since the fuel sulfur content for those sources was reduced in 2000 as a result of an Executive Order of the Governor. As drafted, the proposal includes home heating oil and is consistent with the final fuel sulfur content required by Public Act No. 10-74, *An Act Requiring Biodiesel Blended Heating Oil and Lowering the Sulfur Content of Heating Oil Sold in the State*.

Figure 2

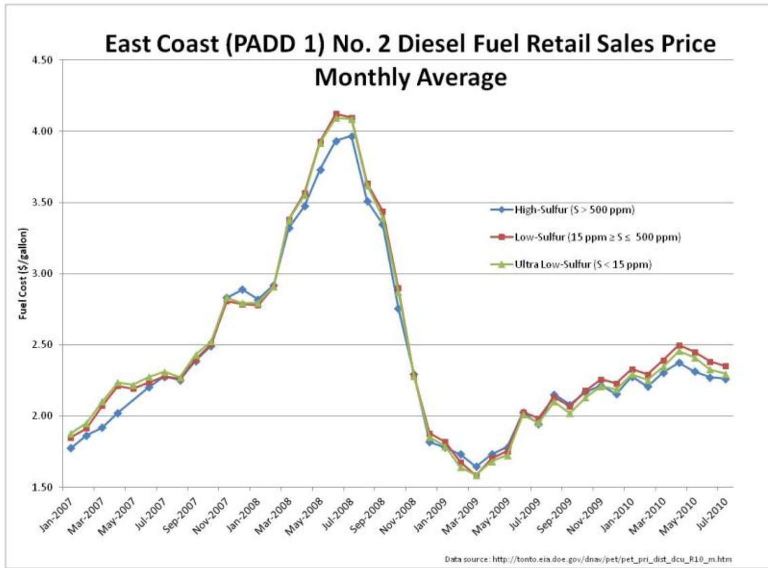


SO_2 Emissions: Sulfur dioxide is generated during combustion from the oxidation of sulfur contained in fuel. The amount of uncontrolled SO_2 emitted is almost entirely dependent on the sulfur content of the fuel and is essentially independent of burner design.

Connecticut sources emitted nearly 20,000 tons of SO_2 in 2008: 3000 tons from mobile sources and 17,000 tons from stationary/area sources.[iv] 96% of stationary/area source SO_2 emissions (85% of total SO_2 emissions) are generated by the combustion of residential and commercial heating oil and electricity generation (*see* Figure 2).

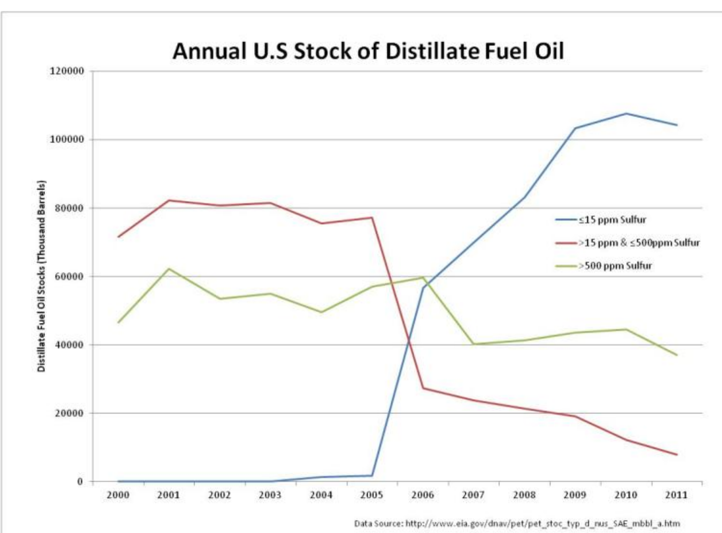
Low-Sulfur Fuel Cost and Availability: Figure 3 shows that between 2007 and 2011 the actual fuel prices paid by consumers fluctuated widely as a result of market conditions unrelated to the regulation of fuel sulfur content. On average during 2007 through 2010, high-sulfur diesel cost 5 cents less per gallon than low-sulfur distillate oil and 3.6 cents less per gallon than ultra-low-sulfur diesel.

Figure 3



Any potential increased fuel costs will likely be offset by lower furnace maintenance costs and higher fuel efficiency, because reducing the sulfur content of fuel oils lowers the rate of boiler fouling.[v] The sulfur in fuels contributes to the corrosiveness of combustion byproducts. So, the use of low sulfur fuel can extend boiler and furnace life and could reduce the cost of new oil-burning equipment because the boilers and furnaces can be constructed using lower-cost materials and be designed with more compact heat exchangers.[vi]

Figure 4



Low sulfur heating oil will enable the market for very high efficiency condensing oil furnaces that can save consumers money through reduced fuel use.

As shown in Figure 4, the stock of ultra-low sulfur distillate oil in the United States has increased significantly over the last decade. This trend is likely to continue as more jurisdictions require the use of lower sulfur fuels. Therefore, sufficient stocks to meet the demand for ultra-low sulfur fuel in 2018 are expected to be available. Further, ultra-low sulfur heating oil will be substantially similar to highway diesel fuel creating a fungible product across the distillate market.

i Mid-Atlantic/Northeast Visibility Region (MANE-VU) membership includes Washington, D.C., Maryland, Delaware, Pennsylvania, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire and Maine and two Native American tribes (the Penobscot Indian Nation and the St. Regis Mohawk Tribe).

ii MANE-VU. June 20, 2007. *Statement of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Concerning a Course of Action within MANE-VU Toward Assuring Reasonable Progress*, (2007 MANE-VU Statement). http://www.manevu.org/document.asp?fview=Formal%20Actions#

iii NESCAUM. 2008. *Public Health Benefits of Reducing Ground-level Ozone and Fine Particle Matter in the Northeast U*.S. http://www.nescaum.org/documents/benmap_report_1-16-08.pdf/view

iv 2008 National Emissions inventory, http://www.epa.gov/ttn/chief/net/2008inventory.html

v Lindemer, Kevin. March 2010. *Ultra-low Sulfur Diesel Fuel/Heating Oil Market Study*. http://www.nora-oilheat.org/site20/uploads/lowsstudy.pdf ; hereafter Lindemer study.

vi McDonald, Roger and John Batey. *Benefits and Advantages of Marketing Low Sulfur Heating Oil Including Results from a New York State Low Sulfur Market Demonstration*. (Paper No. 06-03)