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Estimated Impacts From Idling Locomotives in the Borough of Raritan, N.J.
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In response to complaints from residents of the Borough of Raritan about noise and odors from idling locomotives at the NJ Transit's Raritan rail yard, the New Jersey Department of Environmental Protection (NJDEP), with the cooperation of NJ Transit, has undertaken an effort to identify ways to reduce diesel exhaust emissions from the rail yard. NJ Transit has provided NJDEP with the current locations where locomotives are parked in the yard, as well as the number of hours each locomotive spends in the yard, so that NJDEP could complete a theoretical assessment of potential health risks to nearby residents from idling locomotives. At the same time, NJ Transit has implemented an Idling Minimization Program, under which locomotives are shut off approximately 1 hour after returning to the yard for the evening, or when laying over in the yard for more than 1 hour, when ambient temperatures are above 0 degrees Fahrenheit.

Why are we concerned about diesel emissions?

Diesel engines emit a variety of pollutants, with diesel particulate matter having potentially the greatest health impacts. Diesel particulate matter consists of very small particles (less than 2.5 micrometers - much smaller than the width of a human hair) that may be a mixture of solids and liquid droplets. Diesel particulate matter can cause or aggravate a number of health problems and has been linked with illnesses and deaths from heart and lung disease. These effects have been associated with both short-term exposures (over a 24 hour period) and long-term exposures (over many years). Diesel exhaust also includes over 40 substances, including benzene and toluene, that are listed by the U.S. Environmental Protection Agency (USEPA) as hazardous air pollutants and by the California Air Resources Board as toxic air contaminants. Fifteen of these substances are listed by the International Agency for Research on Cancer (IARC) as carcinogenic to humans, or as probable human carcinogens. Concentrations of diesel exhaust are relatively high throughout New Jersey, due to the many diesel sources, such as trucks, buses and construction vehicles in the state.

How do we estimate health impacts from diesel particulate matter?

A health risk assessment is a tool used to evaluate the potential for a chemical to cause cancer or other illnesses. Health scientists use risk assessments to estimate the increased risk of health problems in people who are exposed to different amounts of toxic air pollutants, such as diesel particulate matter. Health risk assessments do not gather information or health data on specific individuals, but provide estimates of the potential health risk impacts on a population at large.

A health risk assessment for a toxic air pollutant combines results of health effects studies of various animal and human exposures to the pollutant with air quality modeling studies that estimate the level of people's exposures to the pollutant at different distances from the source of the pollutant.

While the estimates provided by risk assessments are not exact, they help scientists and the public evaluate and place into perspective the risks associated with emissions of toxic air pollutants. Due to uncertainties in each of the variables that go into a health risk assessment, there is some uncertainty in estimating the risk to a specific individual or at a specific location. For example, the incremental cancer risk is an estimate that assumes a 70 year lifetime exposure and the worst case meteorological conditions. Because of the conservative nature of the risk assessment process, these assumptions typically overestimate the risk.

How did we perform this risk assessment?

In order to estimate diesel particulate emissions, data was supplied by NJ Transit on the age, make and model of the locomotives used in Raritan Yard. NJ Transit also specified the overnight parking locations for each locomotive. NJDEP used USEPA's published emission rate for the type of engines in NJ Transit's fleet. NJ Transit estimates that actual emissions are likely to be approximately 30% lower. While NJDEP agrees that actual emissions when idling are likely to be lower than the EPA published rate, conducting a conservative risk assessment justifies using USEPA's numbers.

Meteorological data such as wind speed and direction is collected at locations within New Jersey and included in the mathematical model developed by USEPA for predicting air quality. The model predicts the concentration of pollutants at various distances from the sources of pollutants, and a map showing the calculated concentrations is then created. NJDEP predicted concentrations of fine particulate matter near the rail yard, including residences north of the rail yard, residences south of the rail yard, and the elementary school southwest of the rail yard.

What are the results of the health risk assessment?

(a) Are there any violations of the federal health standards?

The federal health standards are concentrations of pollutants in the air that USEPA has determined will protect public health. These are formally called "National Ambient Air Quality Standards or NAAQS" and include standards for fine particulate matter, also known as PM 2.5. The NAAQS for long-term (annual) exposure is 15 micrograms/cubic meter (µg/m3). The NAAQS for short-term (24 hour) exposure is 35 micrograms/cubic meter (µg/m3). When performing modeling, predicted exceedances of the NAAQS are determined by adding the predicted impacts of the source operation to background air quality. Background concentrations are quantities of pollutants that are measured at monitors located throughout the state. The background concentration is due to the combined emissions of all other sources, including motor vehicles, power plants and pollution from upwind sources in nearby states. The risk assessment analysis utilized an annual fine particulate (PM 2.5) background concentration of 10 ug/m3 and a 24-hour PM 2.5 background concentration of 30.3 $\mu g/m^3$, which were based on a 3-year average of ambient levels. The 24-hour PM 2.5 background level is estimated to be 87% of the NAAQS.

1. Annual Exposure
   The estimated annual PM 2.5 concentration, including both background and the effects of the idling locomotives, meets the annual federal health standard. The modeled emissions at all locations (residents to the northeast of the rail yard, residents to the south of the rail yard, and the elementary school location) are under the annual standard of 15 $\mu g/m^3$. This is the case both before and after the Idling Minimization Program was implemented.

2. 24 Hour Exposure
   Prior to implementation of the Idling Minimization Program, there would have been predicted exceedances of the 24 hour fine particulate NAAQS generally north and south of the rail yard. With the Idling Minimization Program in effect, the level of 24 hour fine particulate matter concentrations, including both background and the effects of the idling locomotives at the rail yard, meets the federal 24-hour standard of 35 $\mu g/m^3$ at all locations beyond the property line of the rail yard. ("Background" levels of fine particulates in the Raritan area are estimated to be about 30 $\mu g/m^3$.) However, the Idling Minimization Program does not apply when the temperature is below 0 degrees Fahrenheit. During such periods, there are modeled concentrations above the NAAQS standards south of the rail yard. This is expected to be a rare event based upon recent historic climate data.

	Conditions Prior to Idling Minimization Program ($\mu g/m^3$)	**Conditions After Implementation of Idling Minimization Program ($\mu g/m^3$)**
Off-property Line Contribution from Idling Trains (without background	Up to 15	Up to 3
Average Background Concentration	30	30
24 Hour PM2.5 Concentration at Raritan with background	31 to 45	31 to 33
24 Hour PM2.5 Standard*	35	35

* 24 Hour PM2.5 value represents the maximum predicted value, or "worst case" of these days.

(b) What is the predicted cancer risk from idling locomotives at Raritan?

The estimated, incremental cancer risk ranges from 12 in a million at the residential area to the south to 39 in a million at the school located adjacent to the rail yard after implementation of the Idling Minimization Program The risk to children at the school is actually much less than 39 in a million. The calculated maximum risk assumes a person is living continuously (24/7) at the school location for 70 years. Considering the time spent at

school, the children's risk is less than 1/65 of that calculated. Another exposure consideration is that the children are at school during the day and the trains idle at night. This further reduces the risk. However, because of their age, children may be more sensitive to the PM2.5 emissions. The EPA has recently recommended a potency factor of three when adjusting the unit risk factor for school age children. Applying all these factors, the maximum calculated risk for the children at the school would be about 2 in a million. While there is considerable uncertainly in estimating cancer risk, using conservative assumptions on risk, exposure, and sensitivity, the risk would be in the negligible range.

What are the uncertainties associated with the predicted risk?

Cancer risk is usually estimated as "number of cancer cases in a million" that may result from exposure to a given concentration for 70 years. The predicted incremental cancer risk assumes a continual 70-year inhalation exposure to only the modeled diesel particulate concentration. The cancer risk prediction also assumes the diesel locomotive idling emission rate used will remain constant for the next 70 years. Emissions are likely to be less than those assumed in the assessment, and will decline as locomotives are replaced with newer, lower-emitting diesel engines. There are many uncertainties and assumptions that affect these estimates. The cancer and non-cancer risk predictions only include emissions from idling locomotives at the Raritan Rail Yard, and don't include the many other cancer risks from diet, lifestyle choices such as smoking, and exposure to other air pollutants that occur in the normal course of a person's daily activities. The cancer risk estimates described below are for incremental increased risk from the idling locomotives in Raritan Yard.

What is an unacceptable degree of risk and when should risk be reduced?

NJDEP uses Risk Management Procedures to evaluate risk from sources of pollution. These procedures are usually applied to "point sources" such as smokestacks at an industrial facility. When evaluating the health risk of emissions from existing facilities with many sources of pollutants, NJDEP uses the following guidelines:

NJDEP Guidelines for Evaluating Cancer Risk from Existing Facilities:

CALCULATED CANCER RISK	NJDEP RISK CHARACTERIZATION	ACTION
> 1,000 in a million	Unacceptable risk	Take immediate action to reduce risk.
100-1,000 in a million	Significant risk	Implement short-term (less than 1-yr) risk minimization strategy
10 – 100 in a million	Significant risk	Implement long-term (more than 1-yr) risk minimization strategy
<10 in a million	Negligible risk	A formal risk minimization strategy is not required. Continuing efforts to maintain low risk are appropriate.

What are the uncertainties associated with the predicted risk?
Cancer risk is usually estimated as "number of cancer cases in a million" that may result from exposure to a given concentration for 70 years. The predicted incremental cancer risk assumes a continual 70-year inhalation exposure to the modeled diesel particulate concentration. The cancer risk prediction also assumes the diesel locomotive idling emission rate used will remain constant for the next 70 years. Emissions are likely to be less than those assumed in the assessment, and will decline as locomotives are replaced with lower-emitting diesel engines. There are many uncertainties and assumptions that affect these estimates. The cancer and non-cancer risk predictions only include emissions from idling locomotives at the Raritan Rail Yard, and don't include the many other cancer risks from diet, lifestyle choices such as smoking, and exposure to other air pollutants that occur in the normal course of a person's daily activities. The cancer risk estimates described below are for incremental increased risk from the idling locomotives in Raritan Yard.

Conclusions
1. Based on modeling, there are no predicted exceedances of the annual fine particle standard (NAAQS) in the areas surrounding the Raritan Rail Yard, regardless of whether the Idling Minimization Program is in effect.
2. Based on modeling, there are no predicted exceedances of the 24-hour fine particle standard (NAAQS) in the areas surrounding the Raritan Rail Yard when the Idling Minimization Program is in effect. If the temperature drops below zero degrees Fahrenheit, the Idling Minimization Program doesn't apply, and there is the remote possibility of an exceedance of the 24-hour NAAQS to the south of the rail yard, under rare weather conditions. Prior to implementation of the Idling Minimization Program, modeling showed a predicted exceedance of the 24-hour fine particle standard generally north and south of the rail yard.
3. The predicted worst case cancer risk for assumed constant exposure for 70 years is between 12 and 39 in a million. Since this is considered by NJDEP to be significant (not negligible), NJ Transit and NJDEP will continue their long-term efforts to further reduce cancer risk.

What additional steps will NJ Transit take to further reduce emissions?
1. NJ Transit has recently switched to low sulfur diesel fuel for its locomotives. The use of this fuel is expected to reduce emissions of fine particulate matter PM 2.5. In the future, NJ Transit plans to switch to ultra-low sulfur diesel fuel, once technical issues related to the use of this fuel in locomotive engines are resolved. This will reduce PM 2.5 emissions even further.

2. To maintain the reliability of its locomotive fleet, NJ Transit periodically rebuilds its locomotives. As locomotives are rebuilt, they will, at a minimum, meet USEPA Tier 0 standards that require rebuilt locomotives to produce lower emissions. While the Tier 0 standards do not focus on fine particulate emissions, they will result in a reduction of the amount of NOx produced by the locomotives. NOx is a major contributor to the formation of ground level ozone, another significant air pollutant in New Jersey. In the future, it may be possible for NJ Transit to rebuild the engines to tighter standards (Tier 1 or higher) to reduce particulate matter emissions.

3. In early 2008, NJ Transit will begin assigning some number of newer PL-42 locomotives to Raritan Yard. These locomotives are certified to USEPA Tier 1 emission standards, and emit

fewer fine particulates than the older locomotives, which are not regulated. The total number of PL-42 locomotives ultimately assigned to Raritan Yard will be determined by operational requirements and equipment availability.

4. NJ Transit has committed to keep abreast of the latest developments in controlling locomotive emissions, such as idle reduction technologies, and will consider installing such additional emission controls on its locomotives in the future.