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PCB Lighting in NYC Schools: Dangerous, Inefficient and Obsolete

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Miranda K.S. Massie, Director of Litigation and Training
Katherine Terenzi, Environmental and Health Justice Program Assistant

Introduction

In August 2010, New York City released preliminary results from the pilot study on PCBs in schools that it had undertaken following community outcry, litigation, and negotiations with the US Environmental Protection Agency (EPA). These results led to two conclusions. First, the problem of PCB air contamination in some city schools was even more severe than anyone had believed. Second, while the focus of the pilot study was originally on PCBs in window- and door-frame caulking, in at least some schools PCBs leaked within old fluorescent T12 lighting were contributing substantially to the contamination of the air being breathed by school employees and children.

Parents, school employees, community members, elected officials, and EPA Region 2 have called on the City to remove these old fixtures and replace them with modern lighting. EPA recently adopted new national guidelines urging school districts across the country to eliminate all PCB-containing lights. To advocates, the City's lack of urgency on this issue has suggested an inadequate regard both for science—since the research on PCBs and human health is clear (see Appendix)—and for children's and school employees' well-being.

Further, while recognizing that budgets are tight, we have expressed doubts about the City's claims that the conversion to modern lighting would be unaffordable, given the inevitable savings in energy costs. By today's standards, lights produced before the 1980s were enormously inefficient even when they were new.

This report confirms and details the substantial energy savings that would follow a switch away from T12 lighting. To quote the lighting manual of the City's own Department of Design and Construction, "it is always cost effective to retrofit or replace fixtures that use T12 lamps in existing applications."[1]

Finally, and most dramatically, leaving entirely aside PCB leakage, health impacts, efficiency, and sustainability—*the fixtures in question will all have to be changed within a couple of years anyway*. The US Department of Energy has been phasing out T12 technology since 2005. T12 ballasts were barred from manufacture or sale in mid-2010; T12 bulbs will go out of production in 2012. As the sources cited below make clear, the switch away from T12 lighting approaches inevitably and quickly.

In light of this extraordinary fact, we call on Mayor Bloomberg to adopt, as a matter of urgency, a citywide light-replacement program to reduce our carbon footprint and protect the health of children and school employees.

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[1] Gruzen Samton LLP with Hayden McKay Lighting Design Inc. (January 2005; Expanded July 2006). *Manual for Quality, Energy Efficient Lighting*.

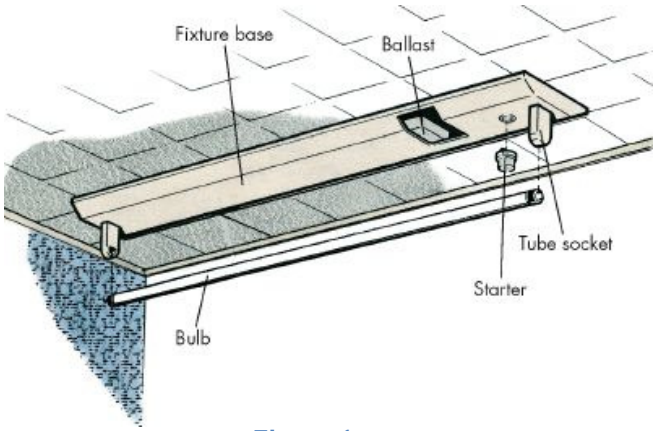

Figure 1

Background and Key Terms

- **Fixture** – the entire structure of the lighting unit.

- **Fluorescent Lamps** – commonly referred to as bulbs. Fluorescent light bulbs use a system of mercury vapor and phosphor coating inside of a glass tube. The size of a fluorescent light bulb or tube is articulated as the diameter in 8ths of an inch – T12 lights are 1.5 inches in diameter and T8 bulbs are 1 inch in diameter.

    - T12 bulbs are older and less energy efficient. Due to their larger diameter, these light bulbs require more mercury vapor and phosphor to operate effectively. *These bulbs will no longer be manufactured after July 1, 2012.*

    - T8 bulbs are skinnier and therefore need less mercury to operate and are more energy efficient.

- **Tube socket** (or socket) – typically on the fixture's base; the bulb connects to this part of the fixture.

- **Ballast** – supporting device used with fluorescent lights which regulates the electrical flow and manages the operation to create appropriate conditions.

    - **Magnetic ballasts** (or T12 magnetic ballast) – older technology with a core of steel plates wrapped in copper windings. Prior to the 1978 ban on PCBs, these ballasts incorporated a small capacitor that

contained PCBs. After PCBs were banned, magnetic ballasts continued to be manufactured but only incorporated capacitors that did not use PCBs. These ballasts are used to support T12 lamps. The US Department of Energy has phased out the manufacturing and sale of magnetic ballasts. They are significantly less energy efficient than the alternative, electronic ballasts. *July 2010 is the last time these ballasts were allowed to be manufactured or sold.*

- **Electronic ballasts** – considerably more energy efficient than magnetic ballasts. T8 bulbs use electronic ballasts to operate effectively. These are the ballasts used in new and retrofit projects.

- **Fixture base** – the foundation of the light fixture which attaches to the ceiling. The ballast is generally secured to the fixture within the base.

The Law

Magnetic (T12) Ballast Phase-out

In 2000 the US Department of Energy began the phaseout process of magnetic ballasts when it promulgated Standard 10 CFR Part 430*, Energy Conservation Program for Consumer Products: Fluorescent Lamp Ballasts Energy Conservation Standards; Final Rule.* These standards established a minimum ballast efficacy factor (BEF). If any ballast did not meet these standards a phase-out process would be implemented. However, certain magnetic ballasts designed to operate energy saving versions of the T12 lamps were not covered under this rule. The Energy Policy Act of 2005 (EPAct 2005), broaden the standards to incorporate the magnetic ballasts operating T12 energy saving lamps.[2] The EPAct 2005 resulted in the phase-out of most magnetic ballasts.[3]

A multistep process to phase out magnetic ballasts followed these laws. The phase-out began on July 1, 2005 when manufacturers were no longer able to sell T12 magnetic ballasts for use in new fixtures. March 31, 2006 marked the last day magnetic ballasts could be incorporated into new fixtures. For four more years, magnetic ballasts could be made for replacement purposes only, and had to be marked as such. July 1, 2010, five years after the beginning of the phase-out, was the last day magnetic ballasts could be sold.

[2] Further research could reveal whether the type of ballast the NYC Department of Education uses were covered in the Energy Conservations Standards of 2000, but there is no question they were included in EPAct 2005.

[3] The exceptions to the EPAct 2005 seem irrelevant to NYC schools. They are for ballasts that can allow extreme dimming, ones made for residential facilities, and outdoor signs.

T12 Bulb Phase-out

In July 2009 the US Department of Energy issued final regulations regarding fluorescent lamps. As part of this rule, the T12 bulb will also be eliminated from production. T12 fluorescent tubes have larger diameters than T8 bulbs and require more mercury vapor to operate effectively and more phosphor for lining. They also consume more energy than the common alternative T8 lamps. In July 2012, T12 lamps will be entirely phased out of production and sales.

The Benefits of Switching from T12 to T8 Technology

T12 magnetic ballasts are completely phased out of production and cannot be replaced. The alternative, electronic ballasts, "utilize solid-state technology to operate at much higher frequency (20,000 Hz) than magnetic ballasts (60 Hz), resulting in energy conservation through lower power loss and higher lamp efficacy for fluorescent lights."[4] The solid-state technology used in electronic ballasts also eliminates the flicker and the humming noise created by older fluorescent light fixtures.[5]

T12 light bulbs also lose their luminescence much faster than T8 lamps. Figure 2 illustrates the rapid decrease in luminescence.[6]

The combined energy savings of moving from T12 lamps and T12 magnetic ballasts to T8 lamps and electronic ballasts is anywhere from 22%[7] – 46%[8]. On most projects there is a simple investment return within 2-7 years.[9]

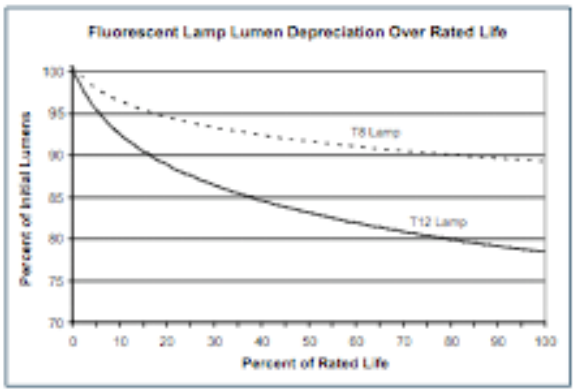

Figure 2

[4] Prepared for NYC Department of Design and Construction *by* Gruzen Samton LLP with Hayden McKay Lighting Design Inc. (January 2005; Expanded July 2006). *Manual for Quality, Energy Efficient Lighting.*
[5] Some initial research indicates that this new technology may increase work productivity and focus, as the brain does not have to constantly adjust to changing light and excess noise.
[6] Energy, U. D. (2005, August). Federal Energy Management Program: Fact Sheet . *(PNNL-SA-46067)* .
[7] Gruzen Samton LLP with Hayden McKay Lighting Design Inc. (January 2005; Expanded July 2006). *Manual for Quality, Energy Efficient Lighting.*
[8] Bloom, Susan; National Lighting Bureau Vice Chair. Quotation in *"Upcoming Ballast Phaseout to Create Major Lighting Upgrade Opportunity,"* LightNOW.org (14 Sept 2009).
[9] Environmental Protection Agency. (2010, December). *"Proper Maintenance, Removal, and Disposal of PCB-Containing Fluorescent Light Ballasts: A Guide for School Administrators and Maintenance Personnel."*

Figure 3 from Energy STAR summarizes the energy savings.[10]

Retrofit option	Base case: Energy-saving T12 lamps with magnetic ballasts	Case 1: T8 lamps with electronic ballasts	Case 2: High-performance T8s with electronic ballasts	Case 3: Case 2 + specular reflector + lens + 50% delamping	Case 4: Case 3 + occupancy sensing and daylight dimming
Average maintained foot-candles	25	30	28	25	26
Power per fixture (W)	156	116	90	45	49
Annual energy use (kWh)	7,507	5,568	4,320	2,160	1,275
Energy savings (%)	NA	26	42	71	83
Annual operating cost ($)	826	612	475	238	175
Upgrade cost ($)	NA	1,165	1,320	1,560	2,150
Simple payback (years)	NA	5.5	3.8	2.7	3.3

Figure 3

Funding

There are many federal and state supported programs that will help subsidize an energy efficiency upgrade.[11] The T12 technology will be entirely phased out by 2012, diminishing the need to incentivize entities to make the switch to T8 or more efficient technology because the market will force that switch in time. So, while there are programs to encourage energy efficiency, the programs that specifically target T12 technology will disappear.

New York City Programs and Statements

I. **Modernizing lighting is a major priority in PlaNYC, the City's comprehensive sustainability plan for New York City. New York City officials, including Mayor Bloomberg, have repeatedly acknowledged the importance and benefits of upgrading outdated and inefficient lighting.**

In a press release last May, the Office of the Mayor announced:

"The retrofit project includes modifications of controls, upgrades to the Building Management System**,** lighting upgrades, replacement of cooling towers and fourteen computer room air conditioners, and the installation of energy efficient motors. The

[10] Energy STAR. (2006, November). *Chapter 6: Lighting*. Retrieved January 10, 2011, from http://www.energystar.gov/index.cfm?c=business.EPA_BUM_CH6_Lighting
[11] US Department of Energy. (n.d.). *Financial Incentives for Energy Efficiency*. Retrieved January 10, 2011, from http://www.dsireusa.org/summarytables/finee.cfm

reduced energy consumption will result in a total annual reduction of 775 metric tons of carbon dioxide equivalent (CO2e), which equates to almost $183,456 in reduced operating costs annually."[12]

"PlaNYC Energy Initiatives" highlights the energy and cost savings correlated with upgrading equipment, including lighting systems[13]:

"Investments in LED stoplights and retrofits to City-owned buildings have already saved the City money and reduced the City's energy consumption."

"This project group consists primarily of replacements of older, inefficient equipment in buildings with newer, efficient models that meet or exceed current product standards and codes for energy efficiency. Examples include upgrades to lighting, HVAC, and refrigeration systems."

At a May 2010 hearing the Department of Citywide Administrative Services (DCAS) also emphasized that the installation of efficient lighting systems saves money and reduces greenhouse gas emissions:

"The ENCORE (ENergy COst REduction) program is a major part of the City's efforts to control energy costs and to improve air quality. The ENCORE agreement with the New York Power Authority allows for energy efficiency and clean energy technology projects, which are paid for by the City of New York and administered by the Office of Energy Conservation (OEC). Projects carried out through this program save energy dollars and reduce greenhouse gas emissions by increasing the energy efficiency of City buildings or switching to cleaner fuels. Here are some examples of ENCORE projects:

- Installation of high efficient lighting systems, including automatic lighting…"[14]

II. The "Manual for Quality, Energy Efficient Lighting" prepared in 2005 for the New York City Department of Design and Construction repeatedly emphasized the specific obsolescence and disadvantages of T12 ballasts and lamps:

"T12 lamps – Linear fluorescent lamps with a 1-1/2" diameter (12/8's of an inch). (They are now considered obsolete for most new applications.) These were the standard fluorescent lamps until T8 lamps came on the market in the 1980s."

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[12] The City Of New York Office Of The Mayor. (2010). Mayor Bloomberg and Commissioner Hirst Announce That Every Major City-Owned Building Has Been Benchmarked for Energy Use.

[13] The City of New York. *Reduce energy consumption by City government-p. 106*. Retrieved January 10, 2011, from PlaNYC Energy Initiatives: http://www.nyc.gov/html/planyc2030/html/plan/energy_reduce-consumption.shtml

[14] Department of Citywide Administrative Services (DCAS). (2010). *Hearing on the Mayor's Fiscal Year 2011 Executive Budget.*

T8 lamps "are the workhorse of the commercial lighting industry and have become the standard for offices and general applications. Since they are 22% more efficient than T12s, it is always cost effective to retrofit or replace fixtures that use T12 lamps in existing applications. NYC, through its Office of Energy Management at DCAS, has had a replacement program for many years to replace T12s with T8s in municipal buildings. T8 lamps use the same socket as T12, but not the same ballast. It has been relatively easy to retrofit T12 installations, often with the assistance of NYC's Department of Citywide Administrative Services (DCAS)."

"Fluorescent magnetic ballasts are significantly less energy efficient than electronic ballasts, and are being gradually phased out due to Department of Energy restrictions. Almost all commercial fluorescent luminaries are provided with electronic ballasts as a standard…"[15]

The City's Department of Design and Construction *requires* electronic ballasts:

"Higher first costs, if any, are quickly offset by energy savings. Electronic ballasts are required in DDC fluorescent lighting applications, both new and retrofit."[16]

III. MTA New York City Transit has already taken these facts into account and retrofitted their system, which decreased their energy use by 26%:

"Compact fluorescent bulbs replaced conventional incandescent light in tunnels because the compact bulb design fit the same sockets. Compact bulbs offer the same benefits as longer fluorescent light tubes and have increased tunnel lighting 500 percent with just a modest power increase of 11 percent. What's more, since each compact fluorescent bulb consumes four-to-six times less energy than an incandescent bulb, the compact bulb yields 1,300 fewer pounds of carbon dioxide emissions over its lifetime of 7,500 to 10,000 hours. Overall, station and tunnel lighting upgrades [including, but not limited to, the switch from T12 to T8 light bulbs] have made stations and tunnels brighter, safer, more secure, and more comfortable, and save NYC Transit $4.8 million a year."

"We are replacing incandescent light bulbs with fluorescent bulbs in subway stations throughout the system. When NYC Transit switched to T12 fluorescent bulbs, station lighting increased 750 percent and power consumption decreased 28 percent. An additional change to T8 bulbs kept lighting as bright as before, but reduced our energy use by an extra 26 percent." [17]

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[15] Gruzen Samton LLP with Hayden McKay Lighting Design Inc. (January 2005; Expanded July 2006). *Manual for Quality, Energy Efficient Lighting*.

[16] Gruzen Samton LLP with Hayden McKay Lighting Design Inc. (January 2005; Expanded July 2006). *Manual for Quality, Energy Efficient Lighting*.

[17] Metropolitan Transportation Authority of the State of New York. (n.d.). *New York City Transit and the Environment*. Retrieved January 10, 2011, from http://www.mta.info/nyct/facts/ffenvironment.htm

Conclusion: T12 Lighting and the Campaign to Rid Schools of PCBs

New York City schools are using a lighting system that will be fully obsolete in less than two years. Other public agencies, including several in New York, have implemented and completed programs to replace T12 lighting systems with up-to-date T8 lighting. All replacement program cost estimates must be measured against the widely anticipated and well-documented long-term energy savings. Most importantly, T12 lighting poses serious public health risks. These lights have leaked toxic PCBs at schools across New York City. We call on the Bloomberg administration to redouble its public health and energy sustainability efforts by replacing these outdated and dangerous lights with safe, modern, and efficient lighting as soon as possible.

Acknowledgment
We are grateful to Edward Olmsted, an industrial hygienist with the United Federation of Teachers. The phase-out of both the magnetic ballasts and T12 light bulbs was first brought to the attention of New York Lawyers for the Public Interest by Mr. Olmsted.

APPENDIX

The Science of PCBs and Health: A Selective Summary

The articles in parenthesis are identified in full in the bibliography on the last page.

Asthma & Respiratory

- Adults and children have an increased risk of asthma and infectious respiratory diseases when exposed to persistent organic pollutants, including PCBs (Carpenter, 2008; Ma, 2007).

- There is a relationship between PCB exposures and lowered levels of immunoglobulins M and A (IgM and IgA) and increases in respiratory infections (Nakanishi, 1985).

Attentional Deficits and Cognitive Function

- Adults who work in buildings in which window caulk is contaminated with PCBs showed higher rates of attentional deficits (Peper, 2005).

- Low-level prenatal exposure to organochlorine compounds including PCBs is associated with an increase in ADHD-like behaviors in children (Sagiv, 2010).

- Children who had prenatal exposure to PCBs had higher incidence of behavioral disorders and lower IQ scores when they were 9 years old (Stewart, 2008).

- Adolescents with elevated serum PCBs do more poorly on several tests of cognitive function than do adolescents with low PCBs (Newman et al., 2009).

Diabetes & Heart Disease

- Hospitalization rates for diabetes in communities near a toxic waste site containing PCBs were amplified (Kouznetsova, 2007).

- Elevated levels of PCBs are associated with an increased risk of having diabetes (Codru et al., 2007).

- Having elevated PCB levels early in life is predictive of developing diabetes later (Lee et al., 2010).

- Residents living in communities adjacent to the Hudson River, which contains high levels of PCBs, had an increased rate of hospitalization for coronary heart disease by over 35% and for acute myocardial infarction by nearly 40% (Sergeev, 2005).

- High levels of PCBs cause the liver to make more cholesterol and lipids, which then increase the risk of cardiovascular disease (Goncharov et al., 2008).

- Having elevated levels of PCBs is the greatest risk factor for having high blood pressure other than age (Goncharov et al., 2010).

Elevated PCB Levels in Blood

- Workers disturbing PCB caulk had elevated PCB concentrations in their blood (Kontsas, 2003; Wingfors, 2006; Herrick, 2007).

Endocrine Effects:

- Adolescent girls with high PCB levels reach puberty at a younger age than girls with lower PCBs (Denham et al., 2005).

- In adolescents, thyroid function is reduced if their serum PCB level is elevated (Schell et al., 2008).

- Higher PCB levels in men is associated with a reduction in the levels of the male sex hormone, testosterone (Goncharov et al., 2009).

Immune System

- PCBs are associated with immune system disruptions including increases in B cells and decreases in CD8+ and natural killer cells (Svesson, 1994).

- Babies, in this case Dutch newborns, with higher prenatal PCB exposures had reduced immune response after vaccination for measles, mumps and rubella (Weisglas-Kuperus, 2000).

- Reduced antibodies against diphtheria and tetanus later in childhood were associated with higher PCB exposure in toddlerhood (Barrett, 2010).

- PCB exposure altered lymphocyte distributions, decreased wheeze, and increased otitis media (Weisglas-Kuperus, 2004).

- Children living in the Faroe Islands where the diet includes PCB-contaminated whale blubber exhibited decreased antibody response after vaccination against tetanus and diphtheria. This effect was associated both with the concentrations of PCBs in their mothers' blood during pregnancy and milk soon after birth, and in the children's own blood at the time of the study (Heilmann, 2006).

Inhalation

- Inhalation of PCBs was associated with multiple system disturbances including "significant serum thyroid hormone elevation" and "[h]istopathologic changes … in the urinary bladder, thymus, and the thyroid" during animal testing (Casey, 1999).

- Inhalation is a major exposure pathway for PCBs and may lead to a greater uptake of PCBs than ingestion (Currado, 2008).

Childhood Leukemia

- The Environmental Protection Agency, the World Health Organization, and the United States Department of Health and Human Services have long characterized PCBs as a known animal carcinogen and a probable human carcinogen.

- Children's risk of developing the most common form of childhood leukemia, acute lymphocytic leukemia, increased by two-fold when PCBs were detected in the dust of a room in which the child spent a significant amount of time (Ward, 2009).

Persistence of PCB Body Burden over Time

- Elevated levels of PCBs can persist in the human body over many years (Seegal, 2010).

Prenatal & Infant Exposure

- Even low level prenatal exposure to PCBs may affect thyroid hormone homeostasis (Chevrier, 2007).

- Prenatal exposure to PCBs may affect growth, especially in girls (Lamb, 2006).

- Growth deficits were also seen among infants born in eastern Slovakia, where a chemical manufacturing plant produced PCBs until 1985 (Hertz-Picciotto, 2003), specifically lower thymic index, which is an estimate of the volume of the thymus, an organ that plays a role in the differentiation and maturation of t-lymphocytes (T-cells, a critical part of the immune system) (Park, 2008).

- Associations were reported between prenatal PCB and p,p-DDE exposures and poor attention in early infancy, including alertness, quality of alert responsiveness, and cost of attention (Sagiv, 2008).

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