TORONTO

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November 9, 2005

BOARD OF HEALTH:

Subject: Criteria Used in the Selection of PM_{10} and $PM_{2.5}$ Efficient Street Sweepers and Fuel Alternative for Street Sweepers (All Wards)

Action taken by the Committee:

The Works Committee received the report (October 20, 2005) from the General Manager, Transportation Services respecting the criteria used in the selection of PM_{10} and $PM_{2.5}$ Efficient Street Sweepers and Fuel Alternative for Street Sweepers, and directed that a copy be forwarded to the Board of Health for information.

Background:

The Works Committee on November 8 and 9, 2005, considered a report (October 20, 2005) from the General Manager, Transportation Services responding to the request of the Board of Health to provide the environmental criteria used in the selection of PM_{10} and $PM_{2.5}$ efficient street sweepers, including any communications/written recommendations from Fleet Services, and the differences in emissions into the air from diesel, diesel/bio-diesel and natural gas for each sweeper.

Recommendation:

It is recommended that this report be forwarded to the Board of Health for information.

Mr. Joseph M. Johnson, Elgin Sweeper Company, appeared before the Works Committee, and filed a submission.

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R. Dyers/tl
Item 14

Sent to: Board of Health
General Manager, Transportation Services

c. Deputy City Manager, Fareed Amin

TORONTO STAFF REPORT

October 20, 2005

To: Works Committee

From: Gary Welsh, General Manager, Transportation Services

Subject: Criteria Used in the Selection of PM_{10} and $PM_{2.5}$ Efficient Street Sweepers and Fuel Alternatives for Street Sweepers
(All Wards)

Purpose:

To report on the environmental criteria used in the selection of PM10 and PM2.5 Efficient Street Sweepers and fuel options for street sweepers.

Financial Implications and Impact Statement:

There are no financial implications resulting from the receipt of this report.

Recommendation:

It is recommended that this report be forwarded to the Board of Health for information.

Background:

City Council at its meeting of July 19, 20, 21 and 26, 2005 adopted the report dated June 13, 2005, prepared jointly by the Divisions of Transportation and Technical Services entitled, "PM_{10} and $PM_{2.5}$ Efficient Street Sweepers for the City of Toronto (All Wards)" and endorsed a number of recommendations dealing with the purchase and deployment of regenerative-air street sweepers.

The Board of Health in considering the above report at its meeting of September 26, 2005, requested that the General Manager, Transportation Services provide to the Board of Health and Works Committee a report outlining the environmental criteria used in the selection of PM_{10} and $PM_{2.5}$ Efficient Street Sweepers, including any communications/written recommendations from Fleet Services; and the differences in emissions into the air from diesel, diesel/bio-diesel, and natural gas for each sweeper.

Comments:

Among many recommendations considered in the June 13, 2005 report, it was recommended that staff be authorized to issue a request for proposals (RFP) limited to regenerative-air street sweeper technology and that the PM_{10} and $PM_{2.5}$ Street Sweeper Testing Protocol, detailed in the report, be adopted as the City of Toronto's interim standard to be used in future RFPs for PM_{10} and $PM_{2.5}$ efficient street sweepers.

The PM_{10} and $PM_{2.5}$ Street Sweeper Testing Protocol provides an objective and quantitative method for assessing the relative maximum PM_{10} and $PM_{2.5}$ levels for the "capture-and-remove-by-sweeper" performance as well as the minimum "disturb-and-deposit-elsewhere" performance of available street sweepers. The rigorous protocol developed by City staff was implemented in a controlled testing environment to establish performance efficiencies for PM_{10} and $PM_{2.5}$, which will be discussed below.

Environmental Criteria Used in the Selection of PM_{10} and $PM_{2.5}$ Efficient Street Sweepers

In July and August of 2004, the PM_{10} and $PM_{2.5}$ Street Sweeper Testing Protocol was used at the Disco Yard facility. Fifteen days of controlled testing was carried out on a total of eight street sweeper models, which included several mechanical, vacuum-assist and regenerative-air models. The testing allowed City staff to determine the following performance efficiencies for each sweeper tested:

- "Removal of Material from Test Track Surface" – amount of material picked-up and removed;
- "Material disturbed and deposited elsewhere" – deposit on sidewalk; and
- "Material disturbed into the air" – PM_{10} & $PM_{2.5}$ air concentrations.

The results of the findings were summarized in the report (June 13, 2005) titled, "PM_{10} and $PM_{2.5}$ Efficient Street Sweepers for the City of Toronto (All Wards)". The overall test findings clearly showed that new technology street sweepers can achieve high performance levels for PM_{10} and $PM_{2.5}$ removal, and that the regenerative-air model, achieved the highest efficiency performance for both PM_{10} and $PM_{2.5}$ in all three key criteria categories.

Based on the findings, performance efficiencies values were derived by the City staff after examining the range of results obtained from the street sweeper testing project. The following are the thresholds for PM_{10} and $PM_{2.5}$ efficiency requirements that were deemed desirable by the City staff, and would be used to evaluate street sweepers procured through future RFP's:

1) PM_{10} Air Contamination – Maximum Concentration defined as 1 second reading of peak exposure following the sweeper's pass and divided by the kilogram of material picked up and entrained inside the hopper – **threshold (< 0.08 mg/m^3/kg)**;

2) PM_{10} Air Contamination – Total Concentration (mg/m^3/kg) defined as total area under the concentration curve, representing concentrations per second during a period of 20 minutes following the sweeper's pass and divided by the kilograms of material picked up and entrained inside the hopper – **threshold (< 11.0 mg/m^3/kg)**;

3) $PM_{2.5}$ Air Contamination – Maximum Concentration defined as 1 second reading of peak exposure following the sweeper's pass and divided by the kilogram of material picked up and entrained inside the hopper – **threshold (< 0.02 mg/m^3/kg)**;

4) $PM_{2.5}$ Air Contamination – Total Concentration (mg/m^3/kg) defined as total area under the concentration curve, representing concentrations per second during a period of 20 minutes following the sweeper's pass and divided by the kilograms of material picked up and entrained inside the hopper – **threshold (< 5.0 mg/m^3/kg)**;

5) Deposit on Sidewalk (%) defined as the amount of test material (as a percentage of the total material applied on the surface) disturbed during the street sweeping process and deposited on the adjacent sidewalk – **threshold (< 0.08%)**; and

6) Removal of Material from Surface Efficiency (%) defined as the amount of test material removed (as a percentage of the total material applied on the surface) from the surface – **threshold (> 90%)**.

Fleet Services was consulted on the above efficiency thresholds and concurred that these measures should be included as part of the RFP to procure regenerative-air street sweepers.

Fuel Types for Street Sweepers

City staff, comprised of Fleet and Transportation Services, undertook a detailed assessment of the most appropriate type of fuel. The fuel type selected would ultimately determine the type of engine that would have to be identified as part of the specifications to vendors, in the procurement of new regenerative-air street sweepers. In addition, the fuel type selection would have to ensure that the sweeper's operational performance is not compromised, is cost effective, and that the fuel contributes to the reduction in the negative environmental impacts of equivalent carbon dioxide (eCO_2) output, consistent with Fleet Services' report entitled, "Green Fleet Transition Plan (2004 - 2007)".

In Fleet Services' evaluation of fuel options for the regenerative-air street sweepers, the following hydrocarbon fuels were considered; diesel, biodiesel, gasoline, and natural gas. The greenhouse gas emission rates (eCO_2 kg/litre) from these fuel types do vary, and significantly in some cases. According to emission factors developed by Natural Resources Canada (NRCAN) and the Canadian Standards Association - Climate Changes, GHG Registries, the differences can be seen in Table Nos. 1 and 2 below.

Table No. 1 – Biodiesel Emission Factors	
Fuel Type	***eCO_2 kg/ L***
Regular diesel	3.12
Soybean	1.27
Canola	1.25
Recycled cooking Oil	0.71
Animal Fats	0.29

(Source: Green Fleet Transition Plan p.20)

Table No. 2 – Hydrocarbon Fuel Emission Factors	
Fuel Type	***eCO_2 kg/ L***
Gasoline	2.80
Natural Gas	0.0022

(Source: Canadian Standards Association - Climate Changes, GHG Registries)

From the numbers in the above tables, natural gas has been a leading alternative fuel in the reduction of greenhouse gas emissions. However, the use of natural gas is not appropriate in all applications. Heavy-duty engine applications, such as street sweepers and garbage trucks, use diesel fuel as the standard, given a number of operational issues and challenges associated with the use of natural gas, including:

- more frequent refuelling trips required due to the limited fuel tank size that can be accommodated in the street sweeper;
- significant re-design requirements and costs to install larger, on-board natural gas fuel tanks;
- increased cost of natural gas engines and associated parts;
- limited availability of natural gas engines for heavy-duty engine applications;
- higher operating costs;
- limited repair network (there is only one warranty dealer to cover repairs and warranty claims in the GTA);
- significantly lengthier times for completing sweeping operations resulting in inefficient service delivery;
- limited locations where the fuel is dispensed and readily available, the use of natural gas would require separate fuelling infrastructure for storage and dispensing to be constructed, which currently is quite costly to implement; and
- compromising the performance of the sweeper in its ability to effectively pick up road debris due to the related power reduction associated with the use of this type of fuel.

As noted above, there are a number of challenges associated with the use of natural gas as a fuel for street sweepers at this time. However, given possible technological advancements in natural gas engines in heavy duty applications, their use in street sweepers will be reconsidered as operational and performance issues are resolved.

Fleet Services has determined that diesel fuel is operationally more suitable for use in street sweepers than natural gas. The environmental effects of this decision have also been considered. The purchase of street sweepers with diesel engines affords the City of Toronto the flexibility of using biodiesel, which produces less harmful emissions of most air pollutants and current diesel engines require no modifications to work with biodiesel.

In the "Green Fleet Transition Plan (2004)", Fleet Services planned for B50 (50% soy bean-based biodiesel) for four months and B20 for eight months in 2006 and 2007, totaling over 2 million litres of pure biodiesel each year for use in various applications. Street sweepers fuelling from one of the City's sites dispensing biodiesel would also use the pre-blended fuel. Biodiesel carries a significant premium over regular diesel and Fleet Services staff are continuing to evaluate the costs and benefits of all bio-fuels including ethanol blended gasoline, low-sulphur diesel and biodiesel.

Conclusions:

The environmental criteria for the acquisition of sweepers were developed on the basis of a rigorous testing program and will facilitate the acquisition of the most efficient PM_{10} and $PM_{2.5}$ equipment available.

The specification of diesel engines for street sweepers ensures that the City's operational needs are met and that the benefits derived from the use of biodiesel, a more environmentally friendly fuel alternative, meets the City of Toronto's objective to reduce greenhouse gases through its fleet of vehicles. Transportation Services will continue to work together with Fleet Services to ensure that the best fuel options are always considered when purchasing such equipment.

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