Proposal for improving the Sanitation in New York City by through the modification of current garbage trucks

To:   Commissioner Kathryn Garcia

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From: Team Clean

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**1. Introduction**

A major issue that has been plaguing New York City is garbage. We live in a city with millions of people who produce a lot of garbage. Currently, the New York State Sanitation department provides a way to clean up the garbage by using garbage trucks that run on a fixed schedule around New York City. These trucks then dump all the garbage in a landfill outside of the city. This is a feasible solution to the garbage issue in New York City, but it is not an efficient solution.

**2. Problem**

There are many problems that occur including but not limited to: contribution to noise pollution, inefficient timing, traffic blockage and a waste of landfill space. In this proposal, we as a group intend on providing additional improvements to the garbage trucks and how they are run to make the system more efficient.

**3. Solution**

Our solution is to improve the design of the garbage trucks by having the space that the garbage normally goes to be changed into an incinerator. This incinerator will then be connected to a filtration system that clears the fumes of any carbon dioxide or CO2 to ensure that we are not further adding to the problem of climate change.

**3.1 Planned Tasks**

**3.1i** **Making garbage trucks more efficient**

Garbage trucks are very important for New York City because they collect the garbage for our city to stays clean. However, some of these trucks have had technical problems that can have potentially disastrous effects. A new report found that truck drivers were laboring on city streets with bald tires, faulty brakes and broken lights (Rivoli, 2016). This demonstrates that the current garbage trucks that the city uses are in terrible conditions and are dangerous for the city. Moreover, it's dangerous during snow days because the drivers with bald tires can easily lose control of the truck. Faulty brakes are another problem these trucks have, as it limits the amount of control the driver has which is especially dangerous in highly populated city. Furthermore, lights are essential for any type of vehicle, and not having them can lead to accidents as the drivers are unable to see. These are only some of the issues that current garbage trucks have. To prevent our garbage trucks from having these faulty mechanisms, we plan to have weekly maintenance on the garbage trucks to ensure that they are in optimal condition.

**3.1ii Reducing the size of the truck and making them electrical**

Decreasing the size of the trucks can provide a solution to road congestion problem in New York City. Traffic is very common in NYC, and having a big truck causes more traffic as they take up too much space in streets. The garbage truck we are proposing will have a reduced size to reduce the amount of road congestion present.

In a year around 14,000 gallons of fuel are burned by garbage trucks alone (Kelly-Detwiler, 2015). By making the truck electrical, the money saved from not using as much fuel will cover the initial cost of having an electrical garbage truck.

**3.1iii Implementing an incinerator and air filtration system**

We plan on filling the empty space of the garbage truck with an incinerator that burns the garbage as the garbage truck goes through its specified route. This way, as more trash is burned, the trucks do not have to be overly large and more area can be covered by each truck. Burning trash can cause foul odors and emit carbon dioxide. To counteract this problem, we will also implement a filtration system that will filter through any bacteria, odors, and carbon dioxide to ensure that the garbage truck is environmentally friendly. Sanitation workers are exposed to 11 different Penicillium species, and on average the genus constituted 84% of each worker’s fungal exposure (Madsen, Alwan, [Ørberg](https://www.ncbi.nlm.nih.gov/pubmed/?term=%26%23x000d8%3Brberg%20A%5BAuthor%5D&cauthor=true&cauthor_uid=27098185), Uhrbrand, & Jørgensen, 2016). This exposure is because of contact with the garbage. Workers are generally exposed to garbage the full day until they return to the landfill site. By implementing the incinerator in the truck, it will lessen that exposure and thus will help to maintain the worker in good health. Moreover, most bacteria cannot survive the hot temperatures of the incinerator and will be killed which eliminates most diseases that a sanitation worker may be exposed to.

**3.1iv Changing current regulations**

Flammable objects will be set aside in another storage container in the truck because flammable objects may lead to uncontrollable fire in the incinerators. Therefore, we have come with a new regulation that states that all flammable objects should be put in red garbage bags. In addition, the working schedule of the garbage trucks must be improved. After living in New York City, we all notice that garbage pickup happens primarily in the mornings. This is problematic because as the garbage trucks get through their schedule, there are more opportunities for them to have accidents among pedestrians. There was an incident in Manhattan that occurred in 2012 where a woman was crossing a red light and a garbage truck hit her (Biderman, 2012). To minimize the possibility of these incidents happening, we plan to have the garbage trucks running during dead hours of the night. In addition, the routes and timing of the routes of each garbage truck must be considered. This is an actual issue that must be considered, to minimize travel costs and ensure that all the garbage has been picked up when it is specified. This is a problem that Buhrkal and Ropke attempt to solve. They attempted to use the “Adaptive Large Neighborhood Heuristic Search” to solve the issue of garbage truck routes (Buhrkal & Ropke, 2012). One of the conclusions that both authors found was when garbage trucks had a larger time frame to complete their specified route, their efficiency improved by 8-13% (Buhrkal & Ropke, 2012). This is something that we plan to incorporate in our plan to implement the garbage trucks. As the times we plan to run the garbage trucks during dead hours of the night, there should be more time to complete their route as they are less likely to encounter citizens.

**3.2 Technical Description Aspect**

**3.2i Spec Sheet**

|  |  |  |
| --- | --- | --- |
| Letter | Measurement | Image |
| A  (Width) | 8 feet | Figure 1: A simplified front view of the modified garbage truck |
| B  (length) | 1 feet |
| C  (Height) | 12 feet |

**3.2ii Components of Garbage truck**

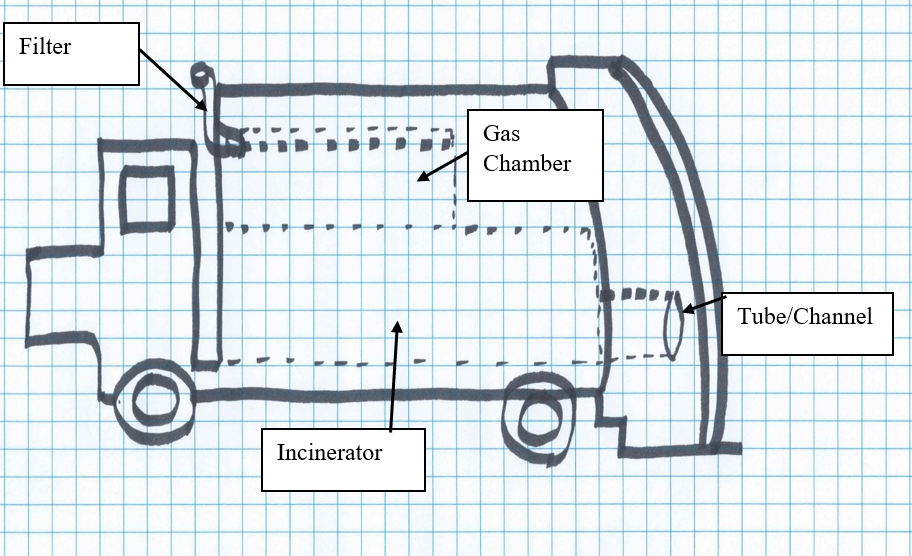


Figure 2: Schematic Front View of the garbage truck with the incinerator and filtration system

Tube/Channel:

When garbage is being loaded into the garbage truck, the tube/channel is a metal structure that prevents the workers from having to be in close proximity to the incinerator and minimizes injuries.

Incinerator:

Most of the back of the garbage truck will be taken up by the incinerator which burns the garbage and is composed primarily of a chamber where the trash goes, and there is an igniter present.

Gas Chamber:

The chamber is space above the incinerator where the fumes from the burnt garbage will collect before flowing through the filtration system.

Filtration System:

A plastic tube with a series of filters for carbon dioxide, odor, and toxins that will filter the fumes from burning the garbage.

**3.2iii Process**

The sanitation workers will first place the garbage into the tube/channel which is connected to the incinerator. At which point, the incinerator will burn the garbage. Then the fumes from the garbage will enter the gas chamber. From there, they will go through the filtration system and be released.

**3.2iv Budget**

|  |  |  |
| --- | --- | --- |
| Components | Cost per item $ | Total $ |
| Garbage truck chassis | 40,000 | 89,200,000 |
| Garbage truck Body | 16,000 | 32,480,000 |
| Filtration system | 3,000 | 6,690,000 |
| Incinerator system | 5,000 | 11,150,000 |
| Electric System | 150,000 | 334,500,000 |

Figure 4: Table showing the calculated expenses of adding the filtration system and incinerator to the 2,230 garbage trucks currently circulating New York City.

|  |  |  |  |
| --- | --- | --- | --- |
| Workers | Pay per hour $/hour | Hours a week (hours) | Total per week $ |
| Electrical Engineers | $25 | 40 | $1,000 |
| Mechanical Engineers | $25 | 40 | $1,000 |
| Civil Engineers | $25 | 40 | $1,000 |
| Computer Engineers | $25 | 40 | $1,000 |
| Sanitation workers | $30 | 35 | $1,050 |

Figure 5: Table showing the average salary that will be received by engineers working on this project and maintaining the garbage trucks along with the salary that will be received by sanitation workers.

After doing the calculations for the materials cost, we determined that each garbage truck costs about $214,000. Given that there are about 2,230 garbage trucks currently circulating through New York City, the total cost for the garbage trucks is about $470 million dollars.

**3.2v Materials Needed:**

Materials for the base truck:

|  |  |
| --- | --- |
| Head Sheet panels | High tensile sheet steel 10 gauge or higher |
| Lower side sheet panels | (45,000) to be 7 gauges or higher |
| Floors | 7-gauge minimum steel plate full length of the container floor needs to be leak proof) |
| Cross members | (under the floor will be 3-inch channels 3.5 lbs. minimum C-Channels on 16-inch centers) |
| Front and rear rollers | Constructed from standard black pipe minimum schedule 40 and shall be 8 inches in diameter with grease fitting |
| Long rails | 6 inches x 2 inches steel tubing minimum ¼ inch wall thickness |
| Front nose rollers | 4-inch O.D. x 6-inch-long with grease fittings |
| Framing | Tail gate to be surrounded with 3 inches x 6 inches x 3/16 inches rectangular tubes |
| Tail gate door | 10-gauge high tensile steel reinforced with two vertical plate stiffeners for full height of door with ½ inch steel plate hinges with 1 1/16 pins and grease fittings |
| Safety Chain | Safety chain is used to secure door and is vital |
| Tail gate opening | Full height and width of container above sump |
| Container hook | 1 ½ inch plate |
| Hook plate | 1-inch plate with hook welded to both sides of the plate. |
| Push plate | 7/16-inch steel plate 18 inches x 66 inches minimum hinged and pinned to provide accessibility and protection from compacting head. |
| Side of roof and head braces | (45,000 psi) 10- gauge minimum high tensile strength at 24 inches for rectangular containers. |
| Sides of body | No less than two vertical V crimps in the metal equally spaced running the length of the container. |
| Paint | Container must be scraped and painted green. Enamel should be used to avoid corrosion. |
| Stencil | Container must have site name stenciled on both side of the container in 8-inch letters. |
| Safety stencil | Warning on all 4 side in 3-inch white letters stating, “WARNING STAND CLEAR WHEN CONTAINER IS OFF GROUND”. |

Materials for the filtration system:

|  |  |
| --- | --- |
| Pre-filter (size of all materials may vary due to amount of garbage) | The first line before pollution and air is moved on to filtration systems |
| Germ defense filter | Traps and reduces any particles (bacteria, mold spores) that may be carrying any viruses |
| Toxin absorber filter | Eliminates any volatile organic compounds (VOC), and other chemicals. |
| Odor remover filter | Eliminates the odor of the burned garbage. |
| Activated carbon filter | The filter that absorbs the odor, VOCs, and chemicals. |
| Brushless direct current motor | A motor that directs the filtered air |
| Negative ion controller (on/off control) | An ion controller that further improves the filtered air |

Materials for the Incinerator:

|  |  |
| --- | --- |
| Main chamber | 3 quarters of the size of container of truck |
| Gas chamber | Must be sized based off how much garbage will be collected (average for specific area) |
| Return pipe gases and ash | Sized based off the gas chamber size |
| Venturi valves | Sized based off the entire incinerators size |
| Igniter | Size depends on main chamber size |
| Clean out port | Sized based from main chamber size |
| Venturi OX inlet | Size is based on the igniters size |
| Elevation grates | Should be 3 inches of base of container to allow ashes to fall |

**4. Qualifications**

Our team of engineers is composed of three mechanical engineers and one computer engineer. The mechanical engineers have experience with CAD software and because of this we are capable of modeling and creating prototypes for the garbage trucks to ensure that they are working to the extent that we have proposed. In addition, we have a computer engineer who can give insight to the inner workings of the garbage truck and adds another perspective in ensuring that the garbage trucks work. As we plan on making the garbage truck potentially run on electricity rather than burning fuel in the future, it is important to have an individual who has experience with electrical components.

**5. Summary**

Our team of engineers has proposed a change to the sanitation trucks currently in use. The idea is to change trucks to be capable of incinerating garbage as it is being picked up and loaded into the back of the truck. The reason for this proposal is the consensus that the system in place currently is not effective. It causes many problems within communities because there is too much garbage, and the system is not efficient in cleaning up the garbage.  Many questions were brought to our attention such as safety, cost, and environmental factors. These questions were considered, and we found the solution through research and critical thinking analysis to each problem it could cause. First on our list was the safety of the workers and everyone around the truck. We focused on the safety of the incinerator. The incinerator would be operated in the trucks with the worker away from the chassis containing the incinerator. Workers would also undergo training to ensure proper usage of the machinery. The Second task tackled was cost. Cost was broken down and a way was found to make the project as cost efficient as possible but seeing as it is a large project it would be expensive. The total projected cost for trucks itself would cost 470 million dollars. Lastly, we considered environmental effects. It was concluded that a filtration system would be put together above the truck to get rid of harmful fumes and smells. The project would begin on April 16, 2018 and the projected finish date would be in June 2019. A project on such a large scale like this will impact many and become very beneficial thus making it a time consuming and expensive project that is worthwhile. If the project is authorized, we will begin submitting progress reports monthly to communicate our research and progress.

**6. Schedule**



Figure 3: Table showing the estimated schedule that will be followed in the implementation of these garbage trucks starting from April 2018 to June 2019

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