American Association of Port Authorities
2006 Environmental Improvement Awards Competition

The Port of Virginia
Air Emissions Reduction Program

Submitted by:

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Director of Environmental Affairs
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June 1, 2006

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I. EXECUTIVE SUMMARY

Over the last decade, environmental interest groups and regulatory officials have increased their focus on the environmental impacts associated with cargo handling operations at the nation's port facilities. Ports across the country have been forced by regulation and legal action to mitigate or reduce emissions associated with operations. In 2005, when Virginia and Federal regulators approached The Port of Virginia regarding impacts from air emissions, they learned that The Port had voluntarily developed and implemented an emissions reduction program as early as 1999. The Port decided to model the effectiveness of the program in terms of its impact on air quality and found that it had reduced air emissions at the marine terminals by as much as 33% over six years.

In 1999, The Port of Virginia implemented a series of equipment purchasing strategies to reduce air emissions and fuel consumption from port operations at The Ports three marine terminals in Hampton Roads. This voluntary initiative was developed by equipment specialists at The Port to reduce fuel consumption and air emissions from cargo handling operations. Specifically, equipment acquisition procedures were revised, requiring all newly purchased *off-road* cargo handling equipment to meet or exceed the latest Environmental Protection Agency (EPA) emission requirements for *on-road* engines. Vendors were required to supply the highest tier on-road engine available. The Port also reviewed equipment inventory, identified equipment that could be replaced with cleaner burning engines, and initiated a phased replacement program.

From 2001 to 2005, The Port purchased 97 replacement hustlers and 90 straddle carriers with the latest EPA on-road certified low emission engines. In addition, the engines on 19 rubber tire gantry cranes were rebuilt to reduce NOx and PM_{10} emissions. Other emission reduction efforts included evaluating fuel ionization equipment, purchasing hybrid vehicles, and converting passenger vehicles from gas to propane. The Port also conducted a thorough review of its forklift fleet and reduced the total number of forklifts from 239 to 185. Eighty-seven diesel and gas burning forklifts were replaced with cleaner burning propane forklifts, and 55% of the pick-up truck fleet was downsized from 8-cylinder to 4-cylinder engines.

It is important to note that cargo throughput at The Port of Virginia increased from 1.06 million TEUs in 2001 to 1.65 million TEUs in 2005. However, as a result of the changes in purchasing policy, VOC, CO, NO_X, PM_{10} and SO_2 emissions dropped 4%, 2%, 4%, 6%, and 11% respectively despite this increase in container handling activity. When the emissions were compared to the level of business, they had decreased 32%, 30%, 32%, 33%, and 37%. This represents a significant reduction in emissions from cargo handling activities despite a growth in container throughput of nearly 55% over the last five years. In addition, emissions from cargo handling activities at the three terminals contributed less than 0.6% to VOC levels and less than 1.9% to NOx levels to the Hampton Roads regional air emissions inventory in 2005.

The Port of Virginia has successfully and voluntarily achieved a 33% reduction in air emissions over 5 years with a change in purchasing strategy. In addition, equipment purchasing, maintenance and fuel costs have decreased as a result of the phased vehicle replacement program and the specification of more efficient, low emission on-road engines. The Port of Virginia Air Emissions Reduction Program has received praise from both the Virginia Department of Environmental Quality and the U.S. EPA not only for its success in reducing emissions but also for its transferability to other ports and industries that have sizeable operating equipment and vehicle fleets.

II. INTRODUCTION

The Port of Virginia is owned and managed by the Virginia Port Authority (VPA) and its operating affiliate, Virginia International Terminals, Inc. (VIT) for the Commonwealth of Virginia. The VPA is the Commonwealth's leading agency for international transportation and maritime commerce, and is charged with operating and marketing the marine terminal facilities through which the shipping trade takes place.

The Port of Virginia is the 9th largest port in the United States, having handled over 1.98 TEUs of containerized cargo in 2005. The Port consists of three marine terminals located in Newport News, Norfolk and Portsmouth and an inland intermodal facility located in Front Royal. These facilities are served by the deepest ice-free channels on the East Coast (50') and six direct service daily trains to 28 major U.S. cities. The Port offers the shipping industry access to two-thirds of the U.S. population with more than 75 international shipping lines delivering goods to the terminals. Approximately $27 billion in import/export cargo flows thought The Port of Virginia each year.

In 1999, The Port of Virginia developed and implemented a number of new equipment purchasing strategies to reduce air emissions and fuel consumption from operations at The Port's three marine terminals in Hampton Roads. This voluntary initiative was developed initially to reduce fuel consumption at the terminals. With the advent of a formal environmental program at The Port of Virginia and the increased attention to air emissions generated by U.S. ports, The Port decided to model the effectiveness of the equipment purchasing program in terms of its impact on air quality and found that the program had reduced air emissions at the marine terminals by as much as 33% over six years.

III. GOALS AND OBJECTIVES

Over the last decade, environmental interest groups and regulatory officials have increased their focus on the environmental impacts associated with cargo handling operations at the nation's many port facilities. Ports around the country, particularly those on the West Coast, have been forced by regulation and legal action to mitigate or reduce emissions associated with port operations. In Virginia, we have been fortunate that the Hampton Roads area, home of The Port of Virginia, has maintained an air quality designation of "attainment" until 2005 when it slipped into "non-attainment" for 8-hour ozone. Prior to 2005, much of the focus in the region has been on water quality improvements at the marine terminals with little attention to the air emission impacts from terminal operations. As a result, in 2005, when Virginia and Federal regulators approached The Port of Virginia regarding impacts from air emissions, they were surprised to learn that The Port had voluntarily developed an emissions reduction program as early as 1999.

The initial objective of the program involved implementing a series of equipment purchasing strategies to reduce fuel consumption from port operations at The Port's Hampton Roads facilities. However, as public attention and regulatory initiatives began to focus on air emissions from various industrial operations and transportation activities, the program objective was modified to include a reduction in air pollutants from cargo handling equipment. The Virginia Port Authority modeled the program in 2004 to determine if it had succeeded in meeting the reduced fuel consumption and air pollutant objectives.

IV. DISCUSSION

Background

To reduce fuel consumption and air emissions from cargo handling operations, equipment specialists at Virginia International Terminals Engineering and Maintenance department (VIT E&M) revised their equipment acquisition procedures, requiring all newly purchased off-road cargo handling equipment to meet or exceed the latest EPA emission requirements for on-road engines.

Objectives and Methodology

VIT E&M implemented the program by requiring vendors to supply the highest tier on-road engine available in the specified off-road hustlers, straddle carriers, container cranes, or rubber tired gantry cranes that VIT E&M wished to purchase. VIT E&M also reviewed their equipment inventory, identified equipment that could be replaced with cleaner burning engines, and initiated a phased replacement program.

From 2001 through 2005, 97 hustlers and 90 straddle carriers with the latest EPA low-emission on-road engines were purchased. In addition, the engines on 19 rubber tire gantry cranes were rebuilt to reduce NOx and PM_{10} emissions. A thorough review of the forklift fleet was also conducted. The total number of forklifts from 239 to 185, and replaced 87 diesel and gas burning forklifts with cleaner burning propane forklifts. The pickup truck fleet was also revamped and 80 8-cylinder pick-up trucks were replaced with smaller 4-cylinder trucks. Other emission reduction efforts included evaluating fuel ionization equipment, purchasing hybrid vehicles, and converting passenger vehicles from gas to propane.

In 2004, the Virginia Port Authority modeled the Air Emissions Reduction Program to confirm its effectiveness. The model divided the 687 pieces of cargo handling equipment operated within The Port

into four categories based on horsepower: off-road equipment greater than 25 horsepower, off-road equipment less than 25 horsepower, on-road mobile vehicles and switch engines. The operational data that was assigned to each group included the annual operating hours, the load factor and the percent of idle time. Emissions were reported in tons per year (TPY) and in TPY per 1,000 TEU to account for how mobile emissions had changed relative to annual increases in cargo volume.

How the Program Fulfills the Award Criteria

Benefits to Environmental Quality

Table 1 shows the total emission reductions achieved from 2001 to 2005 as a result of the purchasing strategies implemented by The Port of Virginia.

Table 1. Total Emissions from Port Operated Equipment, 2001-2005, (TPY)

Emission	2001	2005	Change
VOC	253	244	**-9**
CO	998	986	**-12**
NOx	1387	1334	**-53**
PM_{10}	97	91	**-6**
SO_2	185	165	**-20**

It is important to note that during this period, cargo import/export activity at The Port of Virginia increased by approximately 55% from 1.06 million TEUs in 2001 to 1.65 million TEUs in 2005. This increase in throughput at The Port resulted in increased engine operating hours and fuel consumption; however, emissions generated by The Port were lower as a result of the equipment purchasing program. Table 2 shows the percentage change in emissions normalized to reflect container throughput. The far right column shows the absolute percent change in emissions.

Table 2. Cargo Handling Equipment Emission Normalized To Container Throughput

Emission	Δ%/1,000 Containers	Δ% in Total TPY
VOC	-32%	-4%
CO	-30%	-2%
NOx	-32%	-4%
PM_{10}	-33%	-6%
SO_2	-37%	-11%

Despite double-digit growth in container volume from 2001 through 2005, VOC, CO, NOx, PM_{10} and SO_2 emissions have dropped by 4%, 2%, 4%, 6%, and 11% respectively. When the emissions are compared to the level of business, they dropped by 32%, 30%, 32%, 33%, and 37% respectively. This represents a significant reduction in emissions from VPA on-site activities despite a growth in container throughput of nearly 55% over the last five years. In addition, emissions from cargo handling activities at the three terminals contributed less than 0.6% to VOC levels and less than 1.9% to NOx levels in the 2005 Hampton Roads regional air emissions inventory.

Level of Independent Effort and Involvement by The Port

As stated earlier, the Hampton Roads area, home of The Port of Virginia, has maintained an air quality designation of "attainment" until 2005 when it slipped into "non-attainment" for 8-hour ozone. Prior to 2005, much of the focus in the region has been on water quality improvements at the marine terminals with little attention to the air emission impacts from terminal operations. Seeing how air emissions issues were beginning to affect operations and construction projects at ports located in "non-attainment areas", equipment specialists at VIT E&M voluntarily began to consider the air emission impacts associated with operations at The Port of Virginia and how they could mitigate those impacts before being mandated to do so. Thus, the Air Emission Reduction Program was created. The initial strategies have encouraged VIT E&M to develop and implement other air pollution reduction measures including evaluating fuel ionization equipment, purchasing hybrid vehicles, converting passenger vehicles from gas to propane, using Global

Positioning System (GPS) equipment, yard management software, and creating a centralized chassis pool system to reduce the number of container moves within The Port. The Port is also currently expanding the air emission modeling effort to include these new iniatives.

Creativity of the Program

Many industries and ports around the country have spent millions of dollars retrofitting equipment and building structural controls at their facilities in response to regulatory mandates and pressure from environmental interest groups and regulatory officials. VIT E&M equipment specialists developed and implemented a strategy for reducing air emissions that was neither recommended by others nor required significant capital expenditure or organizational change. The strategy was simple – achieve reductions in air pollutants in phases as replacement or additional equipment was needed by requiring vendors to supply higher-tier EPA certified on-road engines in the requested off-road equipment.

VIT E&M also reviewed their equipment inventory, identified equipment that could be replaced with cleaner burning and more efficient engines, and initiated a phased replacement program for those vehicles. Other emission reduction efforts included evaluating fuel ionization equipment, purchasing hybrid vehicles, and converting passenger vehicles from gas to propane.

Program Results

As shown in Figure 1 of the Appendix, total emissions from cargo handling equipment at The Port of Virginia have remained relatively steady since the implementation of the equipment purchasing strategy in 1999. This is significant given that cargo handling operations at The Port have increased substantially. Figure 2 of the Appendix depicts the dramatic 30% to 37% incremental reduction in VOC, CO, NOx, and PM_{10} when total annual emissions are compared to the annual number of TEUs handled at The Port from

2001 to 2004. Modeling of actual 2005 emissions in terms of TEUs is presently underway; however, preliminary projections show additional reductions of 12%, 7.6%, 1%, and 5%, for VOC, CO, NOx, and PM_{10} respectively.

Cost Effectiveness

Using equipment purchasing strategies to reduce air emissions been has cost effective in a number of ways. First, on-road engines are not only designed to have lower emissions, but they are also outfitted with a computer that controls the fuel system. This system can be programmed so that the appropriate amount of fuel is allocated to the engine based on the demand or load placed on the engine. Limits on idle time can also be programmed into the fuel system computer. All computer-controlled engines at The Port of Virginia are programmed to shut down after 15 minutes of idling. This type of control reduces air emissions and fuel consumption which in turn saves a considerable amount of money in port operating costs; especially given the current state of gasoline prices throughout the Hampton Roads region[1]. On-road engines are also warranted for two-years, while manufacturers offer only a one-year warranty for off-road engines. Longer warranties typically reduce vehicle maintenance costs. Lastly, off-road vehicles with on-road engines can be purchased at approximately the same price as off-road vehicles with off-road engines; therefore no additional costs were incurred by specifying the higher tier on-road engine. In addition, replacing 50% of The Port's 8-cylinder pick-up truck fleet with smaller 4-cylinder trucks reduced vehicle purchasing costs by $280,000 and reduced annual fuel expenditures by $10,000.

Transferability to the Port Industry

The vehicle equipment purchasing strategies that make up the Air Emissions Reduction Program at The Port of Virginia are transferable to any port or industry that operates off-road equipment or has a sizeable

[1] As of May 2006, the average price for a gallon of unleaded fuel in the Hampton Roads area was $2.78. Diesel fuel prices average approximately $2.75 per gallon.

vehicle fleet. Ports that are currently working to reduce emissions from cargo handling operations are welcome to recommend these strategies to their operating tenants. These strategies are easily implemented and, as shown, can produce significant and consistent reductions in emissions of air pollutants on an annual basis.

V. CONCLUSION

The Port of Virginia has successfully achieved a 33% reduction in air emissions over five years resulting from changes to equipment purchasing strategies. Overall, equipment purchasing and maintenance costs have been reduced as a result of smaller engines in the pick-up truck fleet and acquisition of cleaner, more fuel efficient, on-road engines with longer manufacturer warranties. As a result, The Port of Virginia Emissions Reduction Program has received significant attention from the Virginia Department of Environmental Quality and the EPA not only for its success in voluntarily reducing emissions, but also for its transferability to other industries, such as commercial construction companies, transportation authorities and large agricultural entities that have sizeable operating equipment and vehicle fleets. The Port of Virginia will continue to implement these purchasing strategies and will strive to develop and model new measures for improving air quality at its terminals in the future.

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APPENDIX

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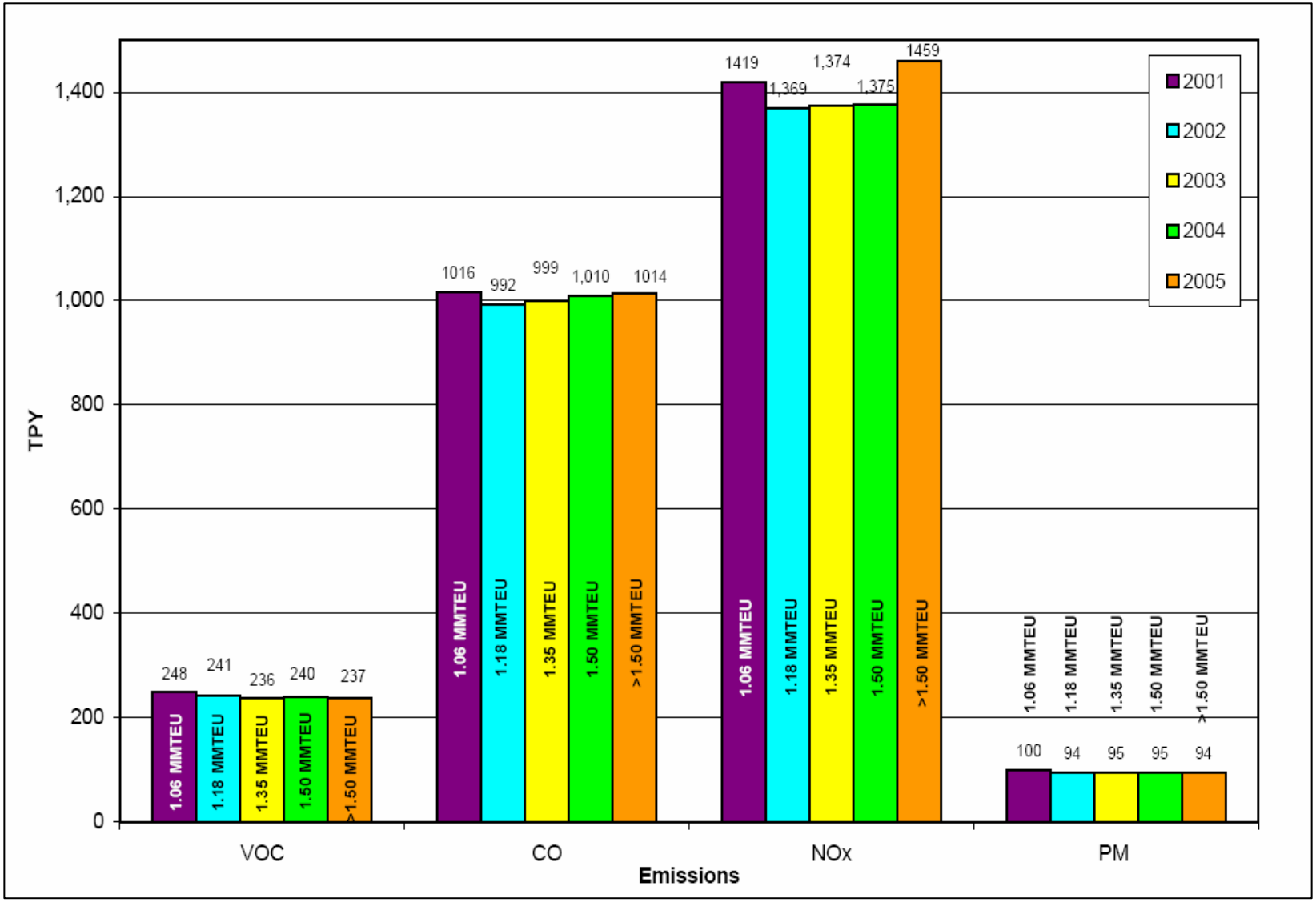

Figure 1. VPA Total Emissions (TPY), 2001 to 2005

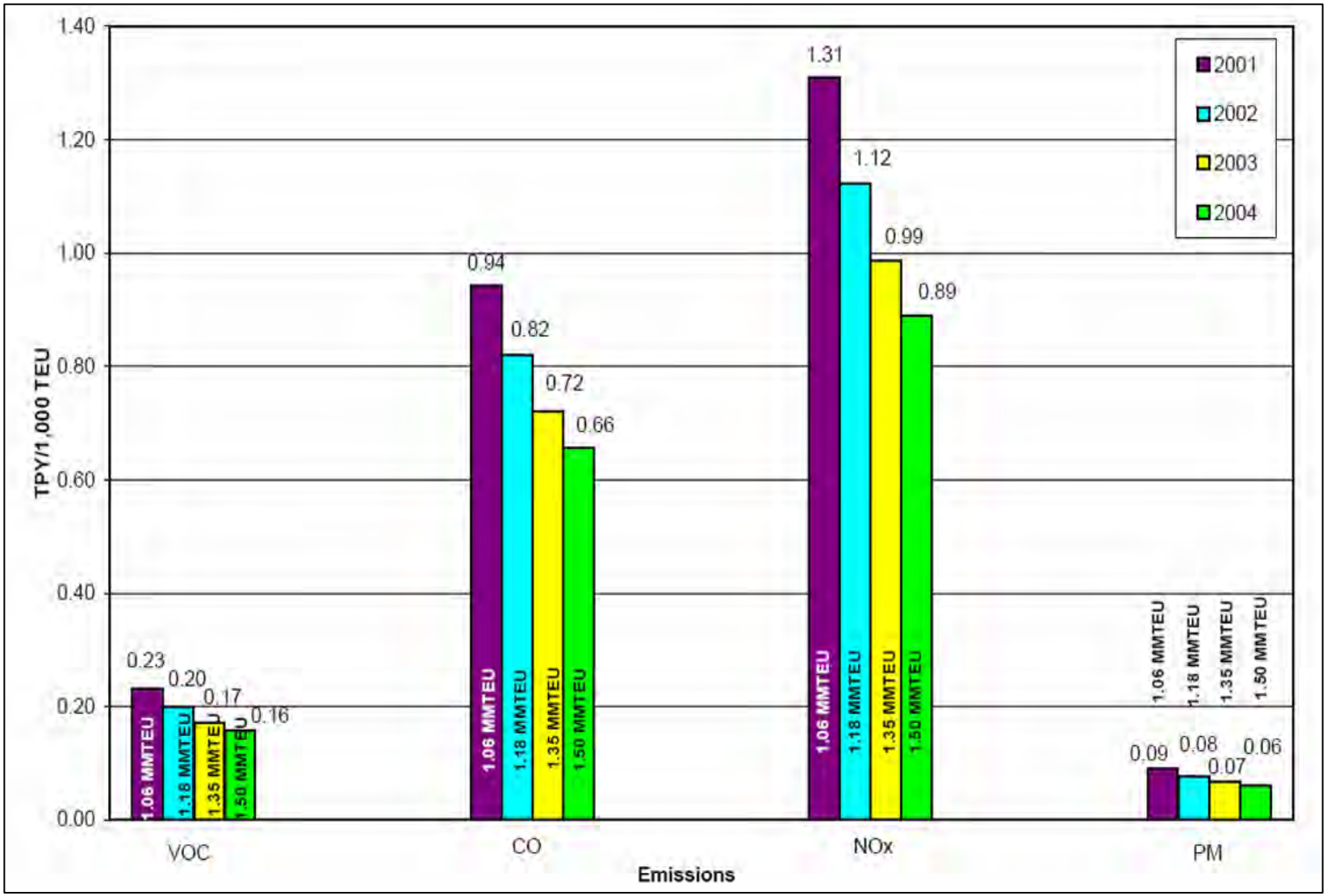

Figure 2. VPA Emissions Per TEU (TPY), 2001 to 2004