



**The Gateway Cities Fleet Modernization Program:
Cleaner Heavy-Duty Trucks for Port and Goods Movement Applications**

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Reference: D0410

FFCA 2007: Gateway Cities Program *Agenda*

- 1 Overview of the Gateway Cities Program
- 2 Relationship to the San Pedro Bay Ports CAAP
- 3 Retrofit Opportunities and Challenges
- 4 Summary and Conclusions



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The Gateway Fleet Modernization Program facilitates a 3-step process to reduce emissions from **in-use** heavy-duty diesel vehicles



Step 1: Capture /scrap older truck



Step 2: Replace with newer truck
(Newer truck emits ~35% less NOx and ~80% less PM)



Step 3 (optional): Retrofit PM-control
(Reduces replacement truck's PM by ~85%, w/ option for 25% NOx reduction)



- **Key premise:** truckers with oldest vehicles can't afford newer, cleaner trucks
- Fleet mod helps replace pre-control trucks with more modern, electronic-controlled trucks
 - Incentive-based, voluntary program
 - Trucker / awardee pays about 25 to 30 percent of total replacement truck's cost
 - Old truck engine / chassis are destroyed
- Allows site- and vocation-specific targeting, e.g.:
 - **POLA:** focus on frequent-haul container trucks
 - **MSRC:** focus on "Goods Movement" vocation
- Facilitates "capture" of MY 1994 to 2006 trucks for emissions upgrades and retrofitting of DECS
- AQ benefits: compelling and cost effective
- Other benefits also realized, e.g.:
 - Improved reliability and safety
 - Trucker reduces annual fuel costs (~35%)



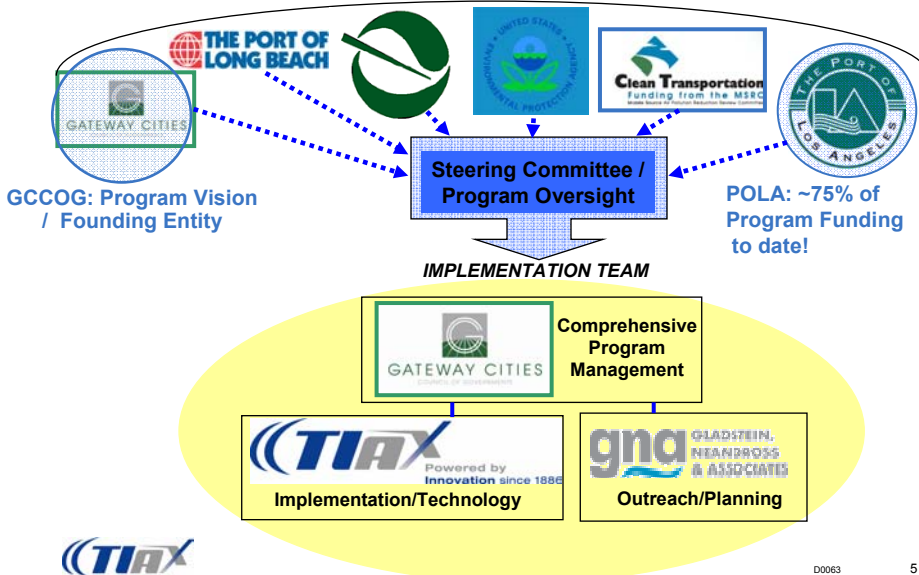
A pre-1987 Gateway Cities truck undergoing scrappage process



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The Program includes oversight and/or funding from 6 government entities . . .



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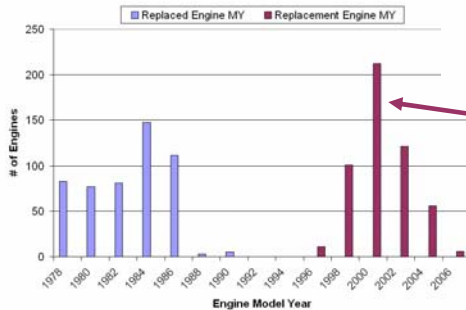
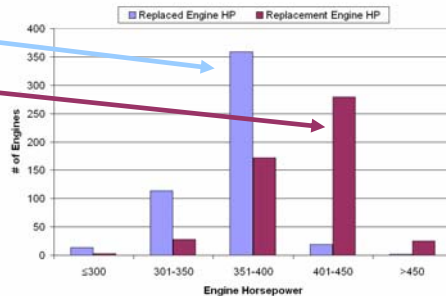
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- Program began in September 2002 (~4.5 years)
- Approximately \$17 million in grant funds have been expended to replace **529** older trucks (mostly pre-1987 MY)
 - **\$12.8 million / 377 trucks – special program funded by the Port of Los Angeles**
 - **\$4.2 million / 152 trucks** - original program funded by ARB, EPA and MSRC (includes latest infusion of \$1.75 million from MSRC)
- All replacement trucks now receive installation of GPS-based “Automatic Vehicle Locator” (AVL) device
- Program enhancements are ongoing, customized to the needs of each individual funding agency, e.g.:
 - Formula for calculating grant awards
 - Adoption of latest emissions factors
 - Tailoring of aftertreatment options
- POLA-funded program is being transitioned into larger-scale HDV-1 of San Pedro Bay Ports CAAP
- “Bridge” funding is now being allocated for this transition
 - \$1.7 million from POLA (50% of expected allocation)
 - POLB funding is under consideration



Trends for 529 Replaced (Old) and Replacement (Newer) Trucks

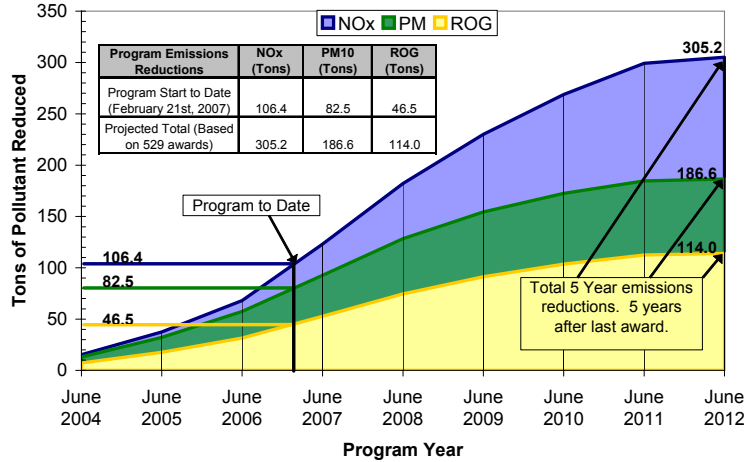
- Replaced trucks (pre-1987) are dominated by Cummins Big Cam engines at 350 to 400 HP
- Replacement trucks (1994 and newer) mostly have 400 to 450 HP engines (e.g., DDC S60)
- “De-rating” replacement truck’s HP is frequently necessary to maintain HP rating within 20% of original truck



- Most common engines for replacement trucks have been MYs 2000, 2001 (affordable)
- 2004+ MY engines becoming more popular as truck prices drop; EGR engines exhibit improved cost effectiveness / higher awards
- Some Level 1 retrofits have been implemented on replacement trucks (with mixed results)



**Gateway Cities Clean Air Pilot Program Emissions Reductions
(All Gateway Awards to Date, 529 Trucks)**



- Provides a snapshot of the current program status (assumes no further awards are made)
- Estimates are based on mileage estimates for all replacement trucks using **EMFAC '07**



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All Gateway Cities Replacement Trucks Receive an Automatic Vehicle Locator (AVL)

- Purpose:
 - Automatically monitor vehicle usage by air basin (SCAB) and POLA boundaries
 - Help ensure emissions benefits are **Real, Surplus, Verifiable and Permanent**
 - Eliminate need for participants to self-report mileage
- Logistics:
 - Installed on replacement trucks at dealership by vendor's authorized technician
 - Truck usage data automatically transmitted to vendor
 - Summarized data provided to Gateway Cities CCOG (TIAX) on monthly basis

Important Note: Only parameters affecting the program's air quality benefits are monitored. No "real-time" monitoring is conducted by the GCCOG (unless vehicle theft or safety are involved).

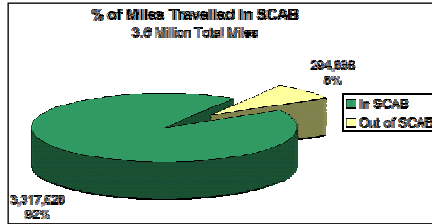


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Experience with AVLS (aka “EMUs”)

- 230 replacement trucks with AVLS have logged 3.6 million miles
- Strong compliance with requirement for 85% of miles in the SCAB (aggregate)
- AVLS important to help monitor/address:
 - Trucker “vocation jumping”
 - Unusual vehicle downtime
 - Vehicle theft



Use of AVLS also entails significant challenges, e.g.:

- Timeliness and accuracy of data from vendor
- Data management and reporting to agencies
- Geo-fencing in micro-areas (e.g., port boundaries)

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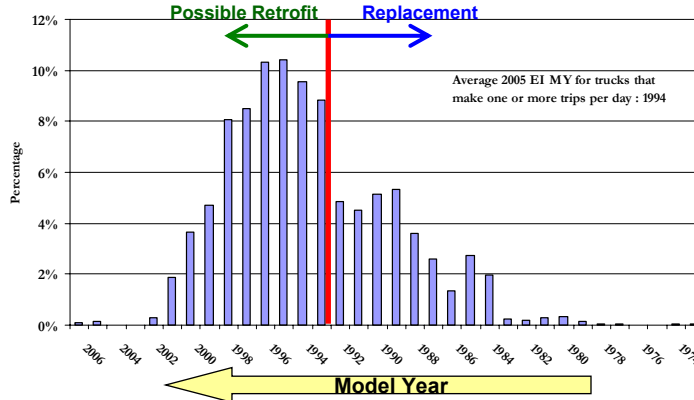
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CAAP Control Measure HDV-1: Replace or Retrofit *Thousands of Port Trucks*

- MY 1992 and older trucks to be **replaced** with new port trucks meeting 2007 emissions standards (both diesel and LNG technologies)
- MY 1993 to 2006 trucks (as many as possible) will be **retrofitted** w/ verified Diesel Emissions Control Strategies
 - Focus: “BACT” Level 3 device that provides 85% PM / 25% NOx reductions



Source: Final 2006 San Pedro Bay Ports Clean Air Action Plan Technical Report

To accomplish these preliminary goals under HDV-1 of the CAAP:

“The current Gateway Cities truck modernization program will be refocused (or a new program developed) to allow only the purchase of new cleaner diesel and alternative fueled trucks, as well as retrofits that meet the proposed . . . (emissions) standards.”

--San Pedro Bay Ports Clean Air Action Plan

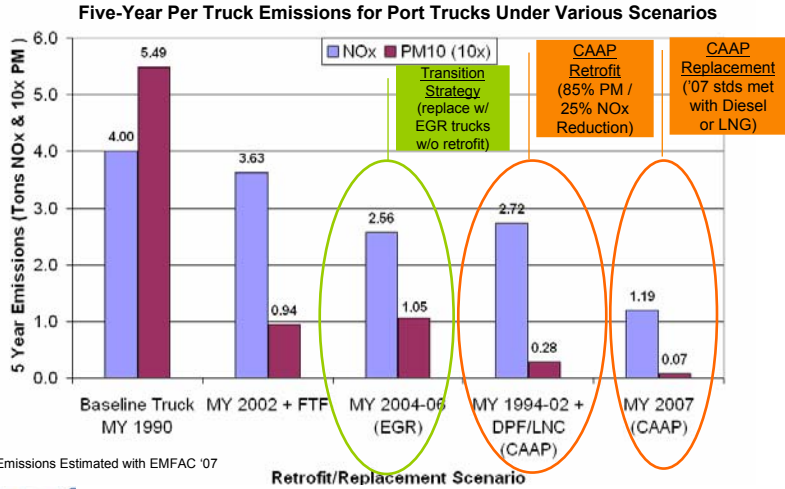
“The Ports (will) begin this program with an infusion of cash to the Gateway Cities Program that would fund a 500-truck program (demonstrating) the applicability of new retrofit technologies. This demonstration program will be activated in the 1st quarter of 2007, and the full 16,800-truck program will be rolled out shortly thereafter.”

--Motion approved with CAAP by both Harbor Commission Boards



FFCA 2007: Gateway Cities Program *Relationship to SPBP Clean Air Action Plan (cont'd)*

- The CAAP seeks replacement / retrofit scenarios that maximize PM10 and NOx reductions
- The Gateway team has assessed and recommended a strategy that can best transition current POLA-funded Gateway program into HDV-1 of longer-term CAAP



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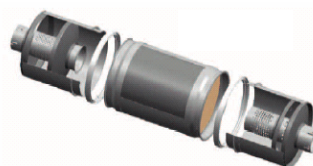


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General Suitability Tests for Retrofitting On-Road HDVs

- Considerations and selection criteria include:
 - Is there a CARB-verified device for the engine make/model year?
 - Are NOx reductions sought in addition to PM reductions?
 - Does engine have EGR, for which no passive DPF is currently verified?
 - Does duty cycle / application generate sufficient exhaust temperatures for a **passive DPF**? If not, can an **active DPF** work? Or, would a **Level 2 flow-through filter** be better for the application?
 - Are there horsepower restrictions? Does truck have dual exhaust?
 - Is targeted end user group likely to properly use / maintain device?
 - Can end user afford higher operational costs (e.g., maintenance, fuel economy penalty)?
- Additional considerations for retrofits:
 - Infrastructure requirements
 - Failure mode of the device
 - Variability of driver workload and duty cycle



Internal view of a DPF



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Specific challenges for retrofitting container port trucks include:

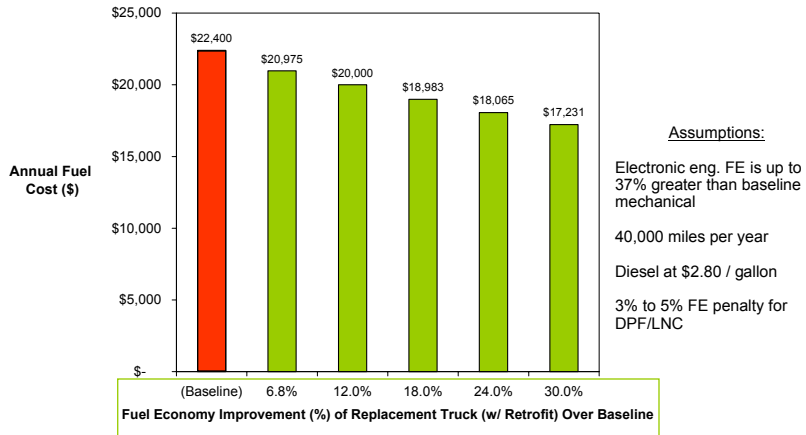
- Average daily mileage varies among drivers (from 50 to 300 miles per day)
- Driver's cargo and load constantly change (20,000 – 80,000 lbs GCWV)
 - 20' vs. 40' containers
 - Bobtailing (tractor with no trailer) or returning empty containers
- Workloads can change seasonally
- Drivers may change carriers, drive for multiple carriers, drive part-time to the Ports, and/or temporarily leave for another trucking vocation
- Engine may not be properly maintained
- **These factors affect exhaust temperatures and/or PM generation rates of the engine, which partly dictate viability of a given retrofit device**
- **Special Consideration:** Port truckers can least afford higher operational costs that may result from retrofitting an existing truck



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Fuel costs to Trucker, Scenario 1: old truck replaced w/ new truck that gets DPF / LNC retrofit at POS

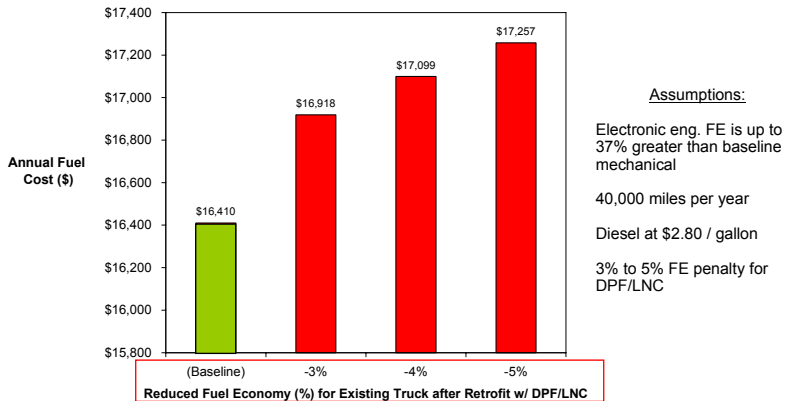


- Replacement truck's electronic engine is much more fuel efficient, easily negating 3% to 5% fuel efficiency penalty associated with DPF / LNC retrofit (**7% to 30% net increase** compared to old truck)
- Trucker gets immediate reduced annual fuel costs (\$1,400 to \$5,200), plus a safer, more-reliable rig
- **Upshot:** benefits of newer truck take "sting" out of DPF/LNC retrofit (added fuel, maintenance costs)



Fuel Costs to Trucker, Scenario 2 - existing MY '93 to '02 truck gets mandatory DPF / LNC retrofit

Under this scenario, incentives and outreach for independent truckers will be essential!



- Existing truck gets relatively good FE (electronic engine), but retrofit causes 3% to 5% FE penalty
- Trucker's annual fuel costs increase (\$500 to \$850), and he/she faces add'l costs for DPF maintenance
- **Upshot:** trucker pays more with no obvious personal benefit



Verified device coverage of engines and model years typically serving the Ports

■ Active & Passive systems verified
 ■ Passive system verified
 ■ Active system verified
 ■ No system verified

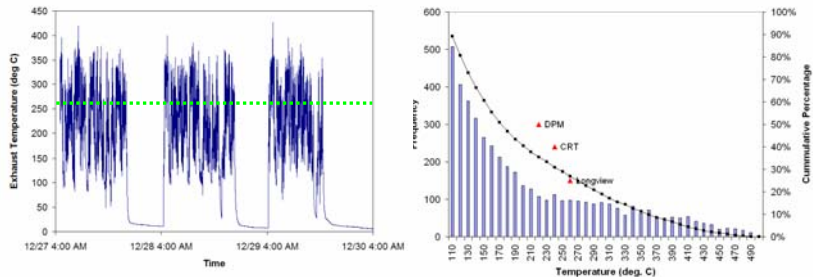
Make	Model	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Cummins	ISM	■	■	■	■	■	■	■	■	■	■	■	■	■
	N14	■	■	■	■	■	■	■	■	■	■	■	■	■
	ISX	■	■	■	■	■	■	■	■	■	■	■	■	■
Caterpillar	3406E	■	■	■	■	■	■	■	■	■	■	■	■	■
	C11	■	■	■	■	■	■	■	■	■	■	■	■	■
	C12	■	■	■	■	■	■	■	■	■	■	■	■	■
	C13	■	■	■	■	■	■	■	■	■	■	■	■	■
	C15	■	■	■	■	■	■	■	■	■	■	■	■	■
Detroit Diesel	S60-11.1	■	■	■	■	■	■	■	■	■	■	■	■	■
	S60-12.7	■	■	■	■	■	■	■	■	■	■	■	■	■
	S60-14.0	■	■	■	■	■	■	■	■	■	■	■	■	■
	MBE4000	■	■	■	■	■	■	■	■	■	■	■	■	■

- Many '94 – '02 engines can theoretically utilize currently verified passive or active systems
- **Real-world considerations:**
 - Applicability of passive DPF depends on exhaust temps, engine condition, EGR, etc.
 - Active DPF systems that regenerate with electrical power (e.g., Cleaire Horizon) require access to power outlets; this currently excludes most port haulers
 - Active DPF system that uses fuel burner (Huss) has size restrictions; for typical engines used in container trucks, this currently costs about 3 times more than a passive DPF






TIAX's exhaust temperature testing effort of port trucks for POLA / POLB

- **Objective:** determine if container trucks generate enough exhaust heat to meet verification requirements of **passive DPF systems** (especially Longview DPF / LNC)
- **Test Plan:** data log 30 trucks (MY '93 to '06, various engine makes, models, etc.)
- **Test Parameters:** mileage, exhaust temperature, driver workload (survey), engine on/off time (estimated)
- **Results to Date:** 28 port trucks have been successfully datalogged
- **Preliminary Conclusion:** Longview's "semi-passive" DPF system can work for a large percentage of port trucks, with careful screening



Example raw exhaust temperature data and histogram showing viability of verified DPFs

TIAX measured temp. losses along the exhaust pipe of one Class 8 Tractor

Turbo Outlet	1995 Freightliner w/DDC S60 Engine	Muffler Inlet
		
Temperature Range: 11 – 482 °C	Approx. 12 ft. of non-insulated exhaust piping.	Temperature Range: 10 – 430 °C



- Container trucks typically have sleeper cabs, resulting in extra-long exhaust piping
- On average, there was a 36 °C loss along the non-insulated exhaust pipe
- **Turbo Outlet:** 31% of time above 260 °C → **Muffler Inlet:** 26% of time above 260 °C
- **Conclusions:** heat loss is significant, and exhaust pipe insulation would be beneficial in some cases; but this is probably not a practicable solution for port trucks
- **Key to retrofit of passive DPFs:** proper screening of port trucks (daily mileage, etc.)



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FFCA 2007: Gateway Cities Program *Summary and Conclusions*

- The Gateway Cities Fleet Modernization program continues to successfully reduce emissions from in-use heavy-duty trucks used in port and goods movement applications
 - 529 trucks replaced (and counting)
 - Approximately 235 tons of NOx / PM / ROG reduced to date (and counting)
- Provides important opportunity to “capture” replacement trucks for upgrades (e.g., low-NOx reflash) and retrofitting of a CARB-verified DECS)
- A new infusion of funding is being received from the Ports, to transition into the larger-scale program envisioned under the San Pedro Bay Ports CAAP
 - **REPLACE** oldest trucks with new trucks meeting ‘07 emissions standards (diesel and LNG)
 - **RETROFIT** suitable existing port trucks with DPF / LNC system to approach ‘07 standards
- Retrofitting of port trucks brings significant challenges, which are now being addressed
- “BACT” DPF w/ LNC appears to be viable for large-scale retrofit effort, with application of:
 - ✓ Screening tools to ID trucks with most-conductive duty cycle, etc.
 - ✓ Outreach and incentive programs for the affected population of port truckers
- Active DPF systems (plug in, fuel combustor, fuel-borne catalyst) are not yet readily available and feasible for **retrofitting** onto most trucks (note: this could change quickly)
- The Gateway program will continue to evolve to meet the needs of specific funding agencies such as the San Pedro Bay Ports



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FFCA 2007: Gateway Cities Program *Summary and Conclusions (continued)*

Thank You For Your Attention!



TIAX wishes to thank the following key program supporters:

- Gateway Cities Council of Governments
- Port of Los Angeles
- Port of Long Beach
- U.S. EPA
- Cal EPA / CARB
- Mobile Source Air Pollution Reduction Review Committee (MSRC)

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