



Quantifying Reductions from Retrofit Projects – NMIM Examples

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Summary

- Overview of EPA verified technology list
- Retrofit parameter files vs. fleet information files
- Two examples of retrofit projects
 - Intended only as examples of the use of NMIM to quantify retrofit reductions
 - Not an endorsement of any particular product
 - Not intended as a comprehensive analysis of all SIP and conformity policy issues that may arise for any particular project



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Verified Technology List

This table summarizes all the diesel retrofit technologies that the U.S. Environmental Protection Agency (EPA) has approved for use in engine retrofit programs. Select the manufacturer link to learn more about the retrofit technology and its operating criteria. The table shows the percent reduction (of verified or tested levels) that EPA will recognize for emission reductions for each technology.

See the [retrofit manufacturers contact](#) page for more information on these manufacturers.

- Key Topics:**
- [Technology](#)
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Verified Retrofit Technologies						
Manuf.	Technology	Applicability	Reductions (%)			
			PM	CO	NOx	HC
Caterpillar, Inc.	Catalyzed Converter/Muffler (CCM)	Highway, heavy-heavy and medium-heavy duty, 4 cycle, non-EGR, model year 1998 - 2003, turbocharged or naturally aspirated engines	20	20	na	40
Caterpillar Inc.		Nonroad, 4 cycle, non-EGR equipped, model year 1996-2005, turbocharged engines with	--	--		--

Example of information on EPA verified retrofit technologies list

<http://www.epa.gov/otaq/retrofit/retroverifiedlist.htm>

Verified Retrofit Technologies						
Manuf.	Technology	Applicability	Reductions (%)			
			<u>PM</u>	<u>CO</u>	<u>NOx</u>	<u>HC</u>
Lubrizol	PuriNOx Water emulsion fuel	Highway & Non-road, heavy-duty, 2 & 4 cycle	16 to 58	-35 to 33	9 to 20	-30 to - 120
Paceco Corporation	MES diesel particulate filter (MES-DPF)	Pre-1996 nonroad, 4-cycle, heavy-duty diesel engines in the 225 - 450 kW (NR7) power range in electrical generation applications	39	90	N/A	95
Various	Biodiesel (1 to 100%)	Highway, heavy-duty, 2 & 4 cycle	0 to 47	0 to 47	0 to - 10	0 to 67
Various	Cetane Enhancers	Highway, heavy-duty, 4 cycle, non- EGR-equipped engines	n/a	n/a	0 to 5	n/a



Retrofit parameter files vs. fleet information files

- In the NMIM interface (“GUI”), you specify the counties, pollutants, vehicle classes, etc, that you want to model
- When you add a retrofit parameter file alone, NMIM reduces the emissions of a specified fraction of the entire fleet in the area modeled.
 - Example – if retrofit parameter file says 20% of buses are retrofit, output will show total emissions of all buses in area assuming 20% are retrofitted
- When you also add a fleet information file, NMIM assumes that is the entire fleet for the area
 - Example – if fleet information file says there are 30 buses, output will show total emissions for a fleet of 30 buses
- Fleet information file allows for finer scale analysis of individual projects



Example 1 – Retrofit 30 transit buses

- What technology is being used?
 - This determines the pollutants affected and the amount of reduction
- Fleet-specific or fleet-wide?
 - Fleet-specific – you know how many vehicles and their average activity
 - Need retrofit parameters file and fleet information file
- What input information do we need and where do we get it?



Example 1 – Retrofit 30 transit buses – Retrofit parameters

- What pollutants are affected by the retrofit project?
 - See verified technologies list for the pollutants affected by specific technology
- What vehicle or engine classes are affected?
 - Need to verify that the retrofit technology is applicable to those vehicle or engine classes on the verified technologies list
 - Example – Transit buses are vehicle class HDDBT



Example 1 – Retrofit 30 transit buses - Retrofit parameters

- What are the initial and final calendar years (CY) of retrofit implementation?
 - Example – the retrofits will be installed on the transit buses over a 2 year period beginning in 2007
 - Initial CY = 2007, final CY = 2008



Example 1 – Retrofit 30 transit buses - Retrofit parameters

- What are the initial and final model years (MY) that will be retrofit?
 - Need to verify that the retrofit technology is applicable to those model years on the verified technologies list
 - Example – The transit bus engines that will be retrofitted are model years 2000 to 2003
 - Initial MY =2000, final MY =2003



Example 1 – Retrofit 30 transit buses - Retrofit parameters

- What percentage of the fleet is retrofit per year?
 - Example – 50% are retrofitted in 2007 and 50% in 2008
 - Make sure the total does not exceed 100%



Example 1 – Retrofit 30 transit buses - Retrofit parameters

- What is the percentage effectiveness of the retrofit?
 - See verified technologies list for the effectiveness of the specific technology
 - Example – the technology provides a 30% reduction in PM, a 5% reduction in NOx, and a 50% reduction in HC



Example 1 – Retrofit 30 transit buses - Retrofit parameters

■ Example retrofit parameters file:

```
Program, Poll, Vclass, RetCYBeg, RetCYEnd, MYStart, MYend,  
    % retrofit per year, % effectiveness  
1, ECARBON, HDDBT, 2007, 2008, 2000, 2003, 50, 30  
1, OCARBON, HDDBT, 2007, 2008, 2000, 2003, 50, 30  
1, SO4, HDDBT, 2007, 2008, 2000, 2003, 50, 30  
1, NOX, HDDBT, 2007, 2008, 2000, 2003, 50, 5  
1, HC, HDDBT, 2007, 2008, 2000, 2003, 50, 50
```



Example 1 – Retrofit 30 transit buses – Fleet information

- What vehicle or engine classes are affected?
 - Should include classes you entered in retrofit parameters file
 - Onroad fleet bug – Fleet information file must include all vehicle classes specified in NMIM GUI. See NMIM handout for details.
 - Example – must include an entry for school buses; just enter 0 for number of vehicles and mileage



Example 1 – Retrofit 30 transit buses – Fleet information

- What model years are in the fleet?
 - Should be within the range of model years you entered in retrofit parameters file
 - Example – transit fleet has engines from model years 2000, 2001, and 2003



Example 1 – Retrofit 30 transit buses – Fleet information

- How many retrofitted vehicles in each vehicle class and model year are in the fleet?
 - Example – the retrofitted transit bus fleet consists of 15 MY 2000 engines, 10 MY 2001 engines, and 5 MY 2003 engines
- Do you expect attrition in these numbers by the analysis year?
 - If so, adjust the fleet information file to reflect this
 - Example – transit agency expects to retire MY 2000 engines in 2012, so no effect on an analysis for 2009, but retrofitted population is reduced after 2012



Example 1 – Retrofit 30 transit buses – Fleet information

- What is the annual average mileage of these vehicles by class and model year?
 - Example – All model years are averaging 45,000 miles per year
- Do you expect the average mileage to change by the analysis year?
 - Example – Transit agency may use oldest buses on lower mileage routes



Example 1 – Retrofit 30 transit buses – Fleet parameters

- Example fleet information file:

Vehicle Class Name, Model Year, Number of Vehicles,
Average Annual Mileage

HDDBT,2000,15,45000

HDDBT,2001,10,45000

HDDBT,2003,5,45000

HDDBS,1995,0,0

- Last line is a dummy entry for school buses to avoid onroad modeling bug



Example 1 – What does my output mean?

- NMIM output from a fleet-specific run is the total emissions for that particular fleet of vehicles in the year specified in NMIM
 - Example – NMIM output using these files would be the total emissions of the specified fleet of 30 transit buses that had been retrofitted as described
- To calculate the reductions that result from the retrofit project, run NMIM again with the retrofit effectiveness set to zero for each pollutant or don't use retrofit parameters file



Example 1 - Replacement project variation

- Transit agency decides to replace 15 MY 2000, 10 MY 2001, and 5 MY2003 engines with 30 MY 2008 engines
- Change retrofit effectiveness to zero or don't use file:

```
Program, Poll, Vclass, RetCYBeg, RetCYEnd, MYStart, MYend, %  
retrofit per year, % effectiveness  
1, ECARBON, HDDBT, 2007, 2008, 2000, 2003, 50, 0  
1, OCARBON, HDDBT, 2007, 2008, 2000, 2003, 50, 0  
1, SO4, HDDBT, 2007, 2008, 2000, 2003, 50, 0  
1, NOX, HDDBT, 2007, 2008, 2000, 2003, 50, 0  
1, HC, HDDBT, 2007, 2008, 2000, 2003, 50, 0
```



Example 1 - Replacement project variation

■ Base case fleet information file:

Vehicle Class Name, Model Year, Number of Vehicles, Average Annual Mileage

HDDBT,2000,15,45000

HDDBT,2001,10,45000

HDDBT,2003,5,45000

HDDBS,1995,0,0

■ Control case fleet information file:

Vehicle Class Name, Model Year, Number of Vehicles, Average Annual Mileage

HDDBT,2008,30,45000

HDDBS,1995,0,0

■ Difference between two runs is the replacement reduction

- Based on previous example, no reduction for replacement of MY 2000 bus engines after 2012



Example 2 – Modeling a fleet-wide fuel technology

- Fleet-specific or fleet-wide?
 - Is the fuel widely sold to the general public or only to specific captive fleets?

 - Can you accurately quantify the number of vehicles and their activity?



Example 2 – Modeling a fleet-wide fuel technology

- Assume that it is a fleet-wide project with vehicles from all onroad heavy duty vehicle classes using the fuel
 - Need to create only a retrofit parameter file
- What inputs do we need and where do we get them?



Example 2 – Modeling a fleet-wide fuel technology

- What pollutants are affected by the retrofit project?
 - Verified technologies list
- What vehicle or engine types are affected?
 - Verified technologies list for any restrictions on vehicle classes since the fuel is widely available in this example
 - For a fleet-specific project you would specify the vehicles or engines getting the fuel, within the limits of what is covered by the verified technologies list



Example 2 – Modeling a fleet-wide fuel technology

- What are the initial and final years of retrofit program?
 - **Very important!** - for a fuel program in NMIM, set initial and final year to the same year to avoid complications with input for percentage of fleet retrofit per year
 - Example – Expect fuel on verified retrofit technology list to be 10% of fuel used beginning in 2007. Set initial and final years to 2007 in NMIM, and percentage of the fleet retrofit to 10%.



Example 2 – Modeling a fleet-wide fuel technology

- What are the initial and final model years that will be retrofit?
 - Verified technologies list for any restrictions on model year coverage since the fuel is widely available in this example
 - Could be all model years in fleet prior to MY 2007



Example 2 – Modeling a fleet-wide fuel technology

- What is the percentage of the fleet retrofit per year?
 - For a fleet-wide fuel program, some portion of the fleet is expected to be using this fuel in the analysis year
 - Might base that on projected percentage of “retrofit” fuel as a fraction of total fuel sold in the analysis year
 - For any fuel program, make sure initial and final calendar years are set to the same year for NMIM modeling



Example 2 – Modeling a fleet-wide fuel technology

- What is the percentage effectiveness of the retrofit?
 - Verified technologies list



Example 2 – What does my output mean?

- NMIM output from a fleet-wide run is the total emissions for the entire fleet of vehicles in the classes, geographic area, and year specified in the NMIM GUI
 - Example – If you specified all counties in the nonattainment area in the NMIM GUI, you would get emissions for the entire diesel fleet in the nonattainment area
- To calculate the reductions that result from the retrofit project, run NMIM again with the retrofit effectiveness set to zero for each pollutant



Nonroad modeling differences

- Either example could apply to nonroad, but nonroad equipment classes and engine types are more complicated
 - Source Classification Code (SCC) for each equipment type retrofitted
 - <http://www.epa.gov/ttn/chief/codes/index.html>
 - Horsepower
 - Model year
 - Technology type – can enter “all” if tech type is unknown
- Use monthly allocation table to model seasonal variation if appropriate and if data are available