

MODELING “ADDITIONAL” AIR TOXICS IN MOVES

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“Major” Air Toxics

- Benzene, formaldehyde, acetaldehyde, acrolein, 1,3-butadiene, ethanol
- Subject of previous presentations
- For gasoline vehicles, model uses algorithms that calculate toxic to VOC ratios based on various fuel parameters and vehicle technology
- For diesel vehicles, ratios vary by control technology but not fuel properties

“Additional” Air Toxics

- Other gaseous hazardous air pollutants (HAPs)
 - Toxic to volatile organic compound (VOC) ratios
- Polycyclic aromatic hydrocarbons (PAHs)
 - PAH/VOC ratios for gas-phase PAHs
 - PAH/OC_{2.5} ratios for particle-phase PAHs
- Metals
 - Emission rates applied to VMT
- Dioxins and Furans
 - Emission rates in toxic equivalents (TEQs) applied to VMT

Changes from MOVES 2010b

- Includes E15, E20, E85
 - MOVES 2010b included only E0 and E10
 - Gasoline vehicle PAH emissions from 2008 Kansas City Study
 - Replace older data from 1998 CE-CERT Study
 - Gasoline vehicle metal emissions (except mercury) from Kansas City Study
 - Replace older data from Ball, 1997
 - Dioxin emissions from recent EPA test program

Gaseous HAPs

2,2,4-Trimethylpentane
Ethyl Benzene
Hexane
Propionaldehyde
Styrene
Toluene
Xylenes
MTBE

Gaseous Exhaust HAPs

- Pre-Tier 2 vehicles still use data from early 1990's Auto/Oil test program
- Tier 2 and later vehicles rely on EPAAct data
 - E0, E10, and E15 use Phase 1 data
 - E20 and E85 use Phase 3 data
- Ratios do not vary for start and running

Diesel Gaseous Exhaust HAPs

- Unchanged from MOVES2010b
 - Pre-2007 from CRC E-75 database of HAP emissions from diesels
 - 2007 and later from HEI ACES
 - Ratios do not vary for start and running

Evaporative and Permeation HAPs

- E₀ and E₁₀ unchanged from MOVES 2010b
 - Evaporative from Auto/Oil and permeation from CRC E-77 program
- No data for E₁₅
 - Fuel speciation data used to adjust E₁₀ evaporative emissions speciation
 - E₁₅ permeation interpolated from E₁₀ and E₂₀ permeation
- E₂₀
 - Evaporative from E₂₀ fuel speciation in EPAAct
 - Permeation from CRC E-77-2c test program
- E₈₅ – Auto/Oil evaporative data used for both evaporative and permeation emissions
- Diesels – spillage emissions from toxic to VOC ratios based on diesel headspace profile from SPECIATE

PAHs

Acenaphthene
Acenaphthylene
Anthracene
Benz(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Chrysene
Dibenzo(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3,c,d)pyrene
Naphthalene
Phenanthrene
Pyrene

Gasoline PAHs

- PAH/VOC ratios for gas-phase PAHs same for start and running
- PAH/OC_{2.5} start and running ratios differ for particle-phase PAHs
- Gasoline vehicle emission rates updated using data from Kansas City test program
 - Data used for both gas/particle phase partitioning and emission factors
 - Although partitioning varies with temperature, partitioning at 47 C was used for all emissions modeling
- Emission ratios do not vary for E0, E10, E15, E20
 - E85 emission ratios estimated by multiplying E0 ratios by fraction of gasoline in E85

Diesel PAHs

- PAH/VOC ratios for gas-phase PAHs same for start and running
- PAH/OC_{2.5} start, running, and extended idle ratios differ for particle-phase PAHs
- Gas/particle phase partitioning for diesels unchanged from MOVES2010b and based on data from Schauer et al., 1999
 - Does not vary by temperature, concentration or other factors in MOVES
- PAH ratios unchanged from MOVES2010b
 - Pre-2007 – CRC E-75
 - 2007 and later – ACES
 - PAH ratios for post-2007 engines much lower

Metals

Mercury (elemental gaseous)
Mercury (divalent gaseous)
Mercury (particulate)
Arsenic compounds
Chromium (Cr3+)
Chromium (Cr6+)
Manganese
Nickel

Gasoline Metals

- Gasoline vehicles
 - Chromium, magnesium and nickel emission rates from Kansas City test program
 - 18% of chromium assumed hexavalent
 - Based on turbine engine combustion data
 - Mercury rates from 2005 EPA test program
 - Arsenic from 2006 et al. Schauer study
 - Emission rates do not vary for E0, E10, E15, E20
 - E85 emission rates estimated by multiplying E0 rates by fraction of gasoline in E85

Metals

- Diesel Vehicles
 - Unchanged from MOVES2010b
 - Chromium, magnesium, nickel
 - Pre-2007 data from CRC E-75
 - 2007 and later from ACES
 - 2007 and later emission rates are much lower
 - Mercury and arsenic from same studies as gasoline

Dioxins

2,3,7,8-Tetrachlorodibenzo-p-Dioxin
1,2,3,7,8-Pentachlorodibenzo-p-Dioxin
1,2,3,4,7,8-Hexachlorodibenzo-p-Dioxin
1,2,3,6,7,8-Hexachlorodibenzo-p-Dioxin
1,2,3,7,8,9-Hexachlorodibenzo-p-Dioxin
1,2,3,4,6,7,8-Heptachlorodibenzo-p-Dioxin
Octachlorodibenzo-p-dioxin
2,3,7,8-Tetrachlorodibenzofuran
1,2,3,4,6,7,8-Heptachlorodibenzofuran
1,2,3,4,7,8,9-Heptachlorodibenzofuran
1,2,3,4,7,8-Hexachlorodibenzofuran
1,2,3,6,7,8-Hexachlorodibenzofuran
1,2,3,7,8,9-Hexachlorodibenzofuran
1,2,3,7,8-Pentachlorodibenzofuran
2,3,4,6,7,8-Hexachlorodibenzofuran
2,3,4,7,8-Pentachlorodibenzofuran
Octachlorodibenzofuran

Dioxins -- Gasoline

- Gasoline vehicle dioxin emission rates based on same data as MOVES2010b
 - 1996 API tunnel study (used in EPA dioxin assessment)
 - However, emission rates updated to use World Health Organization 2005 toxic equivalency factors (TEQs)
- Emission rates do not vary for E0, E10, E15, E20
 - E85 emission rates estimated by multiplying E0 rates by fraction of gasoline in E85

Dioxins -- Diesel

- Data from recent EPA test program replace MOVES2010b emission rates from API tunnel study
- Emission rates for:
 - Pre-2007 (testing on 3 engines)
 - 2007 to 2009 (engine with oxidation catalyst plus catalyzed particulate filter)
 - 2010 and later (added copper zeolite plus selective catalyst reduction, and urea and ammonia slip catalyst)
- Emission rates much lower than MOVES2010b
 - Pre-2007 rates one to two orders of magnitude lower than MOVES2010b.
 - 2007 and later emission rates one to two orders of magnitude lower than pre-2007.