MOVES Fleet & Activity Inputs 1999 Base Year

FACA Modeling Workgroup

December 2, 2003

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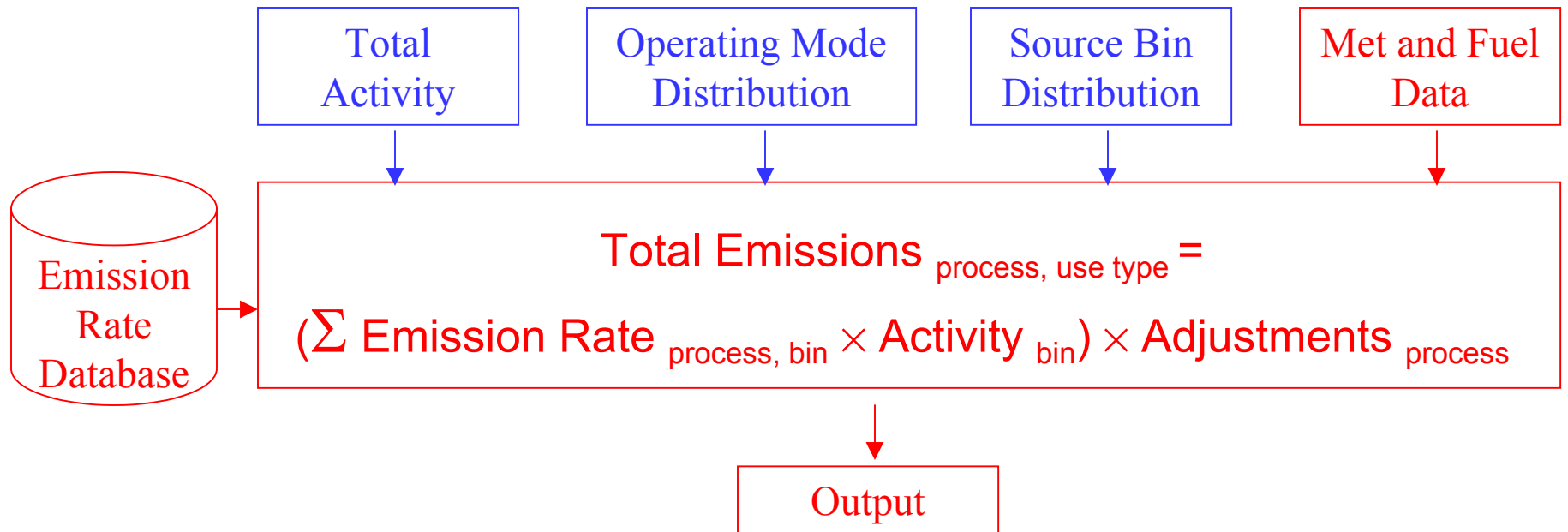
What is "Fleet & Activity Data?"

- **Vehicle Populations & Characteristics**
- **Vehicle Activity Descriptions**

  – Essential to any emissions inventory model

  – NOT data EPA typically collects directly

  – Often based on projections and allocations

  – Important source of uncertainty in emission inventory estimates

Context: Core Model

- **Inputs for a given time & location:**
  - Total Activity
  - Operating Mode Distribution
  - Source Bin Distribution
  - Meteorology and Fuel Data
- **Calculate activity by source & operating mode bins**
- **Retrieve emission rates**
- **Calculate total emissions**
- **Apply emission corrections**
- **Produce output**

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Core Model

Total Activity

Operating Mode Distribution

Source Bin Distribution

Met and Fuel Data

Emission Rate Database

Total Emissions $_{process,\ use\ type}$ =

$(\Sigma$ Emission Rate $_{process,\ bin} \times$ Activity $_{bin}) \times$ Adjustments $_{process}$

Output

Total Activity

- **Population * per-source activity for a given time, location, use type, age**
- **Proposing a <u>time</u> basis – more broadly applicable than g/mi**

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Total Activity Basis

Emission Process	Activity Basis
Running Exhaust, Brake Wear, Tire Wear, Running Loss, Crankcase, Extended Idle	Source Hours Operating (SHO)
Start Exhaust	Number of Starts
Diurnal, Hot Soak	Source Hours Parked (SHP)
Resting Loss, Manufacture/Disposal	Source Hours (SH)
Refueling, Well-To-Pump	Energy (Fuel) Used

Operating Mode Bins

- **Division of total activity into categories that differentiate emissions**

- **Defined by Speed and Vehicle Specific Power**

Characterizing the Fleet

- **Current disconnect between how activity and emission data sources characterize vehicles**
    - e.g. HPMS VMT Classes & EPA Certification Classes
- **Has always required reconciliation**
    - MOBILE guidance includes external HPMS/EPA mapping
- **MOVES approach includes integration of activity and emission data:**
    - Source Use Types
        - a specific class defined by unique activity patterns
    - Source Bins
        - A specific class defined by unique emission characteristics
- **MOVES provides mapping between these**

On-Road Source Use Types

HPMS Vehicle Type	MOVES Source Type
Motorcycles	Motorcycles
Passenger Cars	Passenger Cars
Other 4-tire/2-axle	Passenger Trucks Light Commercial Trucks
Buses	Inter-city Buses Transit Buses School Buses
Single Unit Trucks	Refuse Trucks Single Unit Short-haul Single Unit Long-haul Motor Homes
Combination Trucks	Combination Short-haul Combination Long-haul

Mapping Source Use Types with Source Bins

Source Bin Fraction = 0.4

Source Bin A

Source Use Type

0.4 — Source Bin B

0.2
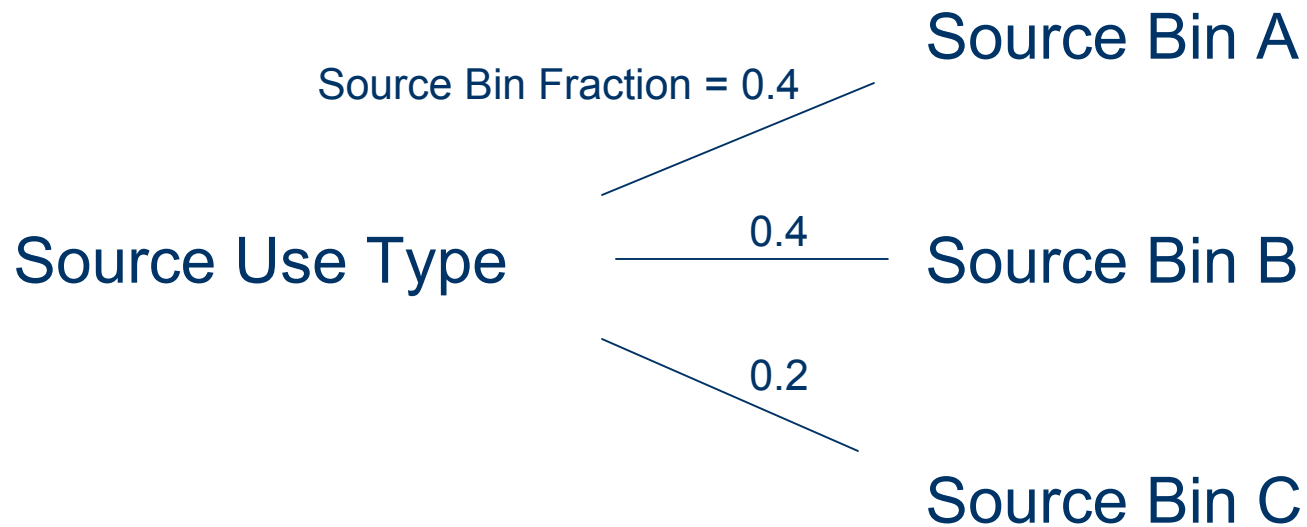
Source Bin C

Source Bin Fractions Vary by Model Year
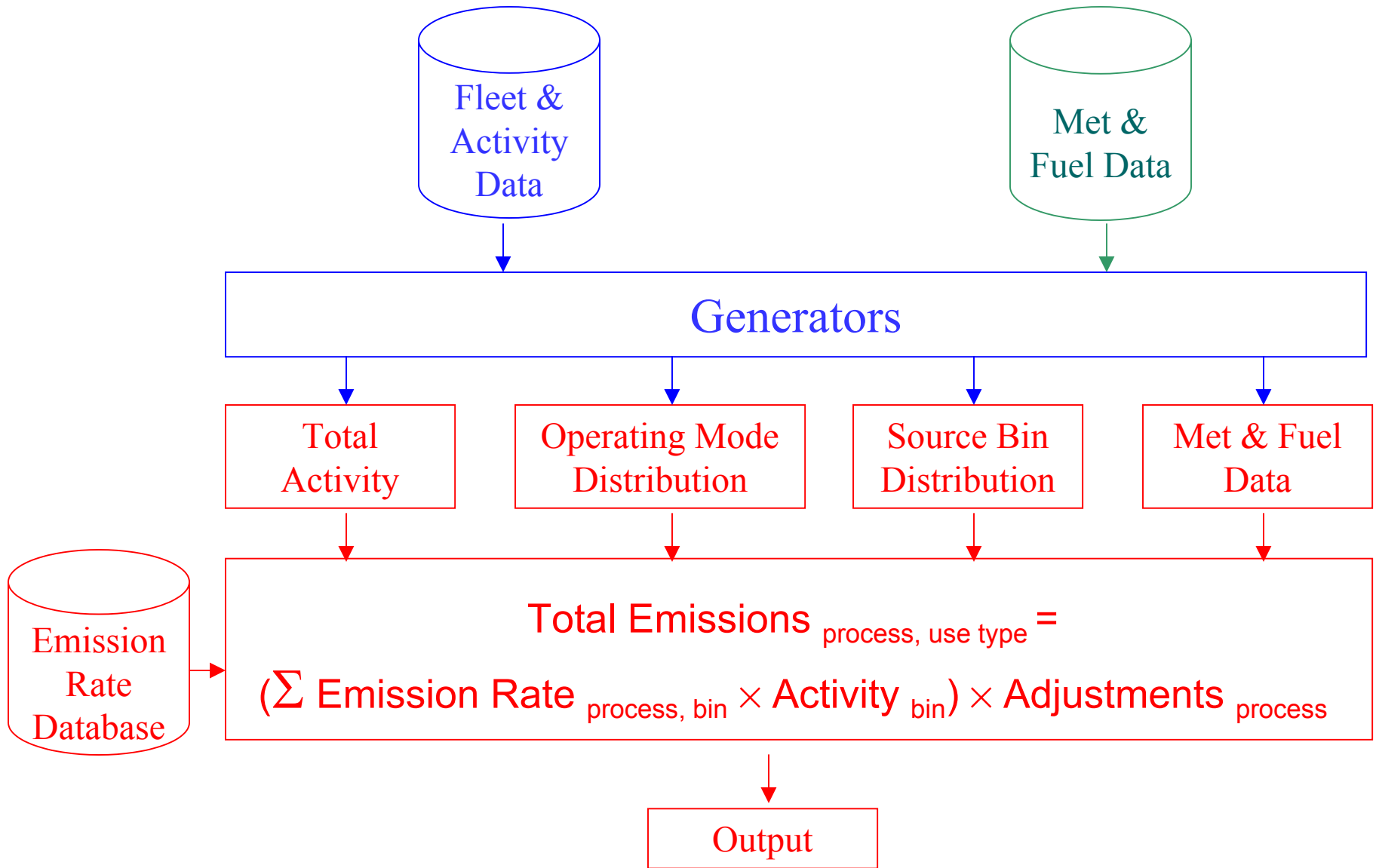
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Source Bins Discriminators by Pollutant

- **Energy:**
  - Fuel Type, Engine Technology, Model Year Group, Loaded Weight, Engine Size

- **CH4 & N20:**
  - Fuel Type, Engine Technology, Emission Technology

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MOVES2004 Source Bin Categories

Fuel Type	Engine Technology	Model Year Group	Emission Technology	Engine Size	Loaded Weight
Gasoline	Null	Null	Null	Null	<=2000 lbs
Diesel	Conventional	1980-and-earlier	Pre-control	< 2.0 L	2000-2500 lbs
CNG	Hybrid Electric-IC A	1981-1985	Non-catalyst	2.1-2.5 L	2500-3000 lbs
LPG	Hybrid Electric-IC B	1986-1990	Oxidation cat.	2.6-3.0 L	3000-3500 lbs
Ethanol	Hybrid Electric-IC C	1990-and-earlier	Tier 0	3.1-3.5 L	3500-4000 lbs
Methanol	Hybrid Electric-DI A	1991-and-later	Tier 1	3.6-4.0 L	4000-4500 lbs
Gas H_2	Hybrid Electric-DI B		LEV	4.1-5.0 L	4500-5000 lbs
Liquid H_2	Hybrid Electric-DI C		Tier 2	> 5.0 L	5000-6000 lbs
Electric	Fuel Cell				6000-7000 lbs
	Hybrid Electric-Fuel Cell A				7000-8000 lbs
	Hybrid Electric-Fuel Cell B				8000-9000 lbs
	Hybrid Electric-Fuel Cell C				9000-10000 lbs
					10000-14000 lbs
					14000-16000 lbs
					16000-19500 lbs
					19500-26000 lbs
					26000-33000 lbs
					33000-40000 lbs
					40000-50000 lbs
					50000-60000 lbs
					60000-80000 lbs
					80000-100000 lbs
					100000-130000 lbs
					> 130000 lbs

One Source Bin = Unique Combination of Fields
"Null" means "Doesn't Matter"

Fleet & Activity Data

Met & Fuel Data

Generators

Total Activity

Operating Mode Distribution

Source Bin Distribution

Met & Fuel Data

Emission Rate Database

Total Emissions $_{process, use\ type}$ =

(Σ Emission Rate $_{process, bin}$ × Activity $_{bin}$) × Adjustments $_{process}$

Output

Fleet & Activity Generators

- **Produce core model inputs from available data**
- **Implementation-specific**
  - Provides link between generic core model and specific implementations
  - **Current generators are for Macroscale GHG**
- **Total Activity Generator (TAG)**
- **Operating Mode Distribution Generator (OMDG)**
- **Source Bin Generator (SBG)**

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Total Activity Generator Inputs

- **Generating Analysis Year Populations by Source Type & Age**
  - Base year vehicle populations
  - Scrappage rates
  - Sales growth rates
  - Age distributions

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Total Activity Generator Inputs

- **Generating Travel Fractions**
  - Base Year VMT by Vehicle Type
  - VMT Growth Rates by Vehicle Type
  - Relative Mileage Accumulation Rates
  - Road type VMT fractions by Source Type

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Total Activity Generator Inputs

- **Converting to time basis & allocating activity in time & space**
  – Temporal VMT distributions (Month, Day, Hour)
  – Distribution of Roadway VMT by county
  – Allocations of starts in time & space
  – Allocation of HD extended idle in time & space
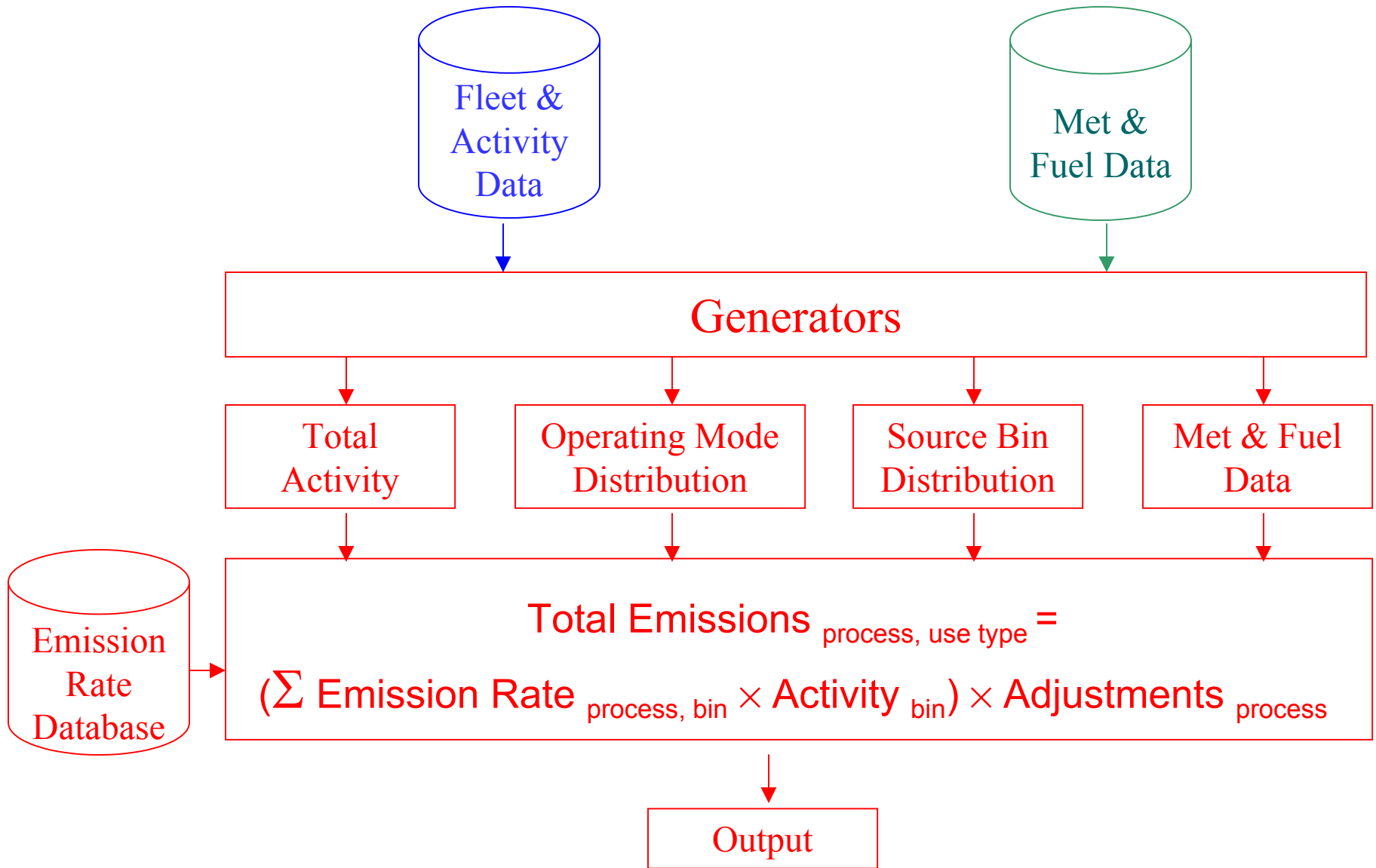 – Average speed distributions

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Operating Mode Distribution Generator Inputs

- **Average Speed Distributions**

- **Driving Schedules**

- **VSP coefficients by Source Type**

  – average weight

  – rolling, rotating & drag coefficients

Source Bin Generator Inputs

- **By Source Type and Model Year**
  - Fuel/Engine Technology Distributions
  - Emission Technology Distributions
  - Size/Weight Distributions

Fleet & Activity Data

Met & Fuel Data

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Emission Rate Database

Total Emissions $_{process,\ use\ type}$ =

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Output

Where do we get default data?

- **Polk--** **Registration data, especially used for light duty**
- **VIUS--** **Census survey of truck data**
- **FHWA--** **VMT data and registration data**
- **Specialized sources:**
  - Federal Transit Administration
  - Recreational Vehicle Industry Assoc.
  - Motorcycle Industry Council
  - School Bus Fleet Magazine
  - MOBILE6
  - Cycle data

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Base Year Vehicle Populations

| SourceType ID	SourceType	1999 Population
11	Motorcycles	4,173,869
21	Passenger Cars	130,163,354
31	Passenger Trucks	57,424,819
32	Light Commercial Trucks	19,184,642
41	Interstate Buses	84,454
42	Urban Buses (transit)	55,706
43	School Buses	592,029
51	Refuse Trucks	88,970
52	Single Unit Commercial (short-haul) Trucks	4,489,140
53	Single Unit Delivery (long-haul) Trucks	265,520
54	Motor Homes	902,949
61	Combination Commerical (short-haul) Trucks	1,088,815
62	Combination Delivery (long-haul) Trucks	806,633

Sales & Scrappage

- **Sales rates**
  - 1999-2001 based on historical sales data
  - 2003-2025 based on NEMS projections
  - 2026-2050 assume no growth

- **Scrappage rates**
  - based on ORNL 1990 estimates

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Age and Source Bin Fractions

- **Determined primarily from Polk & VIUS97**
- **Truck age fractions adjusted from 1997 to 1999 base year using sales & scrappage.**
- **Source Bin fractions for each Source Type**
 - 625 total source bins for 1999 base year

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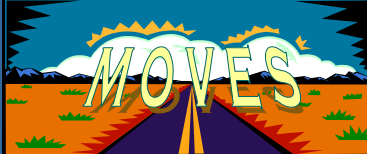
VMT

- **Base Year VMT**
  - from FHWA
- **VMT Growth Rates**
  - derived from NEMS
- **Roadtype VMT fractions**
  - from FHWA
  - Currently unsure how to distinguish long-haul & short-haul VMT
- **Relative Mileage Accumulation Rates**
  - from MOBILE6

Vehicle Type	1999 VMT
Motorcycles	10,580,000,000
Passenger Cars	1,568,637,000,000
2-axle/4 tire	900,735,000,000
Buses	7,657,000,000
Single Unit Trucks	70,274,000,000
Comb. Trucks	132,358,000,000

VMT (cont.)

- **Temporal VMT distributions**
  - For hour, day & month
  - Currently from ATR data (1996)
  - Now the same for all vehicle classes & ages
  - Plan to update with Vehicle Travel Information System (VTRIS) data

VMT fractions by Day
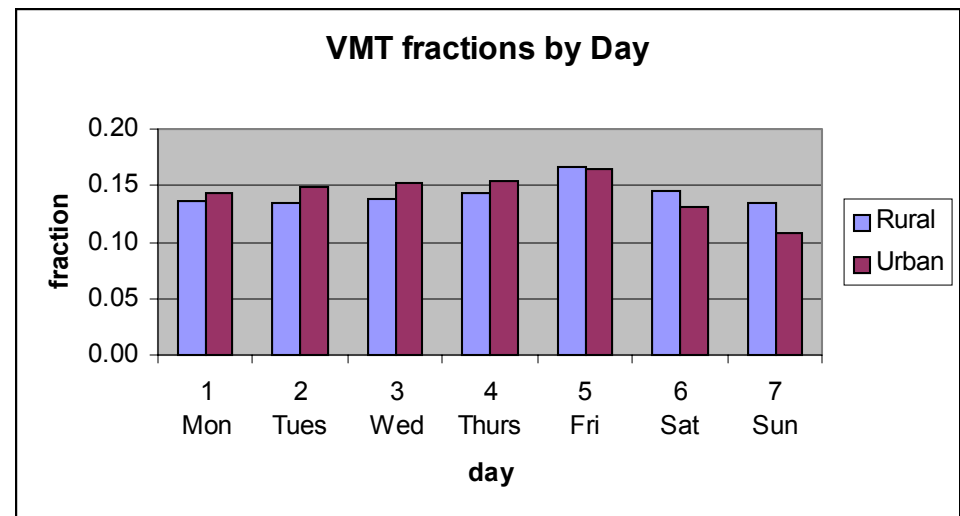
Speed & Drive Schedules

- **Average Speed Distributions**
  - By hour, day & roadway type
  - Currently based on MOBILE6
- **Driving Schedules**
  - By source types, roadway type & average speeds
  - Used to derive operating mode distributions
  - Defaults
    - New MHDV and HHDV schedules developed by ERG based on heavy-duty driving surveys
    - MOBILE6 facility cycles used for LD, with new high-speed schedules
    - WVU cycles for urban bus, refuse truck

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Allocation in Time & Space

- **Source Hours Operating (SHO)**
  - By hour, county; based on VMT, average speed
- **Starts by SHO**
  - Based on trips-per-day from instrumented vehicles and daily VMT allocation
- **HD Extended Idle**
  - Based on hours/SHO from instrumented trucks
  - Regional allocation by Combination Truck Interstate VMT

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Default vs. User Input

- **Defaults will be available for all generator inputs**
  - Primarily for generating default NEI inventories
- **Local data strongly encouraged for some inputs, for example:**
  - Total VMT and VMT growth
  - VMT allocations by time and location
  - Average Speed
  - Age Distribution
  - Alternative fueled vehicle fractions

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Adjusting Fleet & Activity

- Generators assist in converting from available data to data needed by model
- Additional Generators/Importers can be created as needed.

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Data Needs
MOVES vs MOBILE

MOVES	MOBILE6
Requires total VMT.	Total VMT applied outside the model
Vehicle types compatible with FHWA data collection and more consistent with many control strategies	Vehicle types match historical emission standards
Many alternative fuels/technologies	Gas, diesel & CNG only

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Data Needs
MOVES vs MOBILE (cont.)

MOVES	MOBILE6
Distribution of fuels, emission technologies, size & weight	Distribution of fuels, emission technologies, fuel delivery technologies
Speed distributions for all roadway types	Single speed for ramps & local roads
Extended Idle activity	No Extended Idle computed
Spatial distribution of activity	Spatial distribution required multiple runs

Conclusions

- **Fleet & Activity data are critical inputs to total emission inventory**

- **Like MOBILE6, most data from non-EPA sources**

- **Unlike MOBILE, model is designed to take available data and transform into needed core model inputs**

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