Planning for Quality in *MOVES*:
EPA's Next Generation Mobile Source Emissions Model

Chad R. Bailey, MPH

USEPA

Office of Transportation and Air Quality

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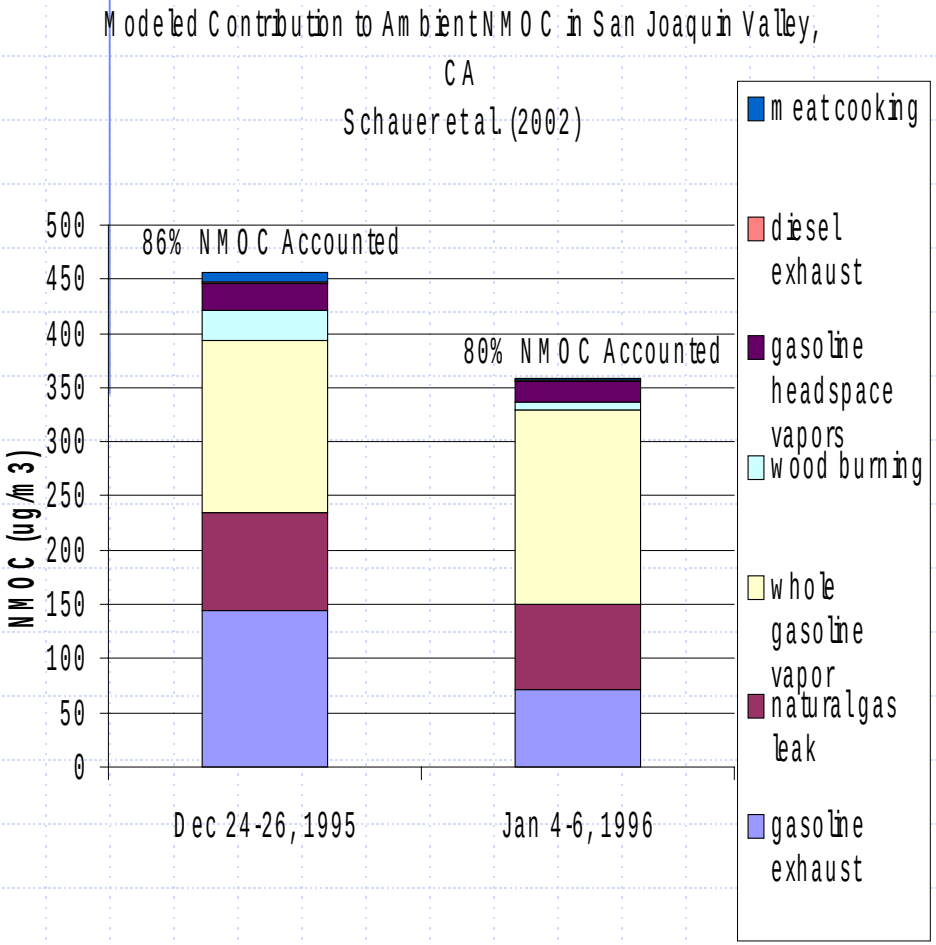
Overview of Presentation

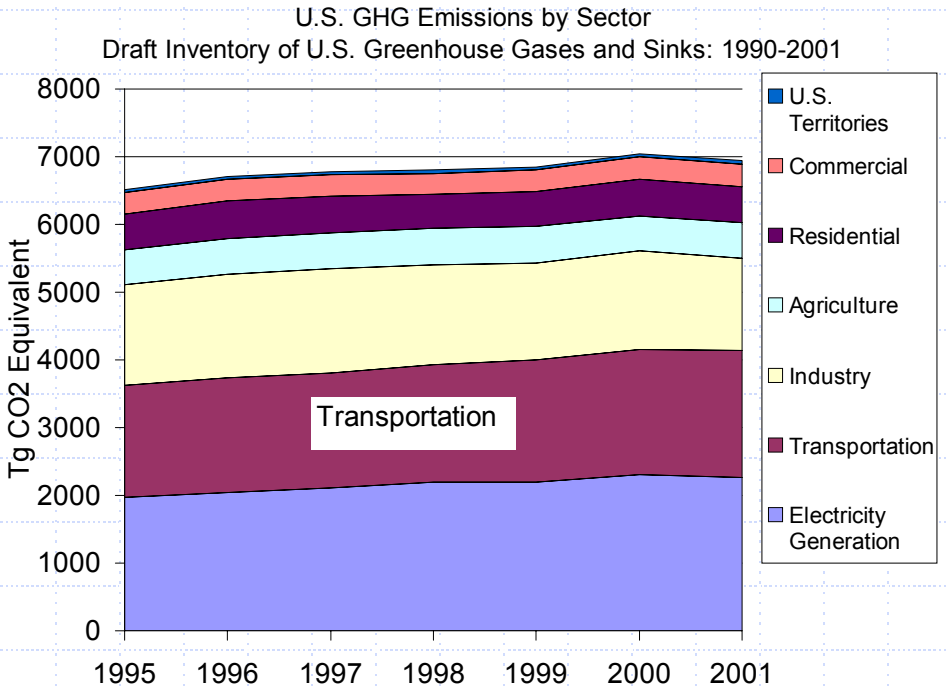
- History and context
- MOVES quality framework
  - "Use cases"
  - Mathematical formulation
  - Data collection and management
  - Model design and software implementation
  - Applications

History and Context

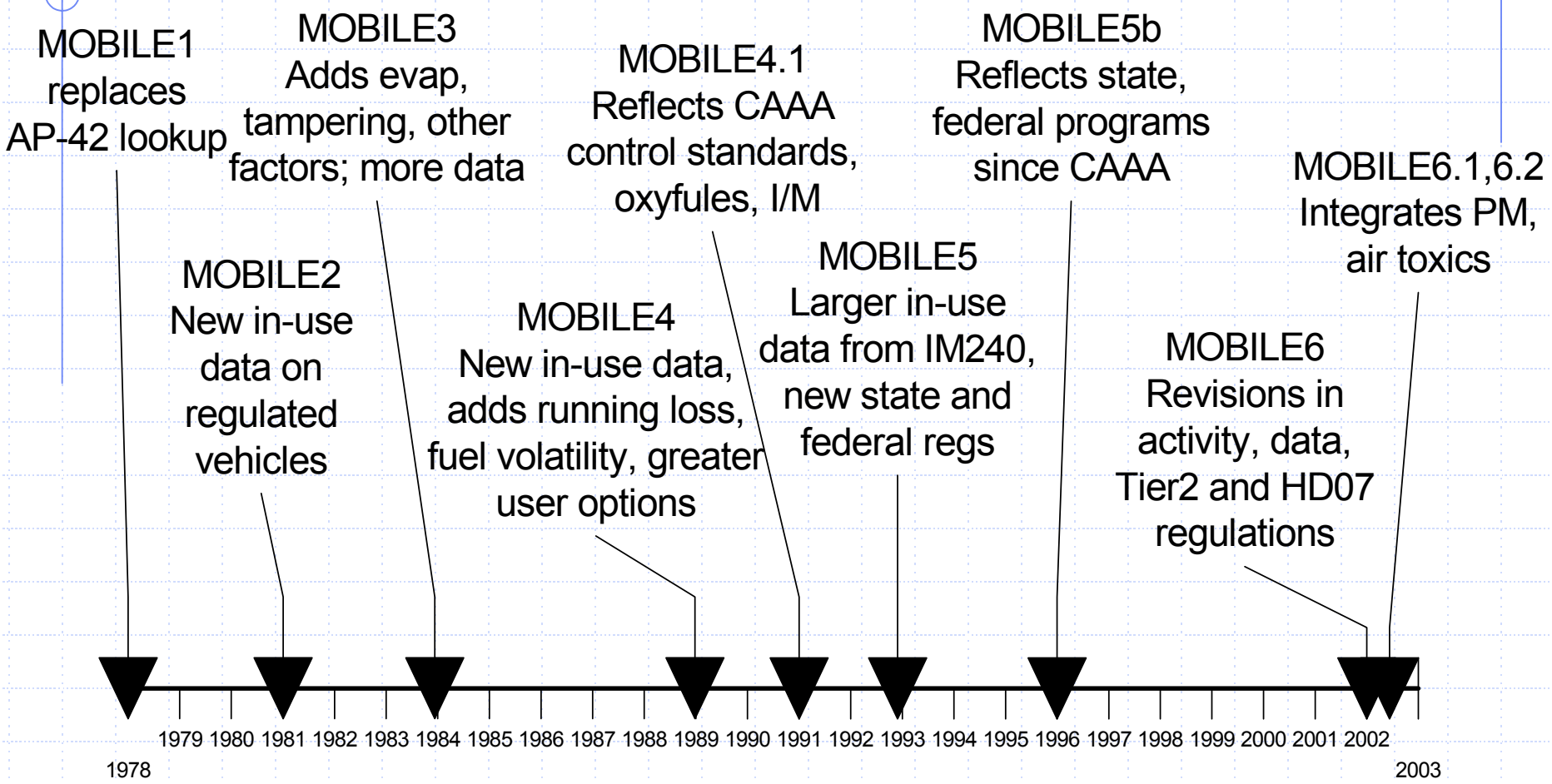
- EPA charged under CAA with determining emission factors from all air emission sources
  - OTAQ uses mobile source models
  - Interface with transportation and AQ
- Models used in multiple decisions
  - SIP planning, conformity, EIS (NEPA), air quality modeling, regulatory analysis

Mobile source contributions to air pollution and energy use is large





History of MOBILE



National Research Council report: *Modeling Mobile Source Emissions*

- Congress charged NAS with reviewing EPA framework
- Panel recommended changes to modeling system
  - More uniform methods between sources
  - Interface with transportation and air quality tools
  - "Toolkit" for multiple applications
  - More frequent revisions and evaluation

MOVES is Born

- MOVES team charged with producing model consistent with NRC recommendations
- Model team includes
  - OAR/OTAQ
  - OAR/OAQPS
  - ORD/NRMRL
  - R4
  - Ford Motor Company R&D
- Regular stakeholder review via FACA
  - Auto and oil industries
  - Academia
  - Transportation planners
  - NGOs
- Independent peer review managed by Southwest Research Institute
  - Standing peer review panel from air quality, transportation, and emissions modelers

Step 1: Defining "use cases"

- National inventory
  - EPA regulations and reports: Emission Trends, NSATA, Tier 2
- Local inventory
  - SIP, conformity/transportation planning, trading programs, etc.
- "Hot spot" and project-level analysis
  - NEPA, exposure analysis for health studies
- Model interaction
  - Travel models (basic and next-generation), dispersion models, photochemical grid model preprocessors
- Policy planning and evaluation
  - Cleaner vehicles and fuels, travel reduction, technology planning, in-use maintenance programs
- Model evaluation
  - Uncertainty analysis, sensitivity, benchmarking, validation
- Model update

Rethinking Methods

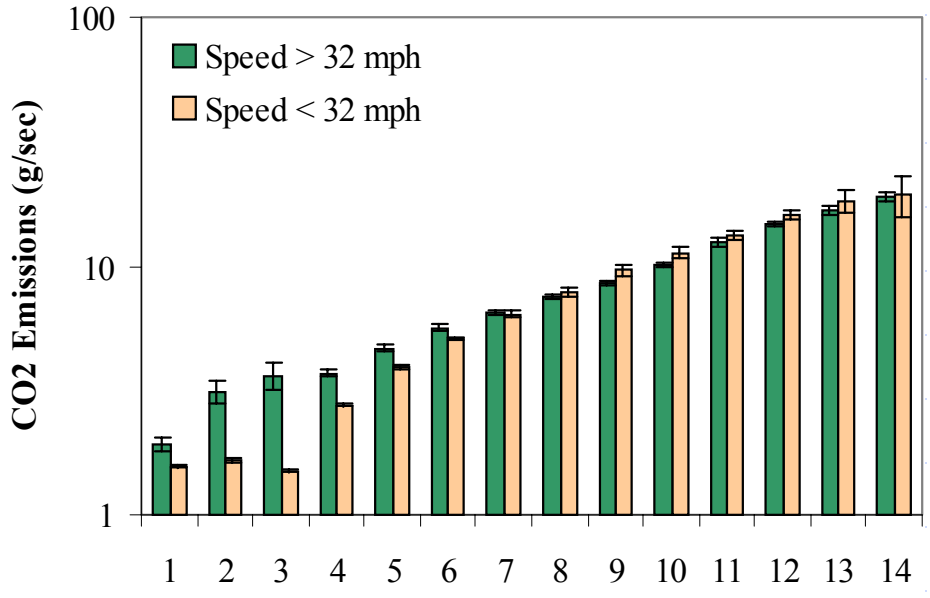
- Research models employ variety of approaches to modeling emissions
- OTAQ engaged in multi-award contract to compare model structures
  - ENVIRON, Inc. (Pollack et al.)
  - North Carolina State University (Frey, Unal, et al.)
  - University of California-Riverside (Younglove, Barth, et al.)
- "Shoot-out" compared modeling approaches using variety of grading criteria
  - OTAQ proposal submitted to same process

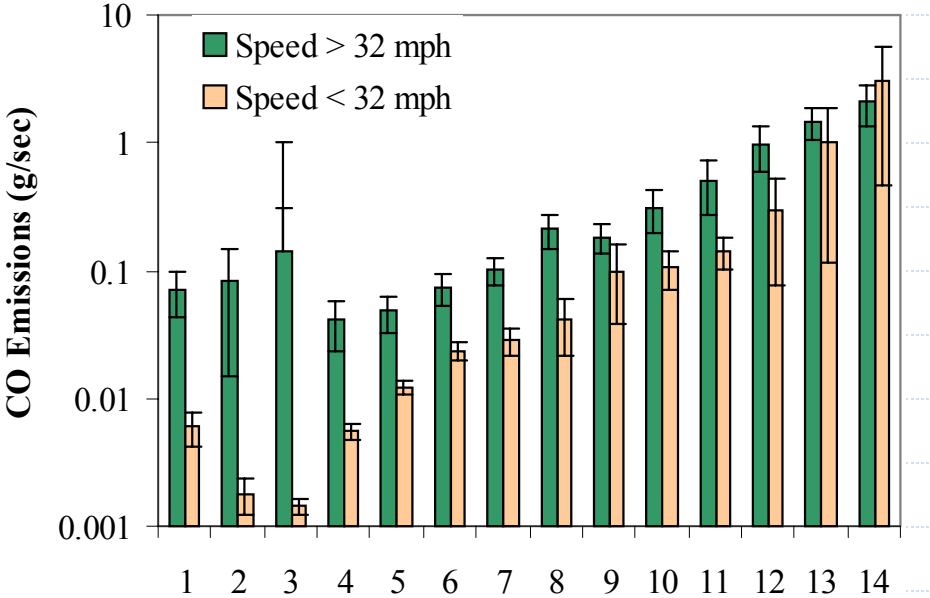
Results of the "Shoot-out"

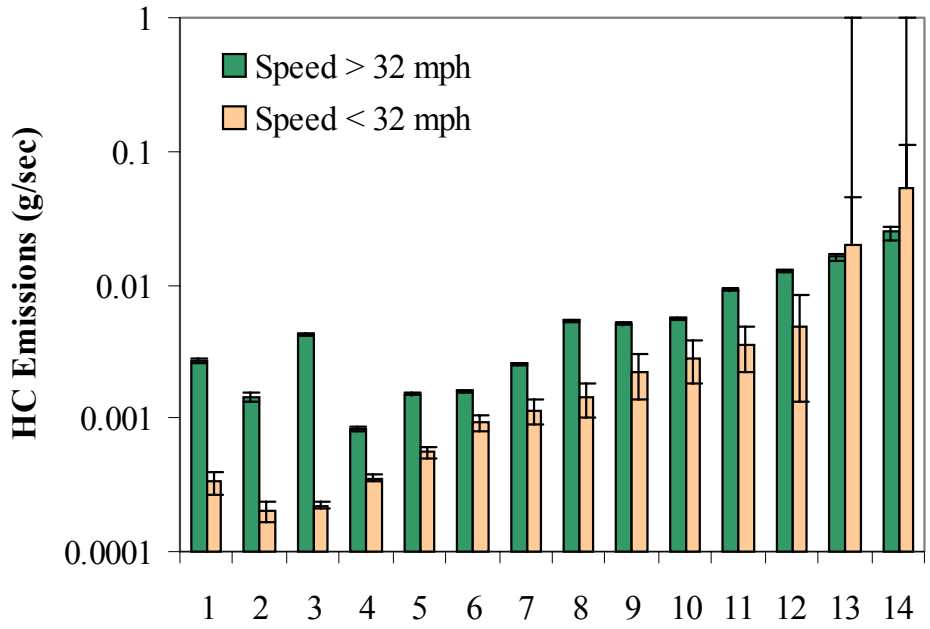
Criteria	Modal	VSP bin	Microtrips	Direct DB	
Consistency across scales	+	+	-	-	
Easily updated	+	+	+	+	
Can accept input from >1 source	+	+	-	+	
Computational efficiency	+	+	-	-	

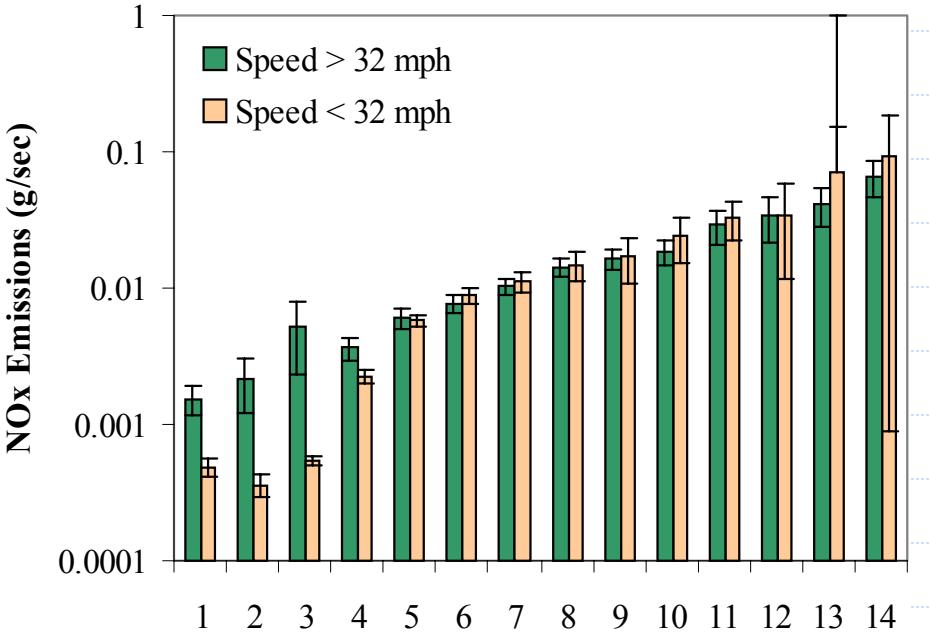
Mathematical Framework

- Modal emissions model based on power
- 14 discrete power power “bins” (HTBR)
- Allows model to employ modern database management systems (DBMS)
- Store parametric distributions for characterizing variability in bins


CO2 Emissions (g/sec)
100
10
1
Speed > 32 mph
Speed < 32 mph
1 2 3 4 5 6 7 8 9 10 11 12 13 14


CO Emissions (g/sec)
10
1
0.1
0.01
0.001
Speed > 32 mph
Speed < 32 mph
1 2 3 4 5 6 7 8 9 10 11 12 13 14


HC Emissions (g/sec)
1
0.1
0.01
0.001
0.0001
Speed > 32 mph
Speed < 32 mph
1 2 3 4 5 6 7 8 9 10 11 12 13 14


NOx Emissions (g/sec)
1
0.1
0.01
0.001
0.0001
Speed > 32 mph
Speed < 32 mph
1 2 3 4 5 6 7 8 9 10 11 12 13 14

Data Collection

- MOVES highly dependent on "secondary data" from non-EPA organizations
- Grading criteria "A-B-C"
  - Documentation quality
  - Completeness
- Contractors and internal staff provided with specific assessment guidelines for applying grades

Mobile Source Observation Database (MSOD)

- Stores multiple emissions data parameters
  - Vehicle description
    - Model year, odometer, technology, regulatory class
  - Continuous data
    - Emission rate, activity, GPS, temperature
  - Integrated data
    - "Bag data"
    - Evaporative emissions
    - Chemical speciation (tailpipe, evaporative, etc)
  - Project documentation
    - Contract number, work assignment
    - Interim and final reports
    - Measurement techniques
  - Data quality indicators
    - Interfaces with grading criteria

Designing DQOs into Model

- Model applications various
  - Not all data appropriate for every model scenario
    - Colorado I/M data in Miami, FL?
    - Future technologies?
- "Binning program"
  - Collates data from MSOD, PERE model
  - Calculates data quality indices, user warnings
    - e.g. %variability contributed by a single vehicle
- Software provides input data quality indicators, flags areas of concern
  - Guides users for when to use physical model to populate model database

Designing DQOs into Model

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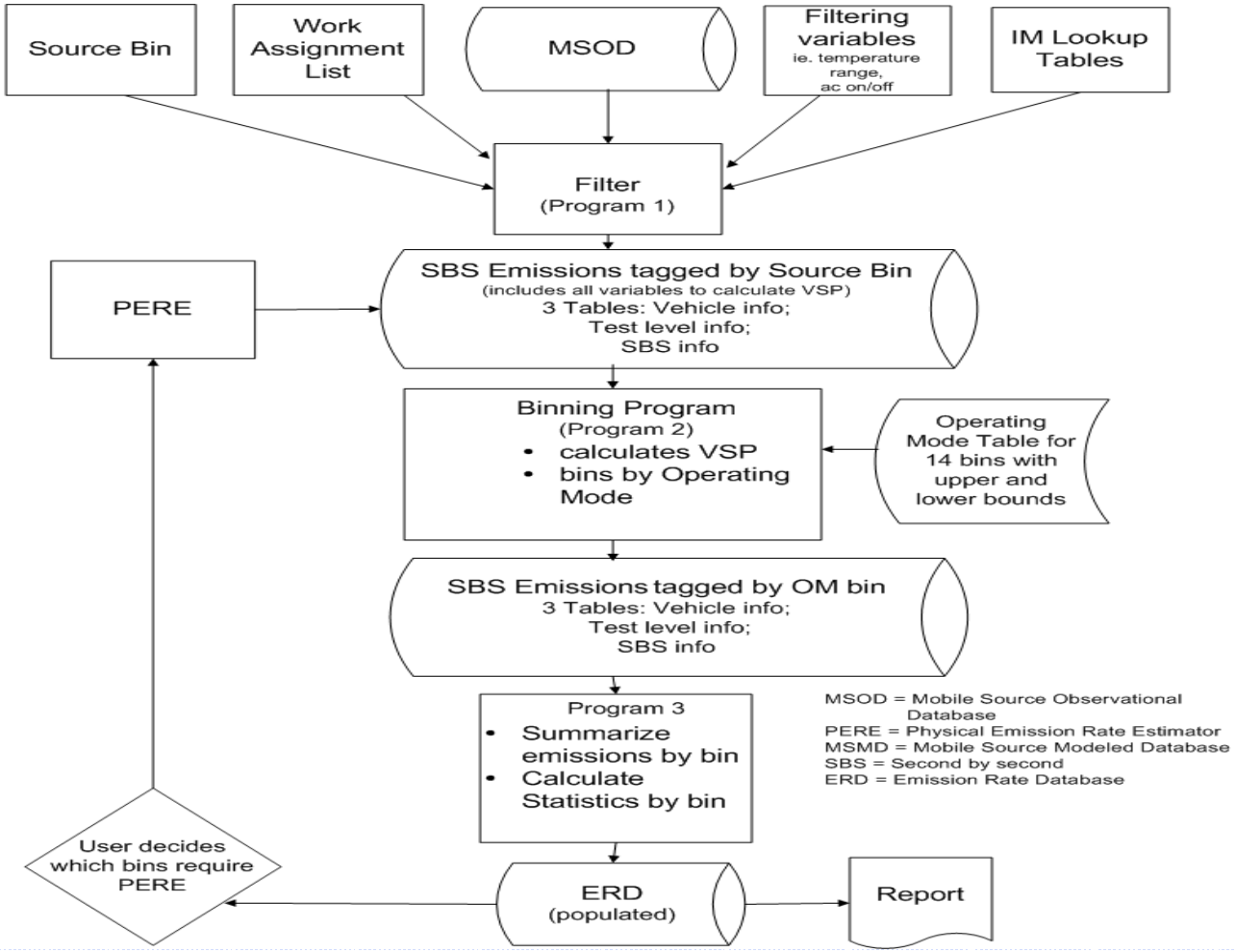

Software Design and Implementation

- Design built upon model objectives
  - Iterative, with top priorities implemented first
- Design documentation subject to external peer review (expert panel)
- Open source tools in public domain
- Standards for coding
  - In-line documentation, version control, etc.
- Adopted elements of eXtreme programming
  - Test, test, test!
- Annual model updates

Implementation Schedule

- MOVES GHG
  - 2004
- MOVES HC/CO/NOx/PM/Toxics
  - 2005
- MOVES Nonroad
  - 2006

Conclusions

- High complexity of mobile source emissions requires new framework for modeling
- Planning for quality integral to model design and implementation
- Has resulted in positive reviews from stakeholder and peer reviews