"Real Emissions Assessment Logging" (REAL)

- On-road vehicles track and report data characterizing their own oxides of nitrogen (NOx) and greenhouse gas (GHG) emissions

	Light Duty	Medium Duty	Heavy Duty
NOx Tracking	n/a	Diesel engines[2]	Diesel engines[2]
GHG Tracking	All engines[1]	All engines[1]	All engines[2]

[1] Phased in over 2019 – 2021 model years (MY)

[2] Started 2022 MY

- Draft proposal: REAL NOx tracking for Tier 5 off-road diesel engines

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REAL in the On-Road Regulations Today

- ## Heavy-Duty On-Board Diagnostics (OBD) Regulation
  - **Title 13, California Code of Regulations, Section 1971.1**
  - (h)(5.3) NOx Tracking Requirements
  - (h)(5.4)-(5.7) GHG Tracking Requirements
  - Adopted by the California Air Resources Board (CARB or Board) in November 2018

- ## OBD II Regulation (Light/Medium-Duty)
  - **Title 13, California Code of Regulations, Section 1968.2**
  - (g)(6.12) NOx Tracking Requirements
    - Adopted by the Board in November 2018
  - (g)(6.3)-(6.6), (6.8)-(6.11) GHG Tracking Requirements
    - Adopted by the Board in September 2015

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REAL: NOx Tracking

- NOx tracking data will:
  - Provide feedback on our regulatory programs
  - Improve our emissions inventory
  - Provide quick, real-world screening tool for flagging potential emissions issues

- Relies on existing technology and hardware to estimate and track NOx emissions

- Minimum NOx mass accuracy requirement:
  - +/- 20% or +/- 0.1 grams/brake horsepower-hour
  - Relative to lab results on hot-start test at the time of certification

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Current REAL NOx Tracking Data Arrays and Parameters

Parameter	Active 100 Hour Array	Stored 100 Hour Array	Lifetime Array	Lifetime Engine Activity Array
NOx mass – engine out (grams (g))	X	X	X	n/a
NOx mass – tailpipe (g)	X	X	X	n/a
Engine output energy (kilowatt-hours (kWh))	X	X	X	X
Distance traveled (kilometers (km))	X	X	X	X
Engine run time (hours (h))	X	X	X	X
Vehicle fuel consumption (liters)	X	X	X	X

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Current Bins for Each Parameter in Each Array

Vehicle Speed kilometer/hour (km/h)

% of Rated Power	0	> 0 ≤ 16	> 16 ≤ 40	> 40 ≤ 64	> 64
≤ 25%		Bin 3	Bin 4	Bin 5	Bin 6
> 25% ≤ 50%	Bin 2	Bin 7	Bin 8	Bin 9	Bin 10
> 50%		Bin 11	Bin 12	Bin 13	Bin 14

Total (Bin 1)

NTE Bin (Bin 15)

Regen Bin (Bin 16)

MIL-On Bin (Bin 17)

NTE: Not-to-Exceed; Regen: Regeneration; MIL: malfunction indicator light

In-Use Analysis Method Background

- REAL has a bin related to the current Not-to-Exceed (NTE) in-use compliance evaluation method.

- Staff proposes to change the NTE bin to be consistent with the new in-use analysis methods in recent regulations.

- The Low NOx Omnibus rulemaking updated the in-use method to the 3 Bin Moving Average Window (3B-MAW) to analyze idle, low load, and higher load operation.

- Through the Clean Truck Partnership agreement with the Truck and Engine Manufacturers Association members, CARB agreed to harmonize with the in-use method in U.S. EPA's Clean Trucks Plan, namely the 2 Bin Moving Average Window (2B-MAW) which separates analysis into idle and non-idle operation.

- Staff proposes to add 2B-MAW bins to REAL accordingly.

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REAL NOx Tracking Proposed Amendments

- Replace NTE bin with 2B-MAW bins.
- Work with SAE International committees to standardize changes.
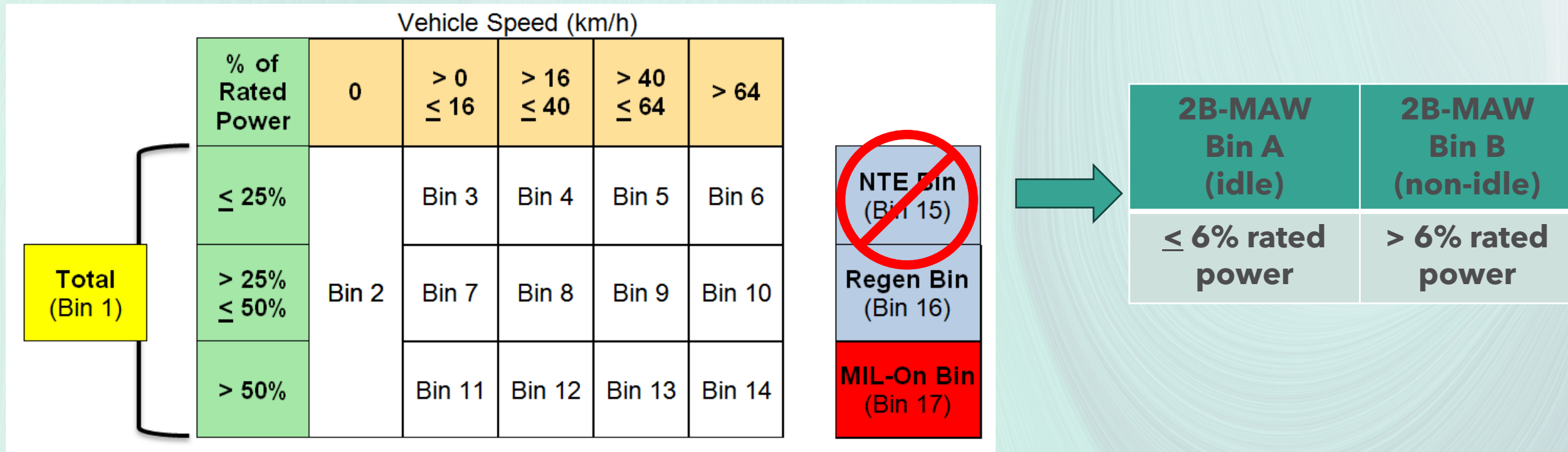
REAL NOx Tracking Proposed Amendments (cont'd)

- 2B-MAW bins only added to parameters and arrays shown below:

Parameter	Active 100 Hour Array[1] (Bins)		Stored 100 Hour Array[1] (Bins)		Lifetime Array[1] (Bins)		Lifetime Engine Activity Array[2] (Bins)	
NOx mass – engine out (g)	1-17	-	1-17	-	1-17	-	-	-
NOx mass – tailpipe (g)	1-17	A, B	1-17	A, B	1-17	A, B	-	-
Engine output energy (kWh)	1-17	B	1-17	B	1-17	B	1-17	B
Distance traveled (km)	1-17	-	1-17	-	1-17	-	1-17	-
Engine Run time (hours)	1-17	A, B	1-17	A, B	1-17	A, B	1-17	A, B
Total fuel consumption (liters)	1-17	-	1-17	-	1-17	-	1-17	-

[1.] Tracks data only when NOx sensors are providing data.
[2.] Tracks data at all times.

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REAL NOx Tracking Proposed Amendments (cont'd)

- 2B-MAW bin data summed following in-use testing protocol
  - 300-second windows of parameter data stored every second
- Data deemed invalid and not included in window if:
  - REAL tracking paused or MIL is on
  - NOx sensor controller indicates reading not stable
  - Infrequent regeneration is active
  - Barometric pressure < 82.5 kilopascal (kPa) (surrogate for 5,500+ feet (ft) exclusion)
  - 2027-2030 MY: Ambient air temperature < 5 degrees Celsius ($^{\circ}$C)
  - 2031+MY: Ambient air temperature < 0 $^{\circ}$C
  - Ambient air temperature > -0.0014 × h + 37.78 $^{\circ}$C
    - For height (feet) use: h ≈ (101.3 – Barometric pressure) kPa × 328 ft / 1.2 kPa
- Window can extend to 599 seconds max: 300 seconds valid data plus 299 seconds invalid data
  - Begin new window if cannot complete 300 valid seconds in less than a 600-second interval
- Partial window data not saved across key cycles

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Open Issues

- Fuel Consumption – Considering whether 2B-MAW tracking should include fuel consumption. This may facilitate comparison of REAL NOx tracking data with data derived from PEMS-based methods.

- 2B-MAW window methodology – Seeking feedback on how to harmonize the 2B-MAW window methodology used in REAL with the method used when post processing PEMS-collected data.

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