



# Tier 5 Rulemaking Idle Reduction Concepts

December 14, 2022

# Outline

- Current Status of Idle Reduction
- Importance of Controlling Idle Oxides of Nitrogen (NO<sub>x</sub>) Emissions
- Potential Idle Reduction Concepts
- Idle Definition
- Request for Feedback

# Current Status of Idle Reduction

- The In-Use Off-Road Diesel-Fueled Fleets Regulation\* in California (CA) contains a 5-minute idle restriction\*\* and a requirement for affected fleets to have a written idle policy.
  - Excludes idling during queuing; for testing, servicing, repairing, or diagnostic purposes; for warming up; and for ensuring safe operation
- CA's and United States Environmental Protection Agency's existing standards for new off-road engines do not include idling restrictions.

\*Title 13 California Code of Regulations § 2449

\*\* Idling limit exclusions described in 13 CCR § 2449 (d)(2)(A) apply.

# Importance of Controlling Idling NOx Emissions

- Idling is common for off-road equipment (potentially 30-50% of time)\*.
- The current off-road emission inventory of California Air Resources Board (CARB) does not isolate emissions from idle because it uses average load factors for the entire operation.
- Idle emission could potentially dominate the overall NOx emission if idle emission rate is much greater than non-idle emission.

**Example:** A 560 kilowatt (kW) engine meeting a 0.04 grams per kilowatt- hour (g/kW-hr) NOx standard running the Non-Road Transient Cycle (NRTC) in which the average load is ~37% of the maximum engine power.

Potential Tier 5 NRTC NOx emission rate =  $0.04 \text{ g/kW-hr} \times 560 \text{ kW} \times 37\% = 8.3 \text{ g/hr}$ , whereas current on-road heavy-duty (HD) idling NOx standard = 30 g/hr.

Idling emission could overwhelm non-idling emission unless idling emission is improved from the current level.

# Potential Idle Reduction Concept

Demonstrate compliance with one of the following two options:

1. Use a non-programmable 5-minute engine shutdown system
  - **Staff requests feedback regarding applying overriding conditions from on-road test procedure\*** (i.e., power take-off, engine coolant temperature < 60 Fahrenheit, regeneration, or service/maintenance). **Are these overriding conditions necessary for off-road? Are any other overriding condition needed for off-road?**
  - **Please provide information regarding safety concerns.**
2. Comply with a NOx idle standard
  - Staff is considering setting the idle standards such that idle emission rate (g/hr) would be comparable to non-idle emission rate (g/hr).
  - Staff is considering setting the standards as a function of engine power and corresponding NRTC standards.

**Feedback requested: Is the 5-min shutdown system option needed?**

\* CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 2004 AND SUBSEQUENT MODEL HEAVY-DUTY DIESEL ENGINES AND VEHICLES, pages 24-25

# Rationale for the Potential Idle NOx Standards (1/3)

- In the recent on-road HD low-NOx Omnibus Regulation, the idling standard for heavy-duty diesel engines (HDDE) is 5 g/hr for model year (MY) 2027 and later.
- Potential issues in applying the on-road standard to off-road:
  - Tier 5 standards must account for different power categories.
  - Each power category has a wide range of power. For example, the factor of 10 difference in engine power in 56-560 kW category potentially creates a greater challenge for larger engines (closer to 560 kW) to meet 5 g/hr.

# Rationale for the Potential Idle NOx Standards (2/3)

- To ensure idle emissions do not dominate the overall emissions, the idle emission rate (g/hr) of an engine should be comparable to its non-idle emission rate (g/hr).
- The potential idle standards are derived as a function of maximum engine power (P) and the corresponding NRTC standards and its average load factor 37%.
  - Example:  $0.04 \text{ [g/kW-hr]} \times 560 \text{ [kW]} \times 0.37 = 8.3 \text{ [g/hr]}$ , rounded up to 9 [g/hr]
- Staff is considering 5 g/hr (i.e., the idle standard for on-road heavy-duty engines MY 2027 and later) to be the minimum standard, and 50 g/hr to be the maximum standard.
- Engines exclusively designed for generator sets and transport refrigeration units (TRU) are exempted since they are not expected to idle and have their own duty cycle.

# Rationale for the Potential Idle NOx Standards (3/3)

- **Preliminary demonstration results at Southwest Research Institute (SwRI):**
  - The standard for the demo engine with max power 187 kW would be 5 g/hr.
  - Test results\* from the off-road low-NOx demonstration engine at SwRI showed < **2 g/hr** of idling emission after 12,000 hours equivalent of hydrothermal aging.
- Further testing will be conducted at SwRI.

\*The test was conducted using Package 1, Team 2 system. The test included 30 minutes of low idle (800 revolutions per minute (RPM)) and elevated idle (1,100 RPM). Average of the tailpipe NOx rate (g/hr) over the last 20 minutes was investigated.



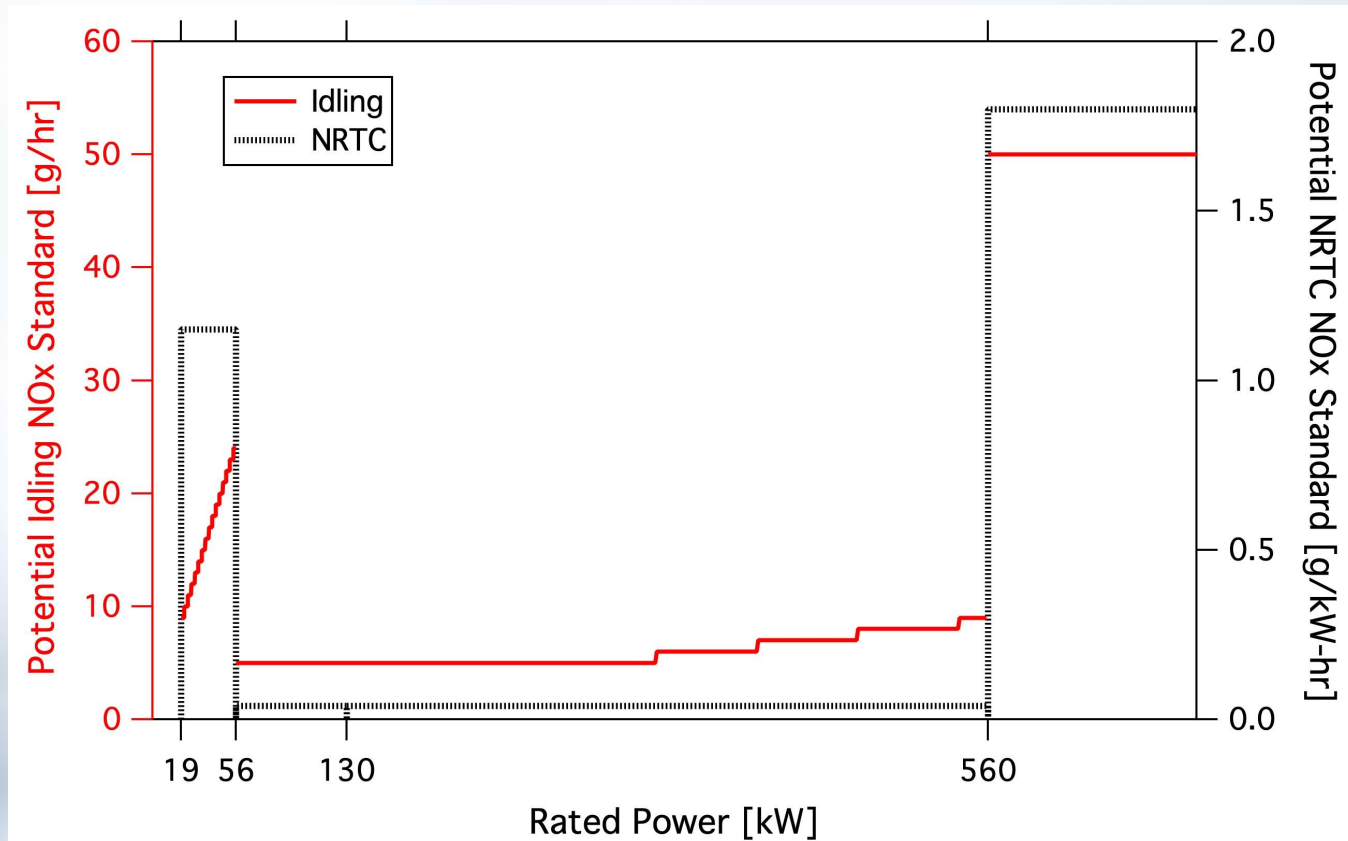
# Tier 5 Potential Criteria Pollutant Standards (g/kW-hr)

Power Category	Application	PM	NO <sub>x</sub>	NMHC	NO <sub>x</sub> + NMHC	CO	Implementation Date
< 8 kW (< 11 HP)	All	0.20			3.8	8.0	2028
8 ≤ kW < 19 (11 ≤ HP < 25)	All	0.10			1.9	6.6	2028
19 ≤ kW < 56 (25 ≤ HP < 75)	All	0.008	1.15	0.19		5.0	2028
56 ≤ kW < 130 (75 ≤ HP < 175)	All	0.005	0.04	0.19		5.0	2029
130 ≤ kW ≤ 560 (175 ≤ HP ≤ 750)	All	0.005	0.04	0.19		3.5	2028
> 560 kW (> 750 HP)	Gen Sets	0.015	0.35	0.19		3.5	2029
> 560 kW (> 750 HP)	Mobile Machines	0.015	1.8	0.19		3.5	2029

HP = horsepower  
CO = carbon monoxide

NMHC = nonmethane hydrocarbon  
PM = particulate matter

# Tier 5 Potential Idle NOx Standards\* Based on Power



# Tier 5 Potential Idle NOx Standards\* Based on Power

Power Category	Application	Potential Tier 5 NRTC NOx Standard (g/kW-hr)	Potential Tier 5 Idling NOx Standard (g/hr)	Potential Tier 5 Idling NOx Standard Range (g/hr)
$19 \leq \text{kW} < 56$ ( $25 \leq \text{HP} < 75$ )	All	1.15	$1.15 \times 0.37 \times P$	9 - 24
$56 \leq \text{kW} < 130$ ( $75 \leq \text{HP} < 175$ )	All	0.04	5	5
$130 \leq \text{kW} \leq 560$ ( $175 \leq \text{HP} \leq 750$ )	All	0.04	$0.04 \times 0.37 \times P$ or 5, whichever is greater	5 - 9
$> 560 \text{ kW}$ ( $> 750 \text{ HP}$ )	Gen Sets	0.35	-	-
$> 560 \text{ kW}$ ( $> 750 \text{ HP}$ )	Mobile Machines	1.8	50	50

Each idle standard is calculated based on the corresponding NRTC standard as a function of maximum engine power (P). Less than 19 kW engines and TRU/gen sets (for all power categories) are exempted.

P: Maximum engine power for the engine family in kW

# Idle-related definition in § 1065.1001

**Idle speed** means the engine speed at which an engine governor function controls engine speed with operator demand at minimum and with minimum load applied (greater than or equal to zero). For engines without a governor function that controls idle speed, idle speed means the manufacturer-declared value for lowest engine speed possible with minimum load. This definition does not apply for operation designated as “high-idle speed.” “Warm idle speed” is the idle speed of a warmed-up engine.

**Staff requests feedback regarding the need to add/modify definitions.**  
Although idle speed is defined, idle load is not defined.  
**Should we define idle load for off-road equipment?**

# Potential Test Procedure

- CA HDDE and vehicles test procedure 86.1360 B.4 defines test procedure to determine compliance to the on-road idling standard.
- Two-mode duty cycles
  - Mode 1: Manufacturer Recommended minimum idle speed, 30 minutes
  - Mode 2: 1100 RPM, 30 minutes
  - The engine manufacturer shall determine the appropriate test load for operating engine accessories.
- **Staff requests feedback:**
  - On-road test procedure refers to Mode 1 as "Curb idle". What is a preferred term for off-road?
  - Staff requests feedback on any challenges associated with using the heavy-duty diesel engine test procedure for off-road. Should the duty cycles be modified? Should there be an upper limit to the test load (e.g., 10% of maximum power)?

# Request for Feedback

- We request feedback regarding the potential concepts including the standards.
- Idle speed is defined, but idle load is not. Should we define idle load? Alternatively, should we set a maximum load percent in the test procedure?
- Are there alternative ways to define the idle standards that account for the wide variation in engine size?
  - Is there a preference in the NO<sub>x</sub> idle standard unit (g/hr or g/kW-hr)?