

NTE for Nonroad Diesel Engines

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Nonroad Diesel NTE in NPRM

- EPA proposed on-highway NTE for nonroad diesel engines
- EPA requested comment on alternative NTE
- Only one NTE will be finalized for nonroad
- This presentation illustrates Alt. NTE and compares results to on-highway NTE



Outline

- Review differences between NTE approaches
 - On-highway
 - Alternative
- Compare results of two nonroad data sets
 - Haul Truck
 - Intermittent hauling between idles during loading
 - Dozer
 - Moderately transient, high-load operation

Major Differences Between NTEs

- On-highway
 - Zone
 - Ambient T, P limits
 - Aftertreatment T
 - Speed, torque, power
 - P_{boost} , T_{boost}
 - T_{coolant}
 - 30s min Avg. in zone
 - Varies depending on time in zone
 - Typically 30s – 5 min.
 - Increments based on crossing zone
- Alternative
 - No Zone
 - Ambient T, P limits
 - Event Avg. Aftertreatment T
 - Leads to 4 g/kW NO_x
 - Some aspects similar to recent Large SI Rule
 - 10% rolling work Avg.
 - Varies depending on rate of work performed
 - Normalized to 6-hr day
 - Typically 15 min. – 1 hr.
 - Increments every 1% work



Advantages of Alternative NTE

- Maximizes usefulness of on-vehicle data
 - Captures the wide variety of nonroad duty cycles
- Places cap on events of significant and contiguous work
 - Seeks maximum emissions of 10% work windows vs. minimum 30-second windows
 - Weights events relatively within duty cycle--proportional to environmental impact
- Allows intermittent excursions to be offset by lower emissions
 - Increases number of possible engineering solutions for engine manufacturers
- Simplifies on-vehicle testing
 - Longer averaging time allows application of FTP average BSFC, eliminating torque measurement
 - Eliminates absolute exhaust flow measurement, only req. signal linear to flow
 - Eliminates engine speed, P, & T measurements, simplifying installation



Test #38 Volvo A35D Haul Truck



Vehicle type **Haul Truck**

Vehicle manufacturer **Volvo**

Vehicle model number and/or vehicle serial number **A35D/V61126**

Engine manufacturer **Volvo**

Engine serial number **247968A**

Major exhaust leaks? If yes, do not test. **No**

Alternator does not provide reliable speed signal? If no, do not test. **O.K.**

Any obvious modifications or mal-maintenance? If yes, note details but proceed with test. **None**

Exhaust pipe ID = OD – 2 x wall thickness **4.325"**

Vehicle model year **2001**

Engine model number and model year **D12C, 2001, TC I-6, EFI, 1 inj/cyl**

Engine hour meter reading if present **4092**

Unit Power (i.e. 12V or 24V) **24V**

Engine rating (i.e. idle speed, rated power & speed, peak torque & speed) **375 hp @ 1900 rpm**

Installation date/time **4/22/02, 5:45 pm**

Removal date/time **5/2/02**

NOTES: Data post-test processed. This hauler was also used at an industrial building construction site.



Test #45 Caterpillar D6H Dozer



Vehicle type **Dozer**

Vehicle manufacturer **Caterpillar**

Vehicle model number and/or vehicle serial number **D6H/3ZF06039**

Engine manufacturer **Cat**

Engine serial number **08Z79758**

Major exhaust leaks? If yes, do not test. **No.**

Alternator does not provide reliable speed signal? If no, do not test. **O.K.**

Any obvious modifications or mal-maintenance? If yes, note details but proceed with test. **None.**

Exhaust pipe ID = OD – 2 x wall thickness, **3.75"**.

Vehicle model year **1995**

Engine model number and model year **3306/1995, turbocharged inline 6 cylinder, mechanical fuel system, 1 injector/cylinder.**

Engine hour meter reading if present **5867.7**

Exhaust after-treatment (i.e. oxidation catalyst? Y/N) **No.**

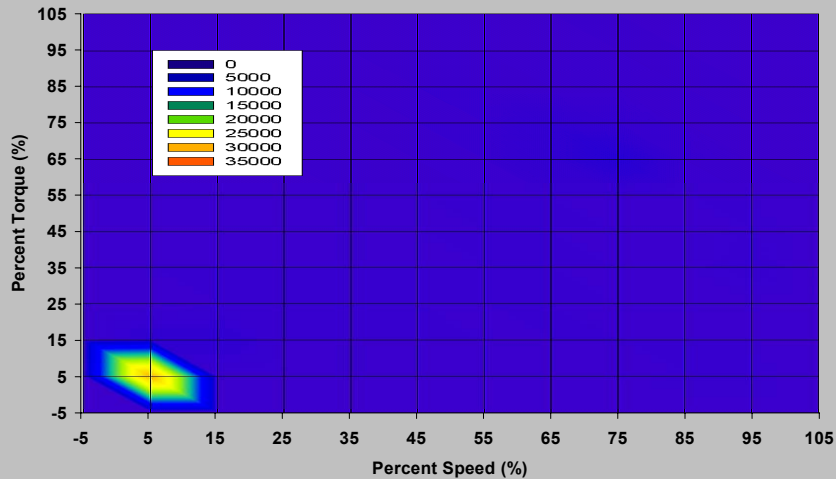
Unit Power (i.e. 12V or 24V) **24V**

Installation date/time **6/4/02, 7:20 pm**

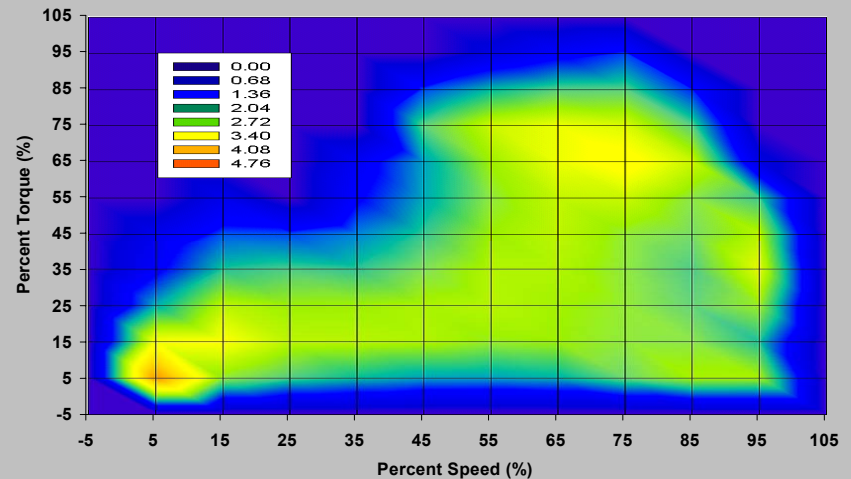
Removal date/time **6/18/02, 6:30 pm**

Haul Truck Duty Cycle

#38 A35D Hauler Truck Duty Cycle
Frequency

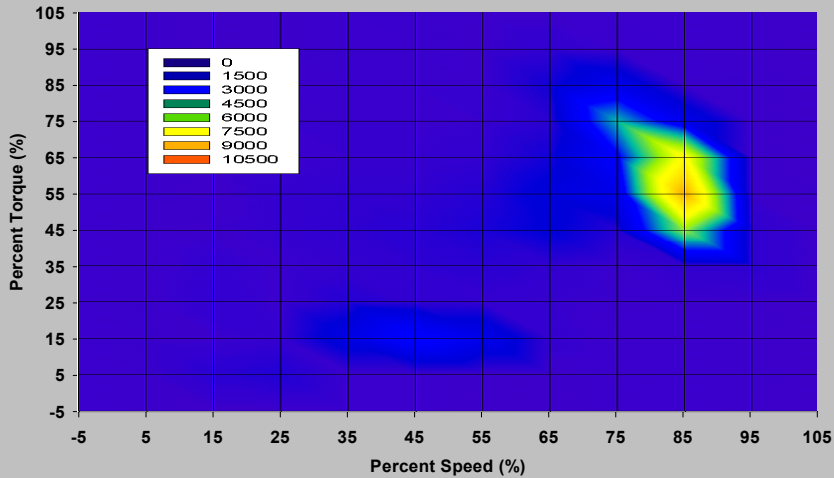


#38 A35D Hauler Truck Duty Cycle
 $\text{Log}_{10}(\text{Frequency})$

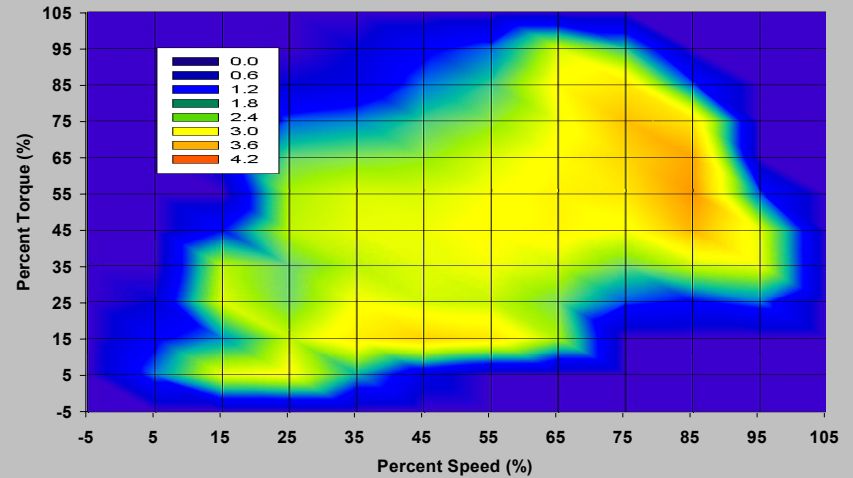


Dozer Duty Cycle

#45 D6H Dozer Duty Cycle
Frequency

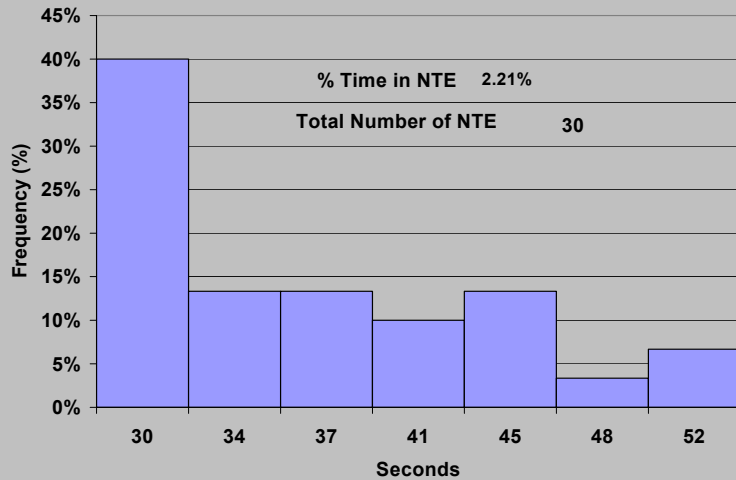


#45 D6H Dozer Duty Cycle
 $\text{Log}_{10}(\text{Frequency})$

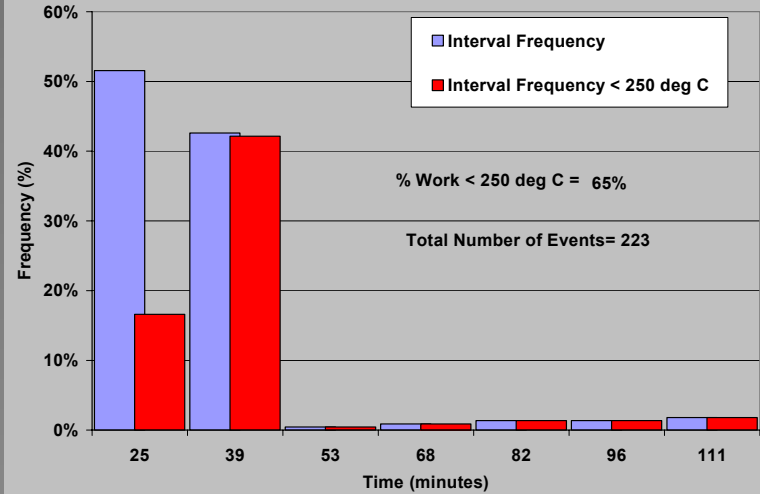


Haul Truck NTE Events

On-Highway NTE Event Durations
#38 A35D Haul Truck

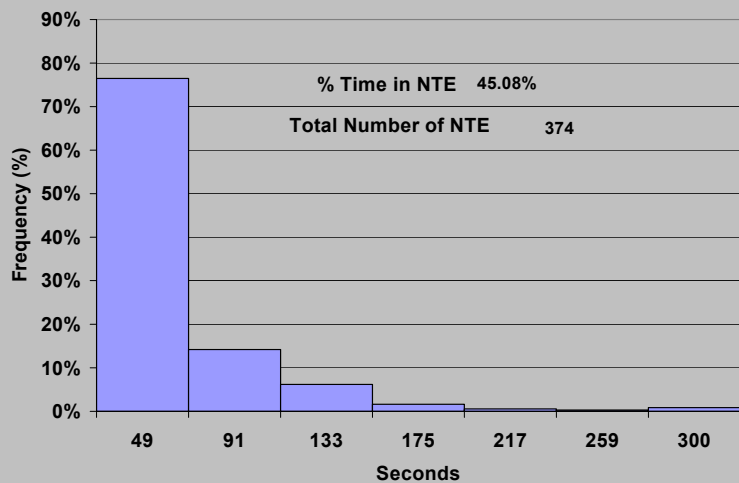


10% Work Interval Duration Histogram
#38 A35D Haul Truck

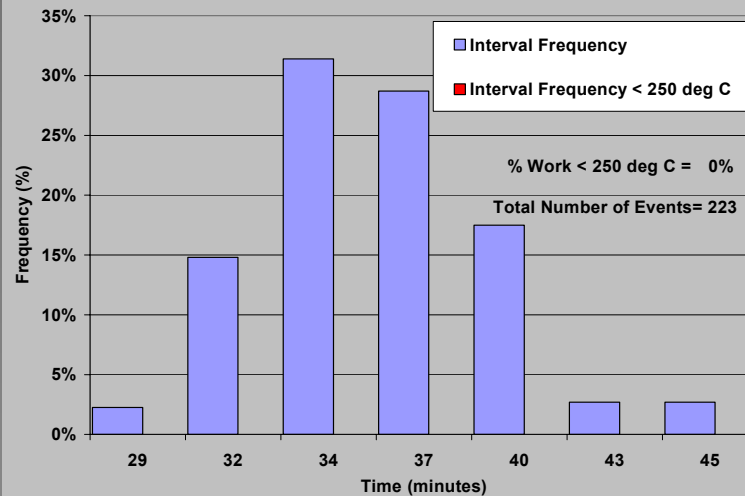


Dozer NTE Events

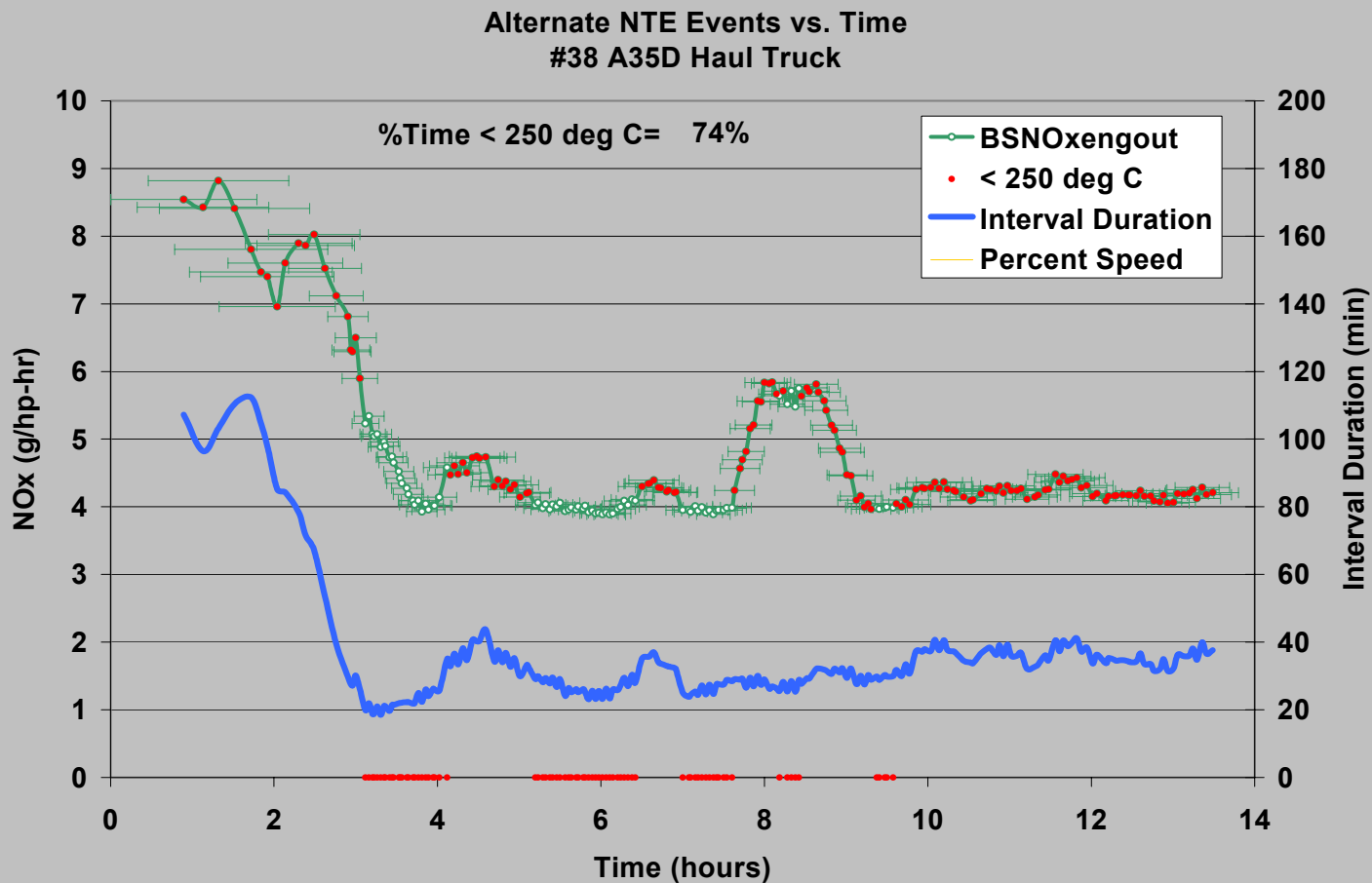
On-Highway NTE Event Durations
#45 D6H Dozer



10% Work Interval Duration Histogram
#45 D6H Dozer

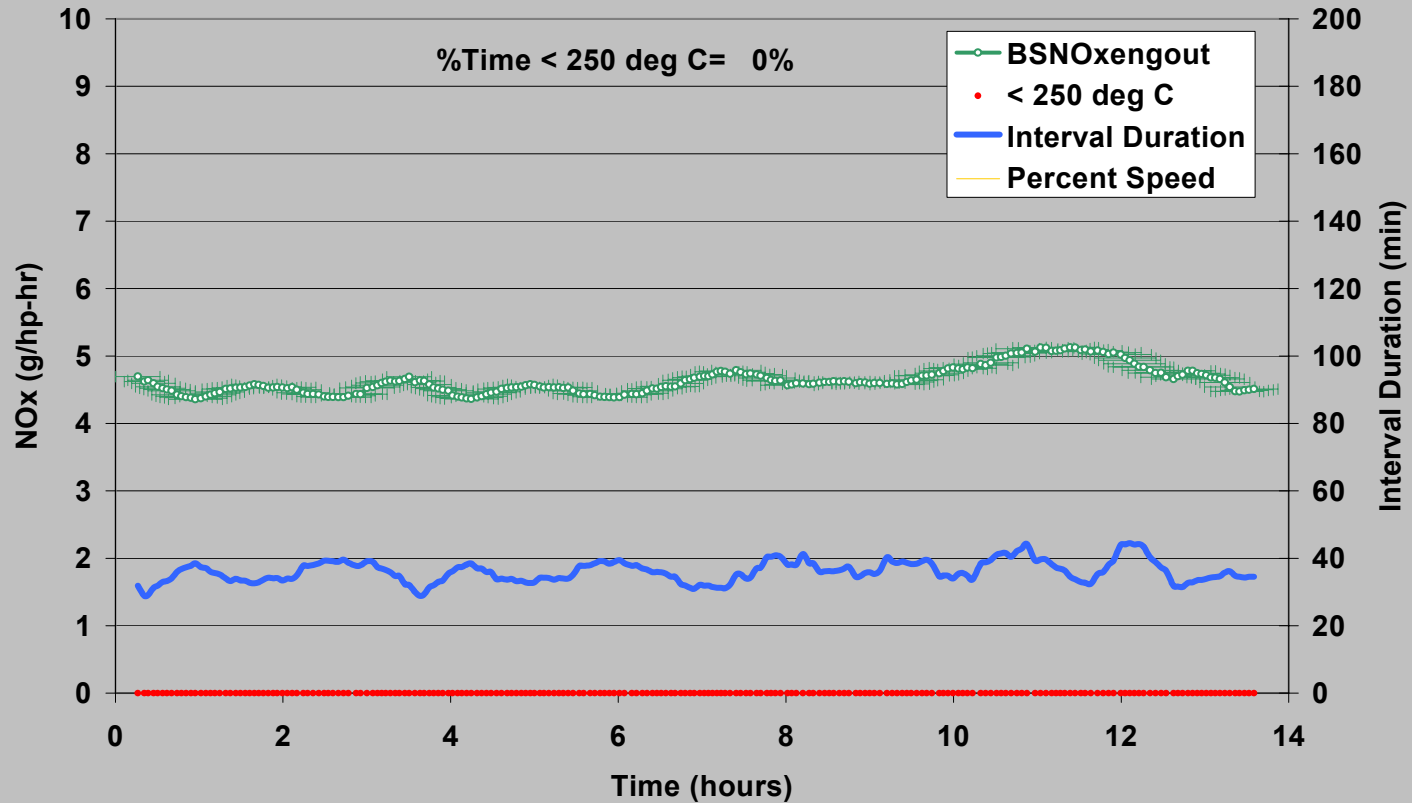


Haul Truck Alternate NTE



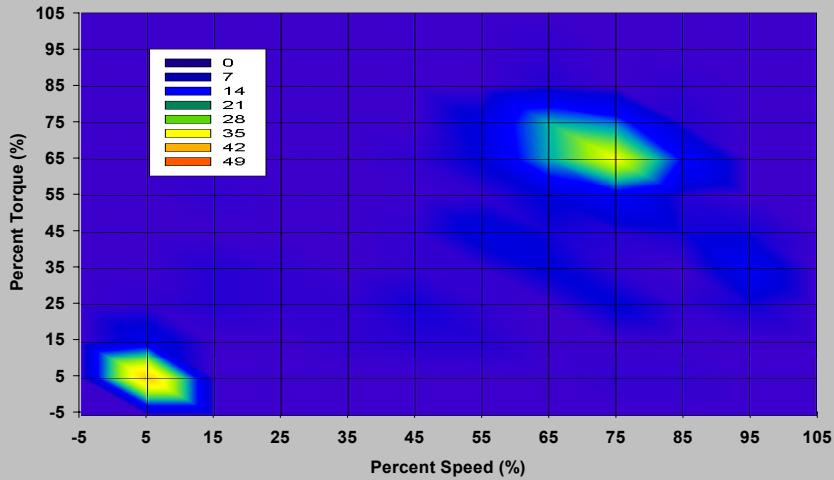
Dozer Alternate NTE

Alternate NTE Events vs. Time
#45 D6H Dozer

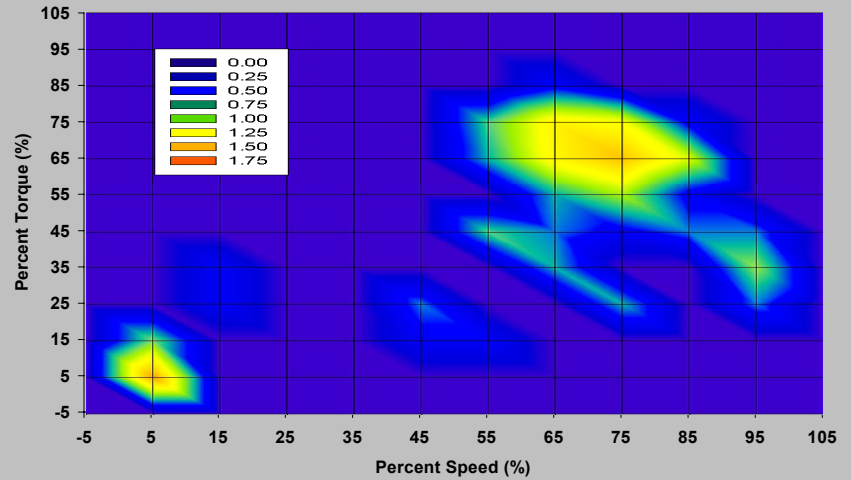


Haul Truck Alt. NTE Power

#38 A35D Hauler Truck Duty Cycle
(Linear) Frequency of 10% Work Intervals

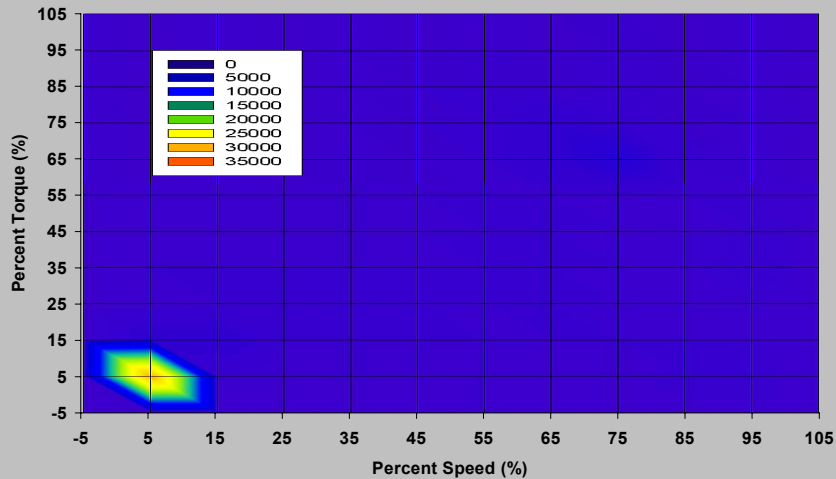


#38 A35D Hauler Truck Duty Cycle
 $\text{Log}_{10}(\text{Frequency})$ of 10% Work Intervals

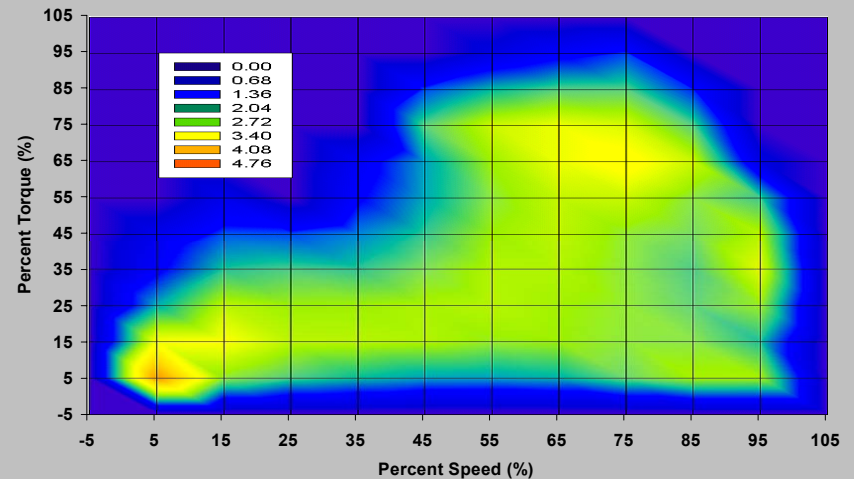


Haul Truck Duty Cycle

#38 A35D Hauler Truck Duty Cycle
Frequency

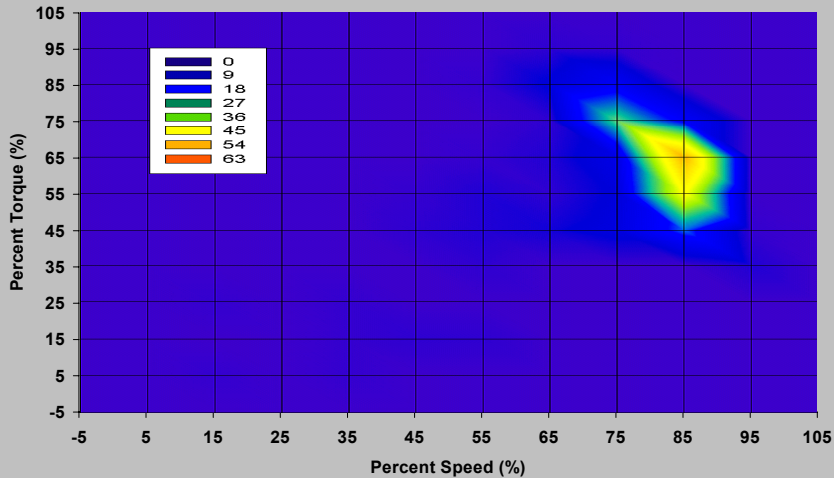


#38 A35D Hauler Truck Duty Cycle
 $\text{Log}_{10}(\text{Frequency})$

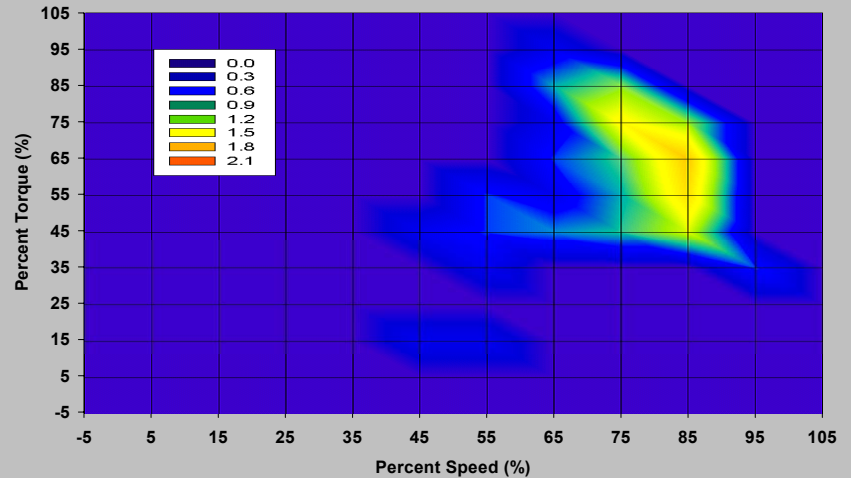


Dozer Alt. NTE Power

#45 D6H Dozer Duty Cycle
(Linear) Frequency of 10% Work Intervals

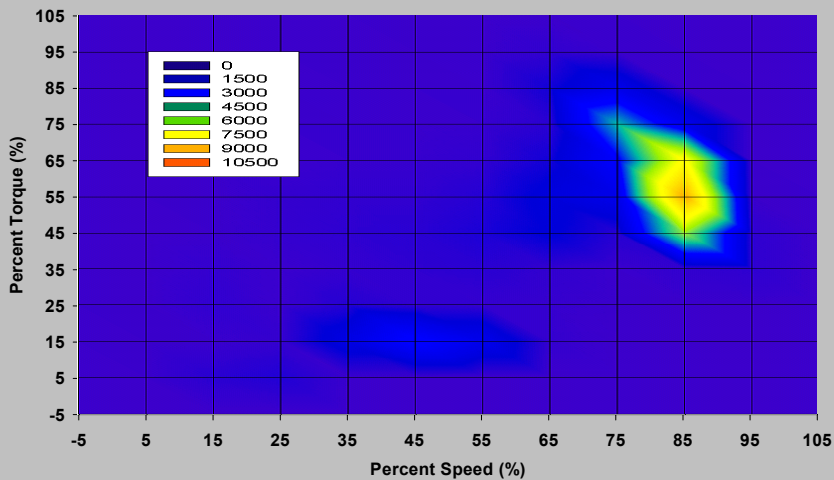


#45 D6H Dozer Duty Cycle
 $\text{Log}_{10}(\text{Frequency})$ of 10% Work Intervals

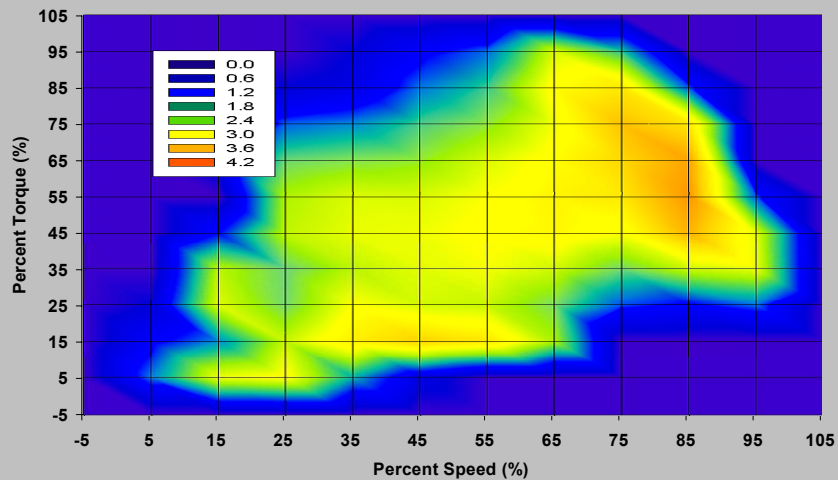


Dozer Duty Cycle

#45 D6H Dozer Duty Cycle
Frequency

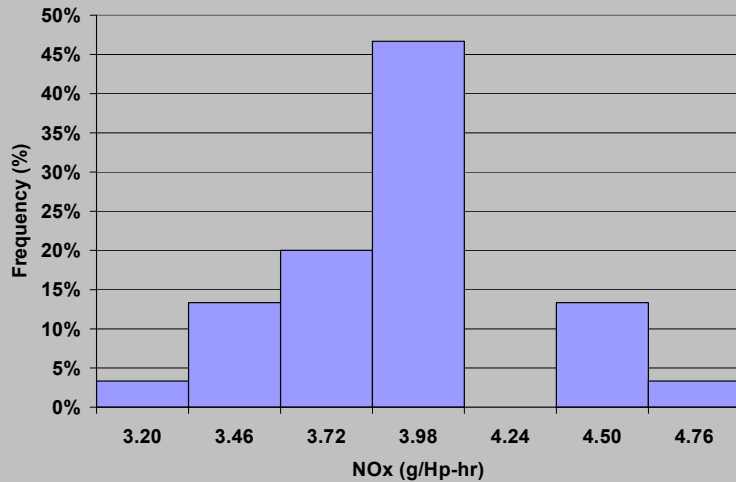


#45 D6H Dozer Duty Cycle
 $\text{Log}_{10}(\text{Frequency})$

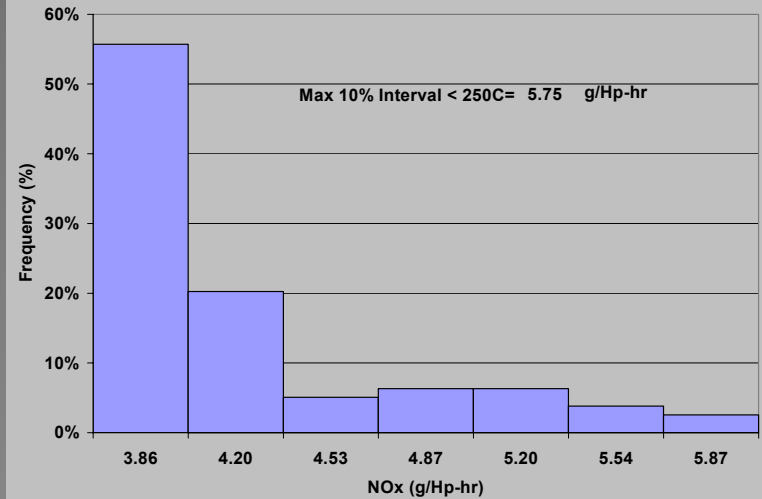


Haul Truck NTE Results

On-Highway NTE Results
#38 A35D Haul Truck

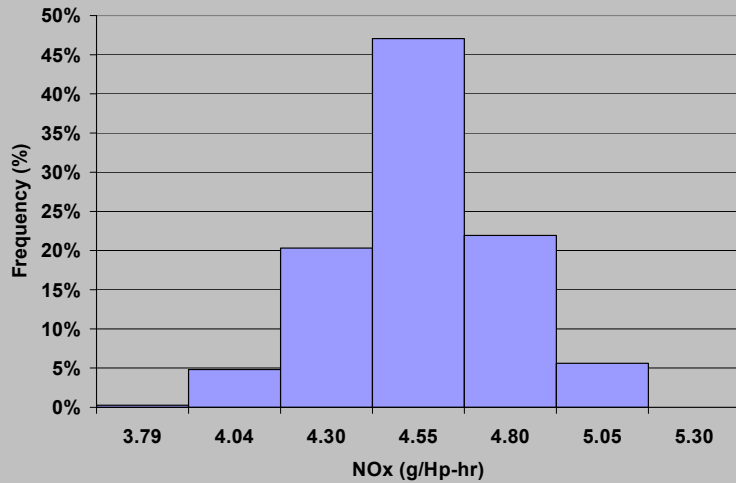


NOx Histogram of 10% Work Intervals <250C
#38 A35D Haul Truck

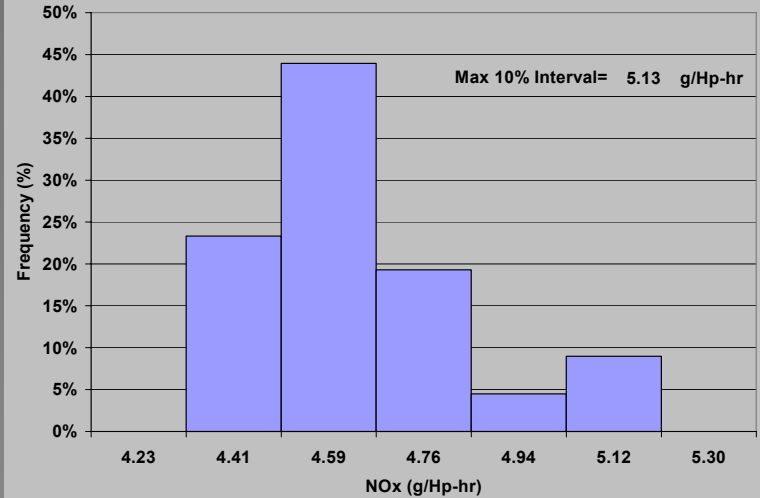


Dozer NTE Results

On-Highway NTE Results
#45 D6H Dozer



NOx Histogram of 10% Work Intervals
#45 D6H Dozer



Questions