



Characterization of CO₂ Emissions from Nonroad Diesel Construction Equipment

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EPA estimates:

- Over 2 million items of construction equipment in US
- Nearly 7 billion gallons of diesel fuel use in 2011
- Over 75 million tons of CO₂ emitted this year

Characterization of CO₂ Emissions

- Sources of variability
 - Equipment types
 - Engine sizes
 - Engine model years
 - Engine loads
 - Equipment duty cycles
- Most data based on engine dynamometer tests
- Field data needed to assess true nature of CO₂ emissions

Research Questions

- How do idle emission rates compare to non-idle emission rates for CO₂ on a mass per time basis?
- How do average emission rates based on field data compare to EPA NONROAD model data?
- How do emission rates vary among equipment types?

Field Data Collection

Portable Emissions Measurement System (PEMS)

- Montana System by CATI, Inc.
- Second-by-second data

Emissions Data

- CO₂
- CO
- HC
- NO_x
- PM

Engine Data

- Manifold Absolute Pressure (MAP)
- Revolutions Per Minute (RPM)
- Intake Air Temperature (IAT)

Montana System by CATI



Tailpipe Probes



Sensor Array



Bulldozer Outfitted with Montana

Summary Statistics for CO₂ Emission Rates (g/hp-h)



		Average	Max	Min	SD	95% CI
Backhoes (n = 8)	Idle	40	55	29	10	7
	Non-Idle	139	244	69	62	43
	Combined	124	233	65	56	39
Bulldozers (n = 6)	Idle	75	124	38	30	24
	Non-Idle	303	516	121	139	111
	Combined	258	481	111	132	106
Excavators (n = 3)	Idle	56	87	38	27	31
	Non-Idle	280	304	244	32	36
	Combined	206	225	177	25	28
Motor Graders (n = 6)	Idle	45	72	18	22	18
	Non-Idle	220	313	141	70	56
	Combined	191	292	128	72	58
Off Road Trucks (n = 3)	Idle	37	39	34	3	3
	Non-Idle	162	196	298	31	35
	Combined	89	112	67	23	26
Track Loaders (n = 3)	Idle	114	243	46	111	126
	Non-Idle	406	471	298	95	107
	Combined	362	443	256	96	108
Wheel Loaders (n = 5)	Idle	39	55	23	14	12
	Non-Idle	154	200	127	28	25
	Combined	118	177	85	38	33



Conclusions

- On average, non-idle emission rates are 3-5 times higher than idle emission rates
- Track loaders had highest overall average emission rates; off-road trucks had lowest
- Field data average emission rates were substantially lower than emission rates used by NONROAD
- Field data emission rates represent more variability among equipment types than NONROAD

Recommendations

Additional research needed to:

- Include other types of equipment such as compactors, cranes, rollers, and scrapers
- Include other types of pollutants such as NO_x, PM, HC, & CO
- Investigate factors affecting variability such as engine size, engine age, and maintenance
- Target idle and non-idle activity durations to help define equipment duty cycles