

Nonroad Idling Emission Estimation Methodology

Activity Factors

Data on idling activity as compared to total usage time are scarce. Three sources of data were relied on for this estimation: CARB, John Deere, and EPA. To estimate the emissions benefit for its nonroad idling rule, CARB asked individuals with significant experience in the industry to estimate the time off-road construction equipment spends idling unnecessarily. Their inquiry resulted in two estimates: 1) publicly owned fleets idle for 1.8% of the hours they are in use, and 2) privately-owned fleets idle 7.5% of the time. CARB further assumes that 95% of nonroad construction equipment is privately owned, giving an average idle rate of 7.2%.

Information obtained from John Deere distributors in the Northeast, who collected data from telematic devices installed on 19 construction machines. These devices allow equipment owners to monitor, in real-time, exactly how the machine is operating, including whether it is idling. The average idling rate from the John Deere survey is 42%, considerably higher than CARB's estimate. Data collected from EPA correspond to the data obtained from John Deere and because of this, and because the data were only for a very small number of equipment it was not included in further analysis.

Emission Factors

Idling emission rates for nonroad engines are likely to vary with rated power, size class, and emissions tier. Data was obtained for 35 nonroad engines tested by North Carolina State University¹. This data set was chosen for several reasons. First, we wanted a data set that contained specific information on idling emissions since USEPA's NONROAD model does not distinguish between emissions from idling and emissions during active use. In addition, when compared to a 1998 Study completed by SWRI² which we also evaluated, the North Carolina State data set was more recent, had more data points, and included Tier 2 as well as Tier 1 engines.

Attempts were made to fit several linear regression models to the data, using oxide of nitrogen (NO_x) emissions, particulate matter (PM) emissions, total hydrocarbon (THC), and fuel consumed as dependent variables. Equation 1 was found to have the best fit with the data with all three pollutants and fuel usages as dependent variables. Other regressions were attempted that included dummy variables for size class, log transformed variables, and separate regressions by engine tier, but none of these models fit the data as well.

Equation 1. Regression Equation for Calculating Emissions

$$Emissions = \alpha * RatedPower + \beta * Tier1 + \gamma * Tier2Plus + \epsilon$$

¹ Frey, C., W. Rasdorf, K. Kim, S. Pang, P. Lewis, and S. Abolhassani (2007). "Real-World Duty Cycles and Utilization for Construction Equipment in North Carolina," Final Report for Research Project No. HWY - 2006 - 08, North Carolina Department of Transportation, Raleigh, NC

² Fritz, S.G. and M.E. Starr, "Emission Factors for Compression Ignition Nonroad Engines Operated on Number 2 Highway and Nonroad Diesel Fuel," Southwest Research Institute. EPA contract # 68-C5-0077, SwRI 08-7601-822, March 1998.

The results of the regression analysis can be seen in Table 1. Figures 1-4 provide a visual representation of the relationships. The data suggest trends that are intuitive; namely, that emissions and fuel usage decrease with improved Engine Tier standards. Additionally, NO_x emissions and fuel consumed were found to correlate with the engine’s rated power. However, no statistically significant relationship was found between rated power and THC or PM emissions.

Table 1: Regression Coefficients

	Intercept	Horsepower	Tier1	Tier2+
NO _x	107.129 (31.314)***	0.752 (0.144)***	-114.889 (27.239)***	-128.951 (29.332)***
PM	1.04 (0.188)***	0.001 (0.001)	-0.645 (0.177)***	-0.823 (0.189)***
THC	17.359 (6.51)**	0.04 (0.03)	-9.778 (5.663)*	-11.709 (6.099)*
Fuel	0.72 (0.161)***	0.003 (0.001)***	-0.544 (0.14)***	-0.499 (0.151)***
* significant at 10%, ** significant at 5%, *** significant at 1%				

EPA’s NONROAD model shows a linear relationship between power rating and emissions. In the data set from North Carolina State discussed earlier, there was no significant relationship between horsepower and PM emissions when just looking at the idling portion of the data. However, if one compares the PM emissions level from nonidling activities with power rating there is statistically significant relationship. This suggests that the data set as a whole is valid.

Furthermore if one assumes idling activity rates of 7.2% to 42% and calculates average emissions based on these rates, one sees a significant relationship as well. These results can be seen in Table 2. Given that the NONROAD model is looking at total emissions, and not just idling, the North Carolina State field results would support this relationship and the NONROAD model would not contradict the relationship between power rating and PM idling emissions observed in the North Carolina State data.

Table 2: Particulate Matter Emissions Models for Non-Idling and Averaged Activities

	Intercept	Horsepower	Tier1	Tier2+
Non-Idling Activity	0.858 (0.632)	0.018 (0.003)***	-0.507 (0.594)	-1.595 (0.635)**
Averaged (Idling 7.2%)	0.871 (0.597)	0.017 (0.003)***	-0.517 (0.561)	-1.541 (0.6)**
Averaged (Idling 42%)	0.931 (0.436)**	0.011 (0.002)***	-0.562 (0.409)	-1.286 (0.438)***
* significant at 10%, ** significant at 5%, *** significant at 1%				

Equipment Populations

In order to account for the likely differences in emission factors for each of the equipment classes described above, we sought to isolate each equipment class within the fleet for further analysis based upon Source Classification Codes (SCCs). We used the NONROAD model to estimate populations of 65 nonroad engine types in each the 13 OTC states in the 2009 baseline year. We then constructed a spreadsheet to further disaggregate the population data by emissions tier and power class, and to calculate the annual activity (hours in operation) for each equipment type and for three size classes and three emissions tiers, using default values contained in NONROAD input data files and

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supporting documentation. We designed the spreadsheet to accept user-specified inputs for scenario year, idling rate, and percent of idling eligible for reduction. In addition, the spreadsheet can calculate emissions both state-by-state and regionwide.

Table 3 shows equipment population and activity data for each machine type in the OTC region. Real-world idling behavior, and fraction of idling that could reasonably be controlled, will likely vary substantially among many of the machine types. Tables 4-5 show avoidable idling emissions and fuel consumption for each machine type under the 7.2% (CARB) and 42% (Deere) scenarios, respectively, where the idling rates were rounded to the nearest significant digit.

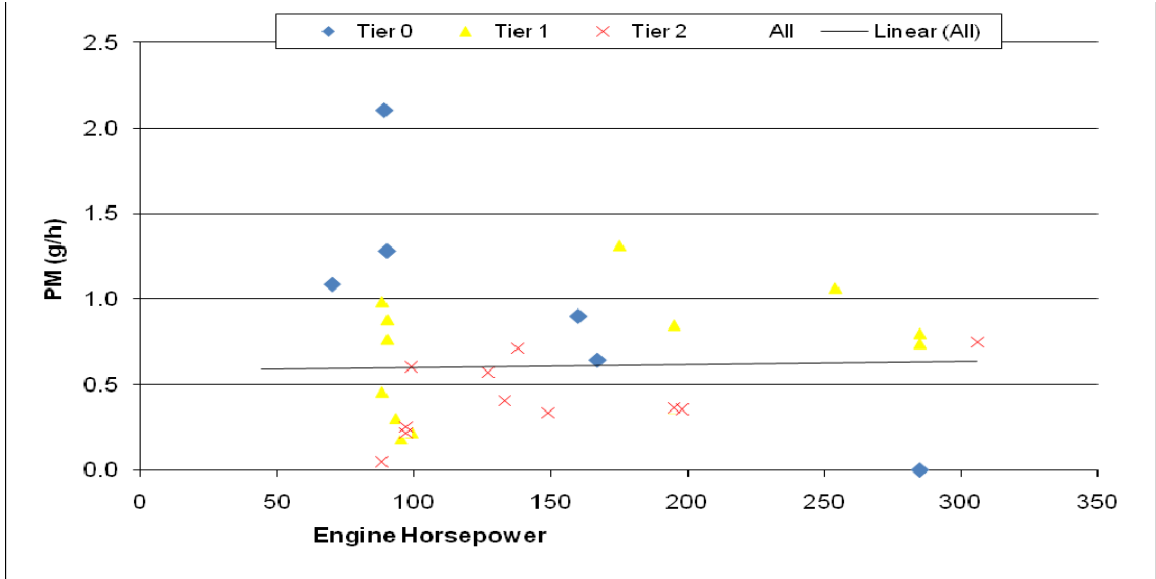


Figure 1: Analysis of NC State Idling PM Emissions Test Data

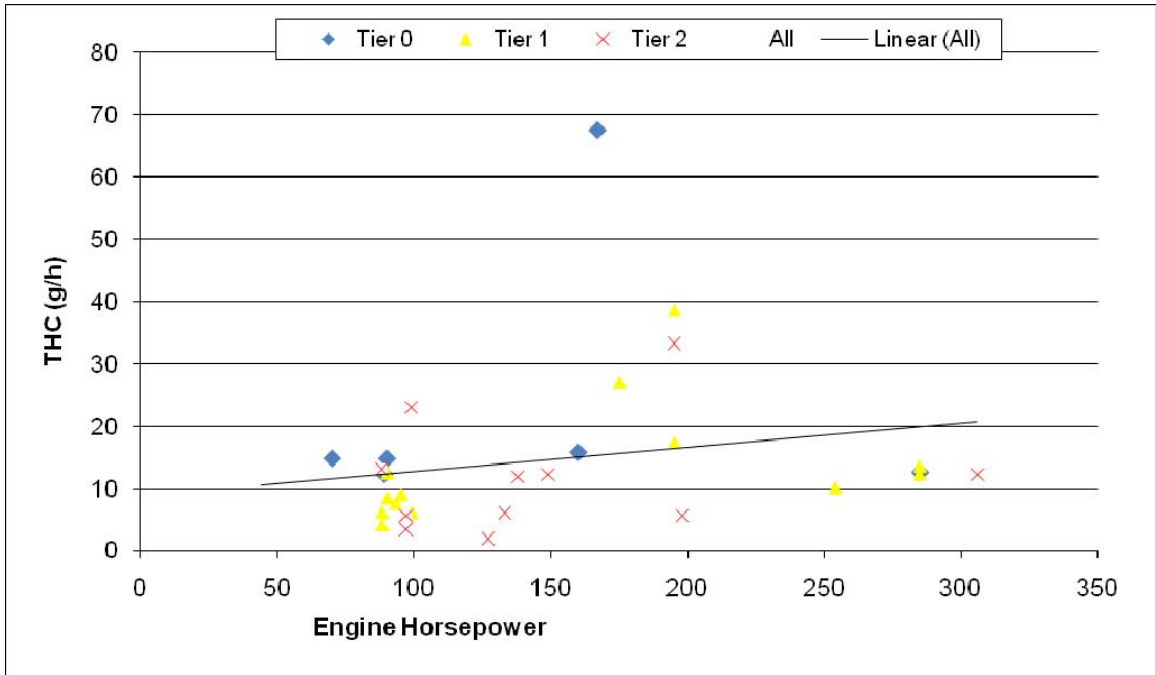


Figure 2: Analysis of NC State THC Idling Emissions Test Data

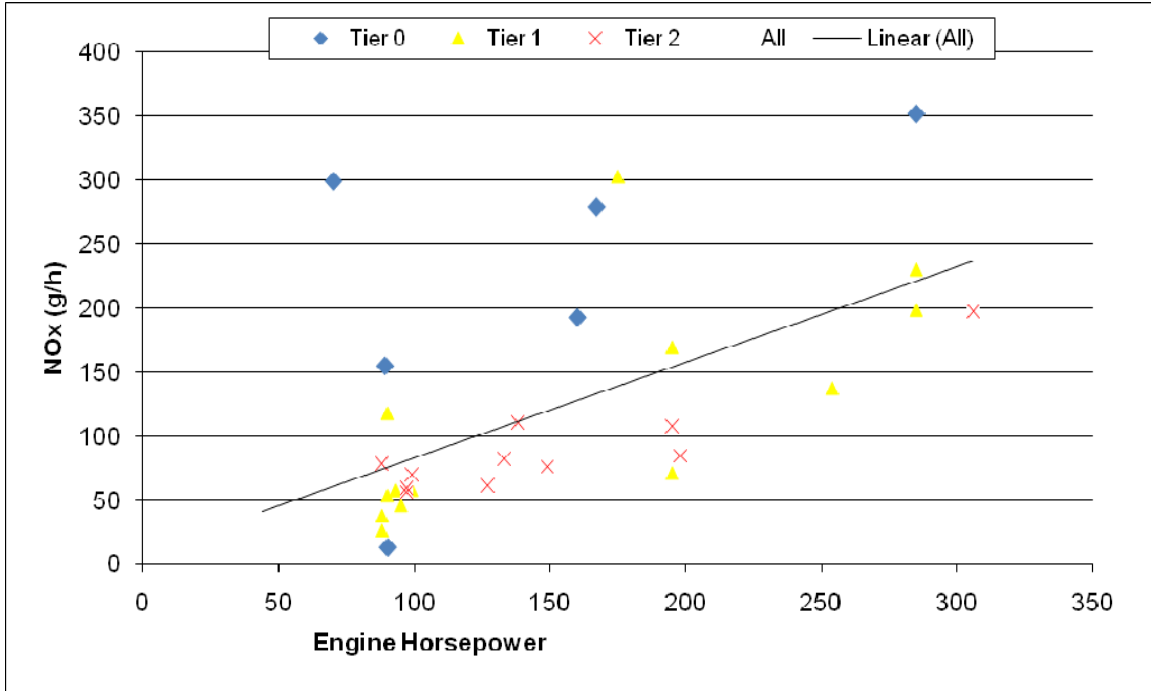


Figure 3: Analysis of NC State Idling NOx Emissions Test Data

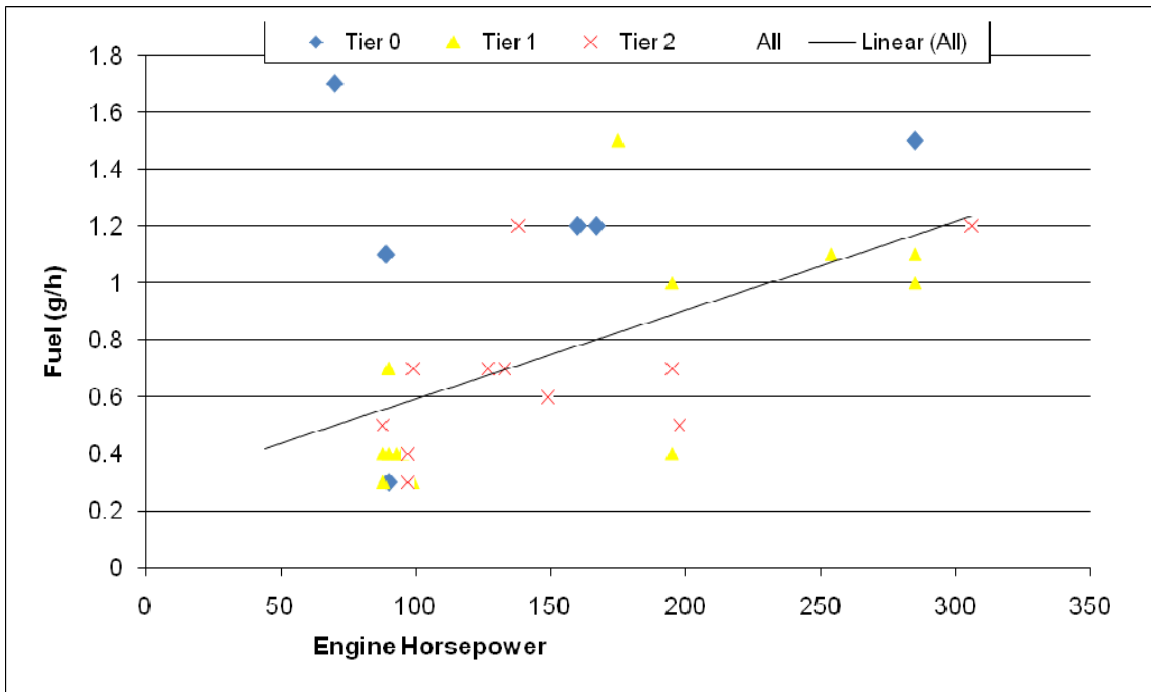


Figure 4: Analysis of NC State Idling Fuel Usage Test Data

Table 3: Equipment Population and Activity Estimates, OTC Region, 2009. Based on data from EPA’s NONROAD model and supporting documentation.

Classification	Equipment Type	Population	Annual Operating Hours per Machine	Total Hours	Population % of Category	Total Hours % of Class	Total Hours % of Fleet	Class Total Hours % of Fleet
Agricultural Equipment	2-Wheel Tractors	24	544	13320	0.02%	0.03%	0.0%	5.7%
Agricultural Equipment	Agricultural Mowers	17	363	6119	0.02%	0.01%	0.0%	
Agricultural Equipment	Agricultural Tractors	81098	475	38521472	76.04%	89.18%	5.1%	
Agricultural Equipment	Balers	314	95	29829	0.29%	0.07%	0.0%	
Agricultural Equipment	Combines	16361	150	2454188	15.34%	5.68%	0.3%	
Agricultural Equipment	Irrigation Sets	1303	749	975829	1.22%	2.26%	0.1%	
Agricultural Equipment	Other Agricultural Equipment	1539	381	586434	1.44%	1.36%	0.1%	
Agricultural Equipment	Sprayers	2584	90	232574	2.42%	0.54%	0.0%	
Agricultural Equipment	Swathers	3415	110	375666	3.20%	0.87%	0.0%	
Agricultural Equipment	Tillers > 6 HP	2	172	381	0.00%	0.00%	0.0%	
Airport Equipment	Airport Ground Support Equipment	4654	732	3406429	100.00%	100.00%	0.4%	0.4%
Commercial Equipment	Air Compressors	28820	815	23488110	9.14%	16.92%	3.1%	18%
Commercial Equipment	Gas Compressors	0	8500	1146	0.00%	0.00%	0.0%	
Commercial Equipment	Generator Sets	179235	338	60581331	56.86%	43.64%	8.0%	
Commercial Equipment	Hydro Power Units	1717	790	1356136	0.54%	0.98%	0.2%	
Commercial Equipment	Pressure Washers	12892	145	1869345	4.09%	1.35%	0.2%	
Commercial Equipment	Pumps	33354	403	13441503	10.58%	9.68%	1.8%	
Commercial Equipment	Welders	59208	643	38070534	18.78%	27.43%	5.0%	
Construction and Mining Equipment	Bore/Drill Rigs	8852	466	4125157	2.23%	1.20%	0.5%	
Construction and Mining Equipment	Cement & Mortar Mixers	3178	275	874031	0.80%	0.25%	0.1%	
Construction and Mining Equipment	Concrete/Industrial Saws	1437	580	833388	0.36%	0.24%	0.1%	
Construction and Mining Equipment	Cranes	7271	990	7198640	1.83%	2.09%	1.0%	
Construction and Mining Equipment	Crawler Tractor/Dozers	21464	936	20090673	5.41%	5.84%	2.7%	
Construction and Mining Equipment	Crushing/Proc. Equipment	1969	955	1880676	0.50%	0.55%	0.2%	
Construction and Mining Equipment	Dumpers/Tenders	869	566	491861	0.22%	0.14%	0.1%	
Construction and Mining Equipment	Excavators	27929	1092	30498416	7.04%	8.87%	4.0%	
Construction and Mining Equipment	Graders	6659	962	6405834	1.68%	1.86%	0.8%	
Construction and Mining Equipment	Off-Highway Tractors	911	855	779114	0.23%	0.23%	0.1%	
Construction and Mining Equipment	Off-highway Trucks	3508	1641	5756177	0.88%	1.67%	0.8%	
Construction and Mining Equipment	Other Construction Equipment	2714	606	1644836	0.68%	0.48%	0.2%	
Construction and Mining Equipment	Other Underground Mining	2396	1533	3673708	0.60%	1.07%	0.5%	
Construction and Mining Equipment	Pavers	4962	821	4073964	1.25%	1.18%	0.5%	
Construction and Mining Equipment	Paving Equipment	1740	622	1082381	0.44%	0.31%	0.1%	
Construction and Mining Equipment	Plate Compactors	4788	484	2317632	1.21%	0.67%	0.3%	
Construction and Mining Equipment	Rollers	17793	760	13522887	4.49%	3.93%	1.8%	
Construction and Mining Equipment	Rough Terrain Forklifts	24819	662	16430366	6.26%	4.78%	2.2%	
Construction and Mining Equipment	Rubber Tire Loaders	30904	761	23518142	7.79%	6.84%	3.1%	
Construction and Mining Equipment	Scrapers	3780	914	3454890	0.95%	1.00%	0.5%	
Construction and Mining Equipment	Signal Boards/Light Plants	14039	535	7510635	3.54%	2.18%	1.0%	
Construction and Mining Equipment	Skid Steer Loaders	115957	818	94852560	29.25%	27.59%	12.5%	
Construction and Mining Equipment	Surfacing Equipment	750	561	421024	0.19%	0.12%	0.1%	
Construction and Mining Equipment	Tampers/Rammers	548	460	252255	0.14%	0.07%	0.0%	
Construction and Mining Equipment	Tractors/Loaders/Backhoes	74512	1135	84571284	18.79%	24.60%	11.2%	
Construction and Mining Equipment	Trenchers	12740	593	7554568	3.21%	2.20%	1.0%	
Industrial Equipment	AC/Refrigeration	66157	1341	88716667	52.07%	59.38%	11.7%	20%
Industrial Equipment	Aerial Lifts	17096	384	6564909	13.46%	4.39%	0.9%	
Industrial Equipment	Forklifts	12511	1700	21269494	9.85%	14.24%	2.8%	
Industrial Equipment	Other General Industrial Eqp	12468	878	10947163	9.81%	7.33%	1.4%	
Industrial Equipment	Other Material Handling Eqp	1621	421	682339	1.28%	0.46%	0.1%	
Industrial Equipment	Other Oil Field Equipment	198	1231	243413	0.16%	0.16%	0.0%	
Industrial Equipment	Sweepers/Scrubbers	10556	1220	12878318	8.31%	8.62%	1.7%	
Industrial Equipment	Terminal Tractors	6444	1257	8099648	5.07%	5.42%	1.1%	
Lawn and Garden Equipment (Com)	Chippers/Stump Grinders	19477	465	9056844	18.89%	17.47%	1.2%	6.8%
Lawn and Garden Equipment (Com)	Commercial Turf Equipment	2840	1068	3032912	2.75%	5.85%	0.4%	
Lawn and Garden Equipment (Com)	Front Mowers	64067	480	30752116	62.12%	59.31%	4.1%	
Lawn and Garden Equipment (Com)	Lawn & Garden Tractors	16180	544	8801711	15.69%	16.98%	1.2%	
Lawn and Garden Equipment (Com)	Leafblowers/Vacuums	107	120	12857	0.10%	0.02%	0.0%	
Lawn and Garden Equipment (Com)	Other Lawn & Garden Eqp.	193	433	83427	0.19%	0.16%	0.0%	
Lawn and Garden Equipment (Com)	Snowblowers	270	400	107920	0.26%	0.21%	0.0%	
Logging Equipment	Forest Eqp - Feller/Bunch/Skidder	3078	1276	3928120	100.00%	100.00%	0.5%	0.5%
Logging Equipment	Shredders > 6 HP	0	120	0	0.00%	0.00%	0.0%	
Pleasure Craft	Inboard/Sterndrive	82363	200	16472518	96.74%	97.53%	2.2%	2.2%
Pleasure Craft	Outboards	2775	150	416315	3.26%	2.47%	0.1%	
Railroad Equipment	Railway Maintenance	1410	943	1329743	100.00%	100.00%	0.2%	0.2%
Recreational Equipment	Speciality Vehicle Carts	10328	435	4492761	100.00%	100.00%	0.6%	0.6%

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Equipment Type	Total Population	Tier 0 & Pre Control	Tier 1	Tier 2+	Tier 0 & Pre Control	Tier 1	Tier 2+	Tier 0 & Pre Control	Tier 1	Tier 2+	Tier 0 & Pre Control	Tier 1	Tier 2+
2-Wheel Tractors	24	242	243	18	4046	4665	474	26350	0	0	174	123	21
Agricultural Mowers	17	405	10	3	6766	195	73	64022	1269	454	373	11	6
Agricultural Tractors	81098	1894935	282760	34815	31620219	5420239	903783	286667311	18532449	4896452	1690723	225338	69771
Balers	314	2149	0	5	35864	8	118	311073	33	492	1859	0	8
Combines	16361	173350	1359	374	2892641	26047	9706	25873728	138736	45211	153217	1288	723
Irrigation Sets	1303	52515	5396	910	876295	103429	23634	7710371	378113	84401	45886	4401	1613
Other Agricultural Equipment	1539	37249	1289	431	621566	24707	11192	5727630	131392	73515	33618	1221	919
Sprayers	2584	16746	20	29	279434	384	745	2528393	1969	3344	14921	19	55
Swathers	3415	27079	1	57	451853	25	1486	4198508	0	9011	24583	1	117
Tillers > 6 HP	2	26	1	0	433	10	2	3968	25	34	23	0	0
Airport Ground Support Equipment	4654	67260	58946	6198	1122354	1129937	160901	12800835	7184544	1305210	70879	60621	14066
Air Compressors	28820	1180519	150542	28009	19698961	2885755	727081	179686082	12218162	3500995	1057835	129272	53465
Gas Compressors	0	0	0	17	0	0	453	0	0	3678	0	0	40
Generator Sets	179235	4042755	97965	23229	67460240	1877888	603010	522490701	4092124	748186	3238314	68433	33120
Hydro Power Units	1717	55468	13245	1767	925573	253896	45864	8093542	613078	127193	48258	9494	2950
Pressure Washers	12892	133124	850	285	2221408	16299	7393	16415421	20774	6570	103366	533	405
Pumps	33354	875038	24081	8456	14601494	461604	219509	114258566	893086	433053	705752	16291	12524
Welders	59208	2534928	64945	13912	42299592	1244925	361158	341109418	3758805	571780	2086360	49688	21438
Bore/Drill Rigs	8852	269097	8969	2264	4490336	171923	58773	43715527	1034596	332275	252540	8997	4602
Cement & Mortar Mixers	3178	59559	977	351	993838	18725	9121	7049490	21492	6481	45026	588	436
Concrete/Industrial Saws	1437	24662	11518	1198	411526	220783	31110	3573086	519131	57605	21351	8199	1916
Cranes	7271	143004	121953	13331	2386260	2337726	346075	25826103	18721033	3583391	144944	141588	33917
Crawler Tractor/Dozers	21464	204467	398419	51576	3411882	7637319	1338869	48899744	79255071	11886873	256797	537452	123123
Crushing/Proc. Equipment	1969	66735	22206	2796	1113594	425659	72574	11190384	3230550	649118	64074	25043	6565
Dumpers/Tenders	869	33286	604	197	555427	11580	5117	4130344	22222	2946	25952	410	268
Excavators	27929	132210	544103	136824	2206146	10429938	3551861	20718407	49796055	23068779	120932	492110	289908
Graders	6659	50103	127173	17501	836057	2437793	454318	7639661	15190760	3240756	44952	129686	38475
Off-Highway Tractors	911	22806	13161	1806	380549	252287	46884	17283571	8869708	1677796	77601	43628	9533
Off-highway Trucks	3508	2412	38310	55910	40246	734364	1451376	2903712	76492026	26405179	12660	336716	189374
Other Construction Equipment	2714	80437	13258	2769	1342223	254149	71873	20989568	3435992	1142780	108276	21190	8692
Other Underground Mining Equipment	2396	198652	19589	3627	3314843	375510	94153	29967968	1669443	487568	176895	17207	7148
Pavers	4962	53757	78147	7813	897027	1498004	202829	7667634	5842542	570141	46040	65260	13553
Paving Equipment	1740	34188	14111	1572	570482	270489	40804	4657976	333113	54728	28376	8720	2267
Plate Compactors	4788	140077	7699	1765	2337425	147586	45831	15187836	0	0	100136	3878	1988

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Rollers	17793	199781	251493	25819	3333690	4820891	670250	28825639	17355626	1883836	172468	204032	43361
Rough Terrain Forklifts	24819	692459	154107	20633	11554852	2954083	535610	106833680	12940014	2536420	626435	134307	39652
Rubber Tire Loaders	30904	391199	418724	44858	6527815	8026544	1164472	82224500	59644632	11607830	444412	466963	112315
Scrapers	3780	44680	76449	11799	745566	1465455	306298	16772979	34025712	6201236	81309	180852	42482
Signal Boards/Light Plants	14039	427317	31128	7892	7130519	596692	204863	51059084	751192	17685	325038	19471	10546
Skid Steer Loaders	115957	6236679	156631	54058	104069609	3002473	1403311	889029931	10958285	4189768	5339174	127640	93354
Surfacing Equipment	750	13720	5567	597	228939	106717	15498	2702497	338104	64162	14836	4325	1092
Tampers/Rammers	548	15614	698	192	260540	13386	4988	1655307	0	0	11006	333	207
Tractors/Loaders/Backhoes	74512	5407853	196817	48712	90239223	3772803	1264534	804647151	19197675	4596529	4769368	182881	88741
Trenchers	12740	310945	73150	9932	5188645	1402217	257830	46806500	5365979	1002995	276469	60566	18108
AC/Refrigeration	66157	594759	1777787	248796	9924571	34078510	6458580	85746590	120157211	13687026	513161	1431822	398577
Aerial Lifts	17096	459121	5379	1000	7661217	103105	25964	63487473	328314	73509	384940	4186	1714
Forklifts	12511	0	153769	239420	0	2947609	6215176	0	16881422	34201339	0	150570	473460
Other General Industrial Eqp	12468	473374	97076	14660	7899047	1860861	380559	68093244	5683470	1118450	407795	74300	24900
Other Material Handling Eqp	1621	48124	399	104	803026	7652	2698	6737167	30448	8388	40690	336	182
Other Oil Field Equipment	198	3025	4606	617	50478	88295	16027	1070678	1465462	187870	5236	8486	1662
Sweepers/Scrubbers	10556	125410	255007	29625	2092679	4888242	769055	18044610	17908221	1735747	108056	208166	48831
Terminal Tractors	6444	12606	155456	35209	210350	2979942	914003	1809679	14041919	4034009	10844	139834	66280
Chippers/Stump Grinders	19477	604604	16412	4516	10088850	314606	117235	100647428	2284535	874107	577452	18082	9876
Commercial Turf Equipment	2840	23493	62421	6939	392016	1196554	180136	3322715	3287294	247452	20004	46418	10615
Front Mowers	64067	1850976	107027	22352	30886685	2051605	580243	229919231	3573531	291453	1444159	71050	31592
Lawn & Garden Tractors	16180	505943	34399	9311	8442516	659399	241713	59805915	685928	13199	382163	20921	12213
Leafblowers/Vacuums	107	908	7	2	15154	136	51	100094	47	0	656	4	2
Other Lawn & Garden Eqp.	193	5399	164	51	90084	3150	1326	709306	6663	1789	4372	114	77
Snowblowers	270	7159	145	67	119462	2776	1730	1746517	48750	41902	9134	277	268
Forest Eqp - Feller/Bunch/Skidder	3078	4555	70262	21295	76004	1346851	552807	1113351	9944106	3551117	5820	78090	45221
Shredders > 6 HP	0	0	0	0	0	0	0	0	0	0	0	0	0
Inboard/Stern-drive	82363	1142267	8595	2437	19060674	164751	63250	202883775	1426897	543969	1143665	10423	5699
Outboards	2775	29406	231	63	490692	4418	1647	3713586	9607	705	23195	161	94
Railway Maintenance	1410	86721	2693	672	1447084	51630	17453	12670392	226299	61207	75518	2352	1207
Speciality Vehicle Carts	10328	309282	5444	684	5160901	104363	17753	39257261	191424	19174	244782	3654	1019
Totals	1153167	32636617	6243892	1282131	544597490	119689563	33283209	4730803211	671157059	177768867	28264850	6058027	2526357

Table 4: Avoidable Emissions from Idling by Source Classification Code in the Ozone Transport Region in 2009 Assuming 7.2% Avoidable Idling

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Equipment Type	TotalPopulation	PM Emissions from Avoidable Idling (g/y)			THC Emissions from Avoidable Idling (g/y)			NOx Emissions from Avoidable Idling (g/y)			Fuel used during Avoidable Idling (lb/y)						
		Tier 0 & Pre Control	Tier 1	Tier 2+	Tier 0 & Pre Control	Tier 1	Tier 2+	Tier 0 & Pre Control	Tier 1	Tier 2+	Tier 0 & Pre Control	Tier 1	Tier 2+				
2-Wheel Tractors	24		1386	1391	104		23121	26657	2709		150572	0	0		992	704	118
Agricultural Mowers	17		2317	58	16		38662	1113	415		365842	7250	2592		2131	61	34
Agricultural Tractors	81098		10828202	1615770	198945		180686967	30972793	5164477		1638098919	105899711	27979725		9661277	1287646	398691
Balers	314		12281	2	26		204938	48	674		1777558	188	2813		10625	2	48
Combines	16361		990572	7765	2137		16529377	148840	55464		147849872	792779	258348		875524	7363	4132
Irrigation Sets	1303		300083	30832	5202		5007398	591023	135051		44059262	2160647	482291		262208	25150	9217
Other Agricultural Equipment	1539		212853	7365	2464		3551807	141185	63957		32729313	750813	420087		192103	6979	5253
Sprayers	2584		95691	114	164		1596765	2192	4259		14447958	11253	19110		85262	107	314
Swathers	3415		154735	7	327		2582019	142	8490		23991472	0	51492		140473	3	670
Tillers > 6 HP	2		148	3	1		2477	56	13		22672	140	194		133	2	1
Airport Ground Support Equipment	4654		384345	336834	35418		6413450	6456784	919433		73147626	41054537	7458342		405021	346408	80376
Air Compressors	28820		6745820	860242	160049		112565491	16490029	4154748		1026777612	69818068	20005684		6044770	738699	305515
Gas Compressors	0		0	0	100		0	0	2591		0	0	21015		0	0	230
Generator Sets	179235		23101455	559797	132737		385487085	10730787	3445769		2985661151	23383565	4275351		18504651	391045	189255
Hydro Power Units	1717		316958	75686	10096		5288986	1450833	262080		46248809	3503305	726817		275761	54252	16858
Pressure Washers	12892		760711	4859	1627		12693760	93135	42247		93802407	118706	37544		590665	3044	2313
Pumps	33354		5000216	137604	48319		83437110	2637735	1254335		652906093	5103347	2474589		4032870	93094	71564
Welders	59208		14485305	371112	79500		241711954	7113860	2063761		1949196674	21478884	3267314		11922059	283933	122502
Bore/Drill Rigs	8852		1537695	51250	12937		25659062	982415	335843		249803013	5911976	1898713		1443083	51409	26295
Cement & Mortar Mixers	3178		340335	5582	2008		5679076	107002	52122		40282800	122811	37036		257290	3361	2492
Concrete/Industrial Saws	1437		140925	65815	6848		2351577	1261619	177774		20417632	2966460	329173		122006	46849	10947
Cranes	7271		817164	696875	76180		13635773	13358432	1977570		147577729	106977329	20476518		828251	809076	193813
Crawler Tractor/Dozers	21464		1168384	2276680	294718		19496471	43641823	7650679		279427108	452886120	67924989		1467409	3071156	703563
Crushing/Proc. Equipment	1969		381345	126889	15975		6363396	2432338	414711		63945054	18460286	3709246		366136	143104	37513
Dumpers/Tenders	869		190204	3452	1126		3173870	66173	29240		23601968	126986	16835		148300	2340	1529
Excavators	27929		755485	3109158	781853		12606551	59599644	20296350		118390897	284548888	131821595		691040	2812055	1656617
Graders	6659		286304	726705	100007		4777471	13930247	2596102		43655208	86804343	18518607		256869	741061	219859
Off-Highway Tractors	911		130317	75207	10320		2174563	1441642	267911		98763260	50684045	9587404		443437	249301	54472
Off-highway Trucks	3508		13782	218914	319484		229979	4196367	8293577		16592643	437097290	150886737		72341	1924089	1082139
Other Construction Equipment	2714		459638	75762	15821		7669848	1452278	410701		119940389	19634239	6530174		618722	121086	49671
Other Underground Mining Equipment	2396		1135153	111939	20725		18941959	2145771	538015		171245532	9539674	2786105		1010829	98325	40843
Pavers	4962		307183	446554	44648		5125868	8560023	1159022		43815049	33385956	3257946		263087	372914	77448
Paving Equipment	1740		195359	80633	8982		3259897	1545654	233164		26617004	1903501	312733		162150	49830	12957

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Plate Compactors	4788	800440	43995	10088	13356711	843349	261889	86787633	0	0	572205	22161	11360
Rollers	17793	1141607	1437104	147539	19049656	27547946	3829997	164717936	99175006	10764774	985530	1165897	247777
Rough Terrain Forklifts	24819	3956907	880610	117901	66027726	16880474	3060627	610478173	73942936	14493829	3579627	767468	226586
Rubber Tire Loaders	30904	2235421	2392708	256329	37301803	45865963	6654127	469854287	340826468	66330455	2539499	2668360	641800
Scrapers	3780	255316	436851	67424	4260380	8374027	1750276	95845595	194432642	35435634	464626	1033441	242757
Signal Boards/Light Plants	14039	2441814	177874	45095	40745825	3409669	1170646	291766196	4292528	101056	1857361	111265	60262
Skid Steer Loaders	115957	35638168	895035	308904	594683477	17156989	8018917	5080171036	62618769	23941530	30509567	729374	533453
Surfacing Equipment	750	78399	31812	3412	1308223	609809	88560	15442842	1932025	366640	84778	24716	6239
Tampers/Rammers	548	89221	3990	1098	1488798	76493	28504	9458899	0	0	62891	1905	1184
Tractors/Loaders/Backhoes	74512	30902015	1124670	278355	515652703	21558876	7225910	4597983718	109701001	26265881	27253533	1045034	507092
Trenchers	12740	1776828	418000	56755	29649400	8012669	1473313	267465713	30662737	5731401	1579822	346092	103472
AC/Refrigeration	66157	3398625	10158783	1421694	56711835	194734345	36906171	489980516	686612637	78211576	2932347	8181842	2277584
Aerial Lifts	17096	2623549	30735	5715	43778383	589170	148365	362785561	1876078	420053	2199656	23918	9796
Forklifts	12511	0	878680	1368115	0	16843478	35515289	0	96465269	195436226	0	860402	2705488
Other General Industrial Eq	12468	2704993	554721	83771	45137412	10633490	2174624	389104252	32476974	6391140	2330256	424571	142285
Other Material Handling Eq	1621	274993	2281	594	4588718	43725	15415	38498098	173990	47934	232515	1919	1039
Other Oil Field Equipment	198	17286	26321	3528	288443	504544	91581	6118157	8374070	1073544	29922	48494	9500
Sweepers/Scrubbers	10556	716629	1457182	169288	11958166	27932814	4394602	103112057	102332690	9918554	617464	1189520	279036
Terminal Tractors	6444	72034	888319	201195	1202002	17028237	5222877	10341022	80239535	23051478	61968	799050	378741
Chippers/Stump Grinders	19477	3454881	93784	25806	57650570	1797751	669914	575128161	13054486	4994899	3299723	103328	56432
Commercial Turf Equipment	2840	134244	356692	39652	2240092	6837450	1029347	18986945	18784537	1414010	114307	265245	60660
Front Mowers	64067	10577006	611582	127726	176495341	11723456	3315676	1313824176	20420175	1665444	8252336	406002	180527
Lawn & Garden Tractors	16180	2891101	196566	53207	48242946	3767993	1381216	341748088	3919588	75423	2183788	119550	69790
Leafblowers/Vacuums	107	5189	41	11	86593	780	291	571967	266	0	3748	21	13
Other Lawn & Garden Eq.	193	30849	939	292	514767	18002	7578	4053177	38073	10220	24985	650	441
Snowblowers	270	40909	828	381	682639	15864	9887	9980094	278573	239439	52192	1585	1531
Forest Eq - Feller/Bunch/Skidder	3078	26027	401495	121687	434308	7696291	3158895	6362003	56823463	20292096	33257	446231	258405
Shredders > 6 HP	0	0	0	0	0	0	0	0	0	0	0	0	0
Inboard/Sterndrive	82363	6527242	49112	13923	108918139	941435	361431	1159335860	8153696	3108397	6535228	59563	32568
Outboards	2775	168035	1317	362	2803956	25248	9409	21220493	54896	4031	132544	920	536
Railway Maintenance	1410	495547	15391	3842	8269051	295027	99730	72402242	1293140	349751	431530	13442	6900
Speciality Vehicle Carts	10328	1767327	31110	3908	29490864	596358	101446	224327208	1093849	109564	1398754	20881	5820
Totals	1153167	186494955	35679385	7326463	3111985656	683940360	190189766	27033161205	3835183195	1015822098	161513431	34617298	14436323

Table 5: Avoidable Emissions from Idling by Source Classification Code in the Ozone Transport Region in 2009 Assuming 42% Avoidable Idling