APPENDIX B

TECHNICAL SUPPORTING INFORMATION

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1. Biodiesel NOx Emissions Calculation

As part of staff's determination of the effect of biodiesel on NOx emissions a methodology was developed that takes into account varying factors including offsetting effects. As part of this analysis staff takes the illustrative fuel volumes from the LCFS re-adoption and the projected Vehicle Miles Travelled (VMT) of NTDEs in EmFAC 2011. The renewable diesel volumes are adjusted by the amount expected to be consumed by refineries. These factors are used to determine the total NOx emissions impacts of biodiesel compared to the use of CARB diesel, as shown in the table below.

After January 1, 2018, biodiesel used above B5 (assumed to be B20) is controlled by in-use requirements and does not cause NOx. Thus this volume is subtracted from total biodiesel to determine the amount of biodiesel (BD) potentially causing NOx. The next step is to determine the amount of biodiesel used in legacy vehicles (non-NTDE). This is important because the NOx increase is seen in legacy vehicles not NTDE vehicles. The proportion of legacy vehicles is determined by subtracting the percentage of NTDEs from 100% to determine the percentage of legacy vehicles. The amount of fuel used in legacy vehicles is then determined by multiplying the percentage of legacy vehicles by the volume of biodiesel potentially causing NOx. The same calculation is then completed for RD. Staff assumed that 40 percent of renewable diesel is used in refineries, and as such does not reduce NOx since refineries may use the NOx benefit of RD in their CARB diesel formulations. The calculated RD used in legacy vehicles is divided by 2.75 to get the amount of RD offsetting BD. As discussed earlier, renewable diesel decreases NOx and the NOx increase from one gallon of biodiesel is offset by the NOx decrease from 2.75 gallons of renewable diesel. The amount of biodiesel offset by legacy RD is then subtracted from the BD amount used in legacy to result in the amount of biodiesel causing NOx. That total is divided by the liquid diesel demand and multiplied by the NOx increase of B100 to determine a %NOx increase from BD. The total change is then multiplied by the diesel portion of the emissions inventory to get NOx increase from biodiesel.

Table B-1: Biodiesel NOx Emissions Calculations

(Million gallons)	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Total Biodiesel	72	97	129	160	180	180	180	185	185	185
B20 (No NOx post 2018)					30	30	30	35	35	35
BD Potentially causing NOx	72	97	129	160	150	150	150	150	150	150
RD Volume	120	180	250	300	320	360	400	500	550	600
Liquid Diesel Demand	3732	3788	3845	3903	3961	4021	4081	4142	4204	4267
	NOx emissions Calculations									
%NTDE (EmFAC 2011) (VMT)	40.09%	50.86%	59.87%	66.35%	71.26%	75.00%	79.78%	85.03%	88.74%	98.44%
BD used in legacy vehicles	43.1	47.7	51.8	53.8	43.1	37.5	30.3	22.5	16.9	2.3
%NOx increase (B100)	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
RD used in legacy	72	88	100	101	92	90	81	75	62	9
%RD used in refineries	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
Legacy RD not used in refineries	43	53	60	61	55	54	49	45	37	6
Legacy BD offset by Legacy RD	16	19	22	22	20	20	18	16	14	2
%NOx increase from BD	0.15%	0.15%	0.16%	0.16%	0.12%	0.09%	0.06%	0.03%	0.02%	0.00%
Emissions Inventory (Diesel TPD)	916	863	818	772	726	680	634	588	542	496
NOx increase from BD (TPD)	1.35	1.29	1.27	1.26	0.84	0.60	0.39	0.17	0.09	0.01
Net NOx increase (from 2014)	0.00	-0.05	-0.08	-0.09	-0.50	-0.74	-0.95	-1.17	-1.26	-1.34
NOx increase from BD (TPY)	492	472	464	459	308	221	144	63	32	3

2. Biodiesel Emissions B5 and B10 Testing Results

As part of staff's determination of biodiesel impacts of low biodiesel blends, we released a spreadsheet of data gathered from all testing we were aware of from B5 and B10 biodiesel blends using a CARB diesel baseline. Those emissions results are included in Table B-2. These data are also available at: http://www.arb.ca.gov/fuels/diesel/altdiesel/20140725B5&B10studies_raw_all_pollutants_%20data.xlsx

Table B-2: Biodiesel B5 and B10 Blends Emissions Testing Results

All raw data on B5 and B10 from animal and soy feedstocks. Values are in g/bhp-hr.									
Fuel	Cycle	Engine	Work	THC	CO	NOx	PM	CO2	BSFC (gal/bhp-hr)
Durbin 2011- Biodiesel Characterization and NOx Mitigation Study									
B5 - Soy	CRUISE - 40mph	2006 Cummins ISM	42.980	0.249	0.613	2.079	0.045	586.063	0.060
			43.210	0.248	0.617	2.044	0.045	579.506	0.059
CARB ULSD	CRUISE - 40mph	2006 Cummins ISM	43.146	0.247	0.582	2.040	0.046	569.448	0.058
			43.372	0.249	0.618	2.012	0.048	573.429	0.058
			43.150	0.257	0.607	2.031	0.049	577.056	0.059
B5 - Soy	CRUISE - 50mph	2006 Cummins ISM	34.379	0.180	0.451	1.776	0.049	539.299	0.055

			34.238	0.181	0.511	1.674	0.054	548.853	0.056
			34.210	0.184	0.481	1.790	0.051	541.312	0.055
			34.193	0.183	0.479	1.791	0.050	542.130	0.055
			34.302	0.184	0.472	1.660	0.052	547.319	0.056
			34.214	0.183	0.474	1.669	0.051	550.718	0.056
CARB ULSD	CRUISE - 50mph	2006 Cummins ISM	34.367	0.181	0.475	1.767	0.052	537.155	0.055
			34.285	0.179	0.458	1.777	0.052	540.383	0.055
			34.265	0.182	0.454	1.757	0.053	538.915	0.055
			34.345	0.190	0.464	1.826	0.053	547.919	0.056
			34.283	0.191	0.505	1.676	0.056	552.006	0.056
			34.249	0.190	0.481	1.677	0.056	552.186	0.056
B5-Soy	FTP	2006 Cummins ISM	26.570	0.300	0.742	2.146	0.074	633.678	0.065
			26.715	0.295	0.676	2.139	0.066	630.990	0.064
			26.556	0.295	0.694	2.146	0.067	635.459	0.065
			26.488	0.282	0.687	2.155	0.066	631.014	0.064
			26.616	0.284	0.686	2.157	0.066	629.410	0.064
			26.621	0.287	0.686	2.137	0.066	631.529	0.064
CARB ULSD	FTP	2006 Cummins ISM	26.650	0.280	0.698	2.076	0.072	624.986	0.064
			26.598	0.286	0.694	2.067	0.072	625.364	0.064
			26.457	0.288	0.710	2.090	0.074	630.497	0.064
			26.525	0.293	0.715	2.076	0.073	629.674	0.064
			26.603	0.297	0.690	2.092	0.073	633.139	0.064
			26.676	0.293	0.673	2.093	0.077	631.495	0.064
			26.593	0.296	0.705	2.097	0.073	634.048	0.064
			26.703	0.289	0.673	2.083	0.070	623.705	0.063
			26.589	0.294	0.681	2.088	0.071	630.334	0.064
			26.656	0.296	0.691	2.068	0.071	627.629	0.064
			26.590	0.298	0.714	2.113	0.072	630.587	0.064
			26.640	0.298	0.689	2.110	0.070	632.011	0.064
			26.639	0.300	0.703	2.112	0.072	633.399	0.064
			26.688	0.306	0.730	2.123	0.073	635.859	0.065
			26.797	0.302	0.686	2.105	0.070	631.540	0.064
			26.675	0.304	0.698	2.104	0.072	633.093	0.064
			26.720	0.298	0.673	2.092	0.070	627.904	0.064
			26.655	0.299	0.682	2.128	0.071	633.331	0.064
			26.660	0.301	0.699	2.106	0.070	631.359	0.064

			26.600	0.293	0.698	2.114	0.071	629.096	0.064
			26.476	0.296	0.717	2.109	0.072	630.787	0.064
			26.691	0.300	0.698	2.099	0.072	628.385	0.064
			26.558	0.289	0.716	2.093	0.071	633.251	0.064
			26.637	0.295	0.725	2.078	0.073	633.116	0.064
			26.662	0.294	0.735	2.080	0.080	632.255	0.064
			26.559	0.294	0.747	2.104	0.073	636.271	0.065
			26.574	0.295	0.693	2.105	0.072	634.493	0.065
			26.605	0.289	0.713	2.109	0.070	633.036	0.064
			26.544	0.290	0.711	2.113	0.071	635.431	0.065
			26.580	0.292	0.711	2.130	0.069	634.065	0.064
			26.620	0.297	0.691	2.105	0.070	636.511	0.065
			26.714	0.293	0.699	2.118	0.071	633.708	0.064
			26.611	0.296	0.683	2.128	0.071	635.402	0.065
B5 - Soy	FTP	2007 MBE4000	28.647	0.005	0.070	1.309	0.000	578.991	0.059
			28.679	0.006	0.046	1.303	0.000	578.899	0.059
			28.535	0.006	0.065	1.312	0.000	581.532	0.059
			28.667	0.005	0.066	1.305	0.000	580.041	0.059
			28.606	0.005	0.065	1.307	0.000	581.602	0.059
			28.674	0.006	0.051	1.306	0.001	580.839	0.059
CARB ULSD	FTP	2007 MBE4000	28.638	0.003	0.073	1.305	0.001	580.798	0.059
			28.535	0.004	0.074	1.295	0.000	579.591	0.059
			28.635	0.003	0.078	1.291	0.000	578.233	0.059
			28.611	0.005	0.067	1.295	0.001	580.980	0.059
			28.542	0.005	0.073	1.295	0.001	580.184	0.059
			28.569	0.004	0.091	1.293	0.001	580.473	0.059
B10-Soy	FTP	2006 Cummins ISM	26.629	0.274	0.707	2.149	0.062	632.076	0.065
			26.643	0.277	0.665	2.154	0.059	630.411	0.064
			26.726	0.277	0.692	2.152	0.054	631.084	0.064
			26.697	0.276	0.679	2.150	0.060	628.027	0.064
			26.689	0.275	0.699	2.164	0.062	629.416	0.064
			26.544	0.282	0.700	2.164	0.062	634.349	0.065
CARB ULSD	FTP	2006 Cummins ISM	26.650	0.280	0.698	2.076	0.072	624.986	0.064
			26.598	0.286	0.694	2.067	0.072	625.364	0.064
			26.457	0.288	0.710	2.090	0.074	630.497	0.064
			26.525	0.293	0.715	2.076	0.073	629.674	0.064

			26.603	0.297	0.690	2.092	0.073	633.139	0.064
			26.676	0.293	0.673	2.093	0.077	631.495	0.064
			26.593	0.296	0.705	2.097	0.073	634.048	0.064
			26.703	0.289	0.673	2.083	0.070	623.705	0.063
			26.589	0.294	0.681	2.088	0.071	630.334	0.064
			26.656	0.296	0.691	2.068	0.071	627.629	0.064
			26.590	0.298	0.714	2.113	0.072	630.587	0.064
			26.640	0.298	0.689	2.110	0.070	632.011	0.064
			26.639	0.300	0.703	2.112	0.072	633.399	0.064
			26.688	0.306	0.730	2.123	0.073	635.859	0.065
			26.797	0.302	0.686	2.105	0.070	631.540	0.064
			26.675	0.304	0.698	2.104	0.072	633.093	0.064
			26.720	0.298	0.673	2.092	0.070	627.904	0.064
			26.655	0.299	0.682	2.128	0.071	633.331	0.064
			26.660	0.301	0.699	2.106	0.070	631.359	0.064
			26.600	0.293	0.698	2.114	0.071	629.096	0.064
			26.476	0.296	0.717	2.109	0.072	630.787	0.064
			26.691	0.300	0.698	2.099	0.072	628.385	0.064
			26.558	0.289	0.716	2.093	0.071	633.251	0.064
			26.637	0.295	0.725	2.078	0.073	633.116	0.064
			26.662	0.294	0.735	2.080	0.080	632.255	0.064
			26.559	0.294	0.747	2.104	0.073	636.271	0.065
			26.574	0.295	0.693	2.105	0.072	634.493	0.065
			26.605	0.289	0.713	2.109	0.070	633.036	0.064
			26.544	0.290	0.711	2.113	0.071	635.431	0.065
			26.580	0.292	0.711	2.130	0.069	634.065	0.064
			26.620	0.297	0.691	2.105	0.070	636.511	0.065
			26.714	0.293	0.699	2.118	0.071	633.708	0.064
			26.611	0.296	0.683	2.128	0.071	635.402	0.065
B5 - Animal	FTP	2006 Cummins ISM	26.756	0.286	0.677	2.079	0.070	621.722	0.065
			26.676	0.292	0.681	2.093	0.070	625.282	0.065
			26.590	0.297	0.685	2.085	0.069	626.072	0.066
			26.570	0.297	0.683	2.093	0.068	627.470	0.068
			26.652	0.300	0.715	2.099	0.071	624.219	0.068
			26.672	0.299	0.674	2.087	0.069	623.306	0.068
CARB ULSD	FTP	2006 Cummins ISM	26.453	0.299	0.724	2.099	0.076	628.314	0.066
			26.585	0.305	0.693	2.087	0.075	628.067	0.066
			26.583	0.308	0.742	2.085	0.076	629.575	0.066

			26.577	0.302	0.713	2.089	0.072	626.206	0.064
			26.629	0.302	0.710	2.074	0.079	623.568	0.063
			26.629	0.302	0.710	2.062	0.079	623.568	0.063
B5 - Animal	FTP	2007 MBE4000	28.601	0.005	0.062	1.311	0.001	581.793	0.059
			28.574	0.008	0.074	1.308	0.001	583.817	0.059
			28.605	0.006	0.070	1.313	0.000	583.982	0.059
			28.480	0.006	0.068	1.316	0.001	587.733	0.060
			28.571	0.005	0.080	1.319	0.000	585.563	0.060
			28.508	0.005	0.077	1.317	0.000	585.178	0.059
CARB ULSD	FTP	2007 MBE4000	28.575	0.004	0.076	1.295	0.001	584.790	0.059
			28.609	0.005	0.073	1.289	0.000	583.101	0.059
			28.545	0.008	0.069	1.290	0.000	584.206	0.059
			28.589	0.006	0.096	1.301	0.001	581.388	0.059
			28.639	0.004	0.089	1.301	0.000	581.705	0.059
			28.524	0.004	0.083	1.307	0.000	583.545	0.059
TRU Study (part of 2011 Biodiesel Characterization and NOx Mitigation Study)									
B5-Soy	ISO 8178-4 C1	1999 Kubota TRU	No data	1.381	6.054	8.635	1.584	619.027	No data
			No data	1.472	6.304	9.000	1.602	621.212	No data
			No data	1.374	5.825	8.784	1.383	621.924	No data
			No data	1.325	5.671	9.109	1.531	621.025	No data
			No data	1.334	6.162	8.538	1.491	622.661	No data
			No data	1.135	6.371	8.671	1.630	626.671	No data
			No data	1.287	6.299	8.592	1.573	630.638	No data
			No data	1.252	6.101	8.692	1.570	629.242	No data
CARB ULSD	ISO 8178-4 C1	1999 Kubota TRU	No data	1.336	5.944	9.055	1.549	620.206	No data
			No data	1.475	5.697	8.987	1.513	619.158	No data
			No data	1.292	5.673	8.714	1.390	623.035	No data
			No data	1.375	6.363	8.816	1.496	624.634	No

									data
			No data	1.343	5.658	8.622	1.506	622.925	No data
			No data	1.241	6.486	8.503	1.585	622.932	No data
			No data	1.243	6.602	8.393	1.608	628.286	No data
			No data	1.134	6.594	8.648	1.615	625.054	No data
			No data	1.204	6.147	8.574	1.428	626.399	No data
			No data	1.117	6.345	8.328	1.610	625.471	No data
			No data	1.335	6.568	8.711	1.723	632.989	No data
John Deere Study (part of 2011 Biodiesel Characterization and NOx Mitigation Study)									
B5 - Animal	ISO 8178-4 C1	2009 John Deere 4045HF	58.025	0.140	1.249	2.640	0.108	654.301	No data
			59.576	0.175	1.166	2.694	0.095	648.814	No data
			59.050	0.129	1.178	2.538	0.100	640.811	No data
			59.298	0.137	1.242	2.694	0.105	654.543	No data
			58.674	0.132	1.310	2.626	0.113	653.924	No data
			57.484	0.143	1.222	2.651	0.098	664.292	No data
CARB ULSD	ISO 8178-4 C1	2009 John Deere 4045HF	58.862	0.169	1.187	2.690	0.076	642.608	No data
			59.538	0.159	1.267	2.685	0.106	646.342	No data
			59.098	0.156	1.214	2.699	0.106	652.373	No data
			58.744	0.217	1.311	2.612	0.107	660.206	No data
			59.672	0.129	1.148	2.648	0.109	637.148	No data
			58.530	0.133	1.323	2.632	0.114	655.929	No data
			58.890	0.135	1.239	2.647	0.099	651.141	No data

			58.841	0.141	1.264	2.722	0.124	649.127	No data
Durbin 2013 - CARB B5 Preliminary and Certification Testing									
B5 - Soy	FTP	2006 Cummins ISM	26.212	0.324	0.816	2.070	0.061	635.115	0.064
			26.128	0.330	0.805	2.067	0.063	636.837	0.064
			26.179	0.335	0.824	2.071	0.063	636.466	0.064
			26.215	0.332	0.801	2.061	0.062	636.491	0.064
			26.214	0.337	0.827	2.065	0.064	636.176	0.064
			26.125	0.339	0.795	2.086	0.063	637.625	0.064
CARB ULSD	FTP	2006 Cummins ISM	26.174	0.317	0.807	2.035	0.067	631.578	0.064
			26.205	0.320	0.813	2.051	0.064	631.097	0.064
			26.267	0.325	0.813	2.034	0.066	631.778	0.064
			26.315	0.317	0.792	2.034	0.066	630.574	0.063
			26.263	0.317	0.787	2.044	0.065	633.602	0.064
			26.157	0.322	0.797	2.064	0.065	635.144	0.064
B5- Animal	FTP	2006 Cummins ISM	26.252	0.347	0.802	1.999	0.062	636.928	0.065
			26.227	0.340	0.780	2.049	0.063	635.310	0.065
			26.202	0.341	0.815	2.055	0.065	637.443	0.065
			26.076	0.309	0.807	2.062	0.062	636.773	0.065
			26.147	0.312	0.807	2.060	0.062	638.336	0.065
			26.207	0.312	0.789	2.050	0.064	638.461	0.065
CARB ULSD	FTP	2006 Cummins ISM	26.174	0.317	0.807	2.035	0.067	631.578	0.064
			26.205	0.320	0.813	2.051	0.064	631.097	0.064
			26.267	0.325	0.813	2.034	0.066	631.778	0.064
			26.315	0.317	0.792	2.034	0.066	630.574	0.063
			26.263	0.317	0.787	2.044	0.065	633.602	0.064
			26.157	0.322	0.797	2.064	0.065	635.144	0.064
B5 - Animal	FTP	2006 Cummins ISM	26.141	0.317	0.734	2.054	0.064	640.411	0.065
			26.235	0.317	0.747	2.059	0.064	637.502	0.065
			26.201		0.710	2.035	0.062	637.357	
			26.237		0.745	2.024	0.066	637.880	

			26.193	0.309	0.731	2.023	0.064	637.041	0.065
			26.269	0.315	0.766	2.022	0.065	636.276	0.065
			26.243	0.303	0.751	2.028	0.065	636.613	0.065
			26.222	0.303	0.714	2.019	0.063	637.752	0.065
			26.267	0.307	0.769	2.030	0.064	635.646	0.064
			26.181	0.291	0.738	2.047	0.064	640.168	0.065
			26.197	0.326	0.740	2.036	0.065	637.503	0.065
			26.184	0.332	0.713	2.032	0.065	638.464	0.065
			26.287	0.308	0.750	2.014	0.064	636.100	0.065
			26.288	0.312	0.808	2.049	0.067	637.861	0.065
			26.241	0.327	0.711	2.035	0.065	630.743	0.064
			26.353	0.323	0.722	2.022	0.064	627.978	0.064
			26.213	0.310	0.758	2.039	0.064	638.419	0.065
			26.232	0.311	0.719	2.031	0.064	640.299	0.065
			26.270	0.326	0.702	2.030	0.064	632.213	0.064
			26.154	0.323	0.708	2.056	0.065	635.355	0.064
CARB ULSD	FTP	2006 Cummins ISM	26.173	0.322	0.771	2.044	0.068	638.055	0.064
			26.245	0.339	0.755	2.040	0.069	630.006	0.063
			26.246	0.283	0.780	2.044	0.067	635.655	0.064
			26.302		0.760	2.036	0.067	634.929	
			26.283		0.771	2.033	0.067	635.720	
			26.320	0.336	0.757	2.046	0.067	635.816	0.064
			26.235	0.312	0.803	2.051	0.065	636.990	0.064
			26.326	0.329	0.809	2.049	0.067	634.778	0.064
			26.249	0.325	0.799	2.031	0.067	638.402	0.064
			26.268	0.341	0.777	2.056	0.067	633.363	0.064
			26.262	0.337	0.805	2.051	0.070	632.077	0.064
			26.239	0.349	0.781	2.044	0.069	630.199	0.063
			26.332	0.315	0.795	2.037	0.066	635.121	0.064
			26.363	0.335	0.760	2.033	0.067	628.785	0.063
			26.192	0.332	0.773	2.046	0.067	633.752	0.064
			26.176	0.350	0.784	2.069	0.068	638.577	0.064
			26.246	0.321	0.793	2.046	0.064	635.479	0.064
			26.300	0.335	0.780	2.044	0.068	637.581	0.064
			26.321	0.336	0.810	2.043	0.068	636.569	0.064
			26.278	0.350	0.804	2.043	0.071	635.689	0.064
Karavalakis and Durbin 2014 - CARB Comprehensive B5/B10 Biodiesel Blends Heavy-Duty Engine Dynamometer Testing									
B5 -	FTP	2006	26.609	0.158	0.672	2.109	0.064	626.926	0.064

Soy		Cummins ISM							
			26.590	0.157	0.675	2.108	0.064	625.733	0.064
			26.705	0.172	0.675	2.103	0.065	621.435	0.064
			26.623	0.168	0.683	2.106	0.065	623.839	0.064
			26.801	0.161	0.686	2.101	0.063	622.351	0.064
			26.621	0.161	0.671	2.094	0.074	624.650	0.064
			26.653	0.175	0.651	2.114	0.064	624.660	0.064
			26.614	0.171	0.665	2.122	0.064	627.011	0.064
CARB ULSD	FTP	2006 Cummins ISM	26.656	0.144	0.680	2.091	0.066	626.286	0.063
			26.666	0.172	0.674	2.083	0.067	623.633	0.063
			26.659	0.167	0.702	2.080	0.070	622.790	0.063
			26.718	0.179	0.666	2.079	0.068	620.006	0.063
			26.683	0.149	0.675	2.087	0.068	625.166	0.063
			26.509	0.175	0.680	2.081	0.069	625.365	0.063
			26.623	0.171	0.667	2.093	0.068	624.758	0.063
			26.620	0.177	0.683	2.092	0.021	623.524	0.063
B5 - Soy	UDDS	2006 Cummins ISM	5.341	0.428	1.979	6.075	0.101	805.284	0.083
			5.318	0.425	1.958	6.089	0.115	806.198	0.083
			5.285	0.454	1.995	6.140	0.118	803.728	0.082
			5.388	0.436	1.912	5.829	0.114	789.118	0.081
			5.327	0.414	1.929	6.160	0.110	802.930	0.082
			5.300	0.406	2.054	6.171	0.120	815.394	0.084
			5.395	0.462	1.982	5.915	0.116	786.343	0.081
			5.376	0.438	1.861	6.096	0.119	793.979	0.081
CARB ULSD	UDDS	2006 Cummins ISM	5.401	0.393	1.845	6.024	0.086	795.862	0.081
			5.389	0.443	1.878	6.102	0.113	791.042	0.080
			5.367	0.474	2.093	5.844	0.113	793.163	0.080
			5.232	0.461	1.903	6.076	0.109	814.959	0.083
			5.331	0.463	1.921	6.064	0.115	796.322	0.081
			5.306	0.396	1.881	6.042	0.099	804.611	0.082
			5.298	0.443	2.069	5.978	0.111	806.123	0.082
			5.378	0.429	1.848	5.940	0.113	788.578	0.080
			5.339	0.460	1.963	5.874	0.109	789.834	0.080
B5 - Soy	SET	2006 Cummins	124.510	0.058	0.353	1.866	0.035	527.587	0.054

		ISM							
			124.719	0.059	0.354	1.875	0.035	528.600	0.054
			124.548	0.067	0.351	1.863	0.036	527.730	0.054
			124.543	0.064	0.354	1.852	0.036	529.935	0.054
CARB ULSD	SET	2006 Cummins ISM	124.399	0.067	0.352	1.861	0.036	530.775	0.054
			124.586	0.071	0.371	1.842	0.039	531.263	0.054
			124.570	0.065	0.363	1.847	0.038	529.526	0.053
			124.546	0.072	0.356	1.862	0.039	530.713	0.054
B5 - Soy	FTP	1991 DDC60	24.041	0.056	1.566	4.460	0.124	549.100	0.056
			24.060	0.056	1.548	4.450	0.061	550.680	0.056
			24.108	0.054	1.522	4.423	0.060	545.378	0.056
			23.885	0.059	1.527	4.460	0.061	547.776	0.056
			24.152	0.054	1.571	4.477	0.059	546.983	0.056
			24.089	0.054	1.548	4.479	0.061	547.319	0.056
			24.003	0.054	1.521	4.468	0.060	545.599	0.056
			24.088	0.054	1.514	4.429	0.059	543.807	0.056
CARB ULSD	FTP	1991 DDC60	24.090	0.056	1.659	4.413	0.067	551.036	0.056
			23.956	0.056	1.602	4.421	0.066	550.577	0.056
			24.055	0.056	1.586	4.401	0.066	549.490	0.056
			24.054	0.056	1.582	4.411	0.067	546.202	0.055
			24.109	0.054	1.615	4.399	0.064	546.887	0.055
			23.999	0.057	1.585	4.432	0.065	547.842	0.055
			24.110	0.055	1.556	4.416	0.059	542.331	0.055
			24.030	0.055	1.549	4.394	0.066	543.799	0.055
B5 - Soy	UDDS	1991 DDC60	3.914	0.208	2.123	11.206	0.039	686.604	0.070
			3.922	0.214	2.162	11.344	0.052	687.872	0.071
			3.936	0.213	2.102	11.378	0.036	682.080	0.070
			3.825	0.226	1.984	12.080	0.046	706.644	0.072
			3.940	0.202	2.107	11.191	0.037	682.656	0.070
			3.955	0.208	2.004	11.181	0.043	677.613	0.070
			3.808	0.217	2.212	11.851	0.036	711.225	0.073
			3.883	0.206	1.929	12.027	0.042	692.957	0.071
CARB ULSD	UDDS	1991 DDC60	3.907	0.196	2.138	11.177	0.033	687.912	0.070
			3.966	0.207	1.925	11.003	0.026	671.689	0.068
			3.940	0.216	1.951	11.457	0.043	688.026	0.070
			3.960	0.214	1.999	11.107	0.036	676.508	0.069

			3.995	0.197	1.976	10.903	0.026	670.123	0.068
			4.026	0.195	1.919	10.843	0.028	665.558	0.067
			3.985	0.210	1.987	11.529	0.042	677.009	0.069
			3.901	0.209	1.863	11.404	0.028	685.082	0.069
B5 - Soy	SET	1991 DDC60	96.561	0.024	1.501	7.415	0.018	472.264	0.048
			96.527	0.024	1.532	7.353	0.019	472.815	0.049
			96.736	0.023	1.471	7.420	0.019	471.757	0.048
			96.716	0.023	1.522	7.354	0.019	471.178	0.048
CARB ULSD	SET	1991 DDC60	96.754	0.023	1.546	7.381	0.020	475.016	0.048
			96.564	0.025	1.558	7.308	0.023	472.114	0.048
			96.621	0.024	1.543	7.410	0.020	473.600	0.048
			96.522	0.024	1.524	7.324	0.019	470.655	0.048
B10 - Soy	FTP	2006 Cummins ISM	26.689	0.159	0.675	2.126	0.061	626.427	0.064
			26.710	0.156	0.677	2.128	0.060	625.609	0.064
			26.610	0.171	0.673	2.128	0.061	625.517	0.064
			26.643	0.167	0.665	2.121	0.061	625.227	0.064
			26.669	0.165	0.676	2.104	0.060	622.391	0.063
			26.686	0.164	0.674	2.116	0.060	623.945	0.063
			26.689	0.173	0.665	2.104	0.059	620.955	0.063
			26.679	0.074	0.696	2.068	0.062	624.381	0.063
CARB ULSD	FTP	2006 Cummins ISM	26.569	0.150	0.690	2.086	0.069	628.285	0.063
			26.643	0.174	0.698	2.081	0.068	624.724	0.063
			26.681	0.171	0.695	2.085	0.068	623.383	0.063
			26.644	0.182	0.690	2.093	0.070	624.493	0.063
			26.687	0.156	0.677	2.064	0.067	623.122	0.063
			26.643	0.179	0.680	2.061	0.068	621.981	0.063
			26.634	0.176	0.680	2.061	0.069	623.280	0.063
			26.696	0.067	0.700	2.041	0.069	620.977	0.063
B10 - Soy	UDDS	2006 Cummins ISM	5.286	0.441	1.868	6.189	0.110	833.226	0.085
			5.209	0.427	2.058	6.249	0.115	821.626	0.084
			5.276	0.464	1.926	6.192	0.120	798.438	0.081
			5.452	0.429	1.835	5.969	0.114	773.917	0.079
			5.257	0.428	2.105	6.166	0.114	812.722	0.083

			5.329	0.438	1.962	6.114	0.118	803.185	0.082
			5.383	0.431	1.989	6.032	0.107	782.687	0.080
			5.263	0.431	2.035	6.174	0.120	806.079	0.082
CARB ULSD	UDDS	2006 Cummins ISM	5.418	0.406	2.076	5.701	0.091	777.837	0.079
			5.371	0.448	1.834	5.802	0.107	783.911	0.079
			5.377	0.451	1.791	5.966	0.113	785.636	0.080
			5.425	0.501	1.799	5.795	0.114	771.695	0.078
			5.322	0.394	1.929	6.061	0.092	797.735	0.081
			5.284	0.463	2.055	6.051	0.117	800.415	0.081
			5.213	0.459	1.918	5.976	0.118	810.873	0.082
			5.290	0.487	1.917	6.036	0.124	795.973	0.081
B10 - Soy	SET	2006 Cummins ISM	124.050	0.069	0.335	1.891	0.033	532.803	0.054
			124.267	0.065	0.340	1.895	0.034	530.683	0.054
			124.366	0.055	0.342	1.905	0.033	531.303	0.054
			124.334	0.066	0.344	1.893	0.033	534.490	0.054
CARB ULSD	SET	2006 Cummins ISM	124.516	0.071	0.361	1.857	0.042	528.103	0.053
			124.296	0.072	0.360	1.864	0.039	531.702	0.054
			124.589	0.058	0.329	2.057	0.035	528.118	0.053
			124.394	0.071	0.362	1.844	0.039	533.069	0.054
B10 - Soy	FTP	1991 DDC60	23.951	0.051	1.466	4.535	0.040	545.347	0.056
			23.950	0.051	1.447	4.545	0.055	546.778	0.056
			24.100	0.053	1.424	4.480	0.057	542.826	0.055
			23.874	0.053	1.446	4.535	0.059	549.990	0.056
			24.133	0.048	1.443	4.487	0.054	545.646	0.056
			24.125	0.051	1.445	4.495	0.055	546.297	0.056
			23.966	0.052	1.407	4.489	0.058	547.050	0.056
			24.127	0.053	1.437	4.468	0.059	545.045	0.056
CARB ULSD	FTP	1991 DDC60	23.997	0.053	1.549	4.446	0.066	544.742	0.055
			24.077	0.052	1.521	4.493	0.063	543.284	0.055
			24.037	0.056	1.486	4.458	0.066	543.312	0.055
			24.024	0.053	1.495	4.421	0.065	544.388	0.055
			23.994	0.051	1.572	4.399	0.064	547.771	0.055
			24.008	0.051	1.554	4.449	0.067	548.299	0.056
			24.107	0.057	1.470	4.440	0.067	543.195	0.055

			24.149	0.055	1.498	4.386	0.067	545.515	0.055
B10 - Soy	UDDS	1991 DDC60	3.892	0.282	2.067	11.537	0.033	688.438	0.070
			4.019	0.235	2.035	11.222	0.051	673.671	0.069
			3.969	0.187	1.973	11.338	0.030	671.496	0.068
			4.025	0.188	1.911	11.408	0.042	668.260	0.068
			3.919	0.206	2.061	11.316	0.026	684.954	0.070
			3.831	0.218	2.106	11.710	0.035	701.493	0.072
			3.894	0.206	2.009	11.373	0.027	685.500	0.070
			3.953	0.211	1.937	11.523	0.034	678.714	0.069
CARB ULSD	UDDS	1991 DDC60	3.851	0.240	2.184	11.454	0.048	633.992	0.064
			3.967	0.184	1.916	10.878	0.032	655.914	0.066
			3.941	0.193	1.900	11.356	0.035	674.042	0.068
			3.889	0.179	2.038	11.332	0.038	680.864	0.069
			3.919	0.206	1.932	11.252	0.037	683.429	0.069
			3.898	0.207	1.997	11.152	0.026	678.309	0.069
			3.906	0.220	1.967	11.528	0.041	685.783	0.070
			3.790	0.214	2.079	11.620	0.032	702.421	0.071
B10 - Soy	SET	1991 DDC60	96.569	0.022	1.452	7.533	0.019	476.304	0.049
			96.443	0.024	1.509	7.559	0.020	475.018	0.048
			96.856	0.021	1.435	7.554	0.018	475.960	0.048
			96.720	0.022	1.477	7.512	0.003	478.397	0.049
CARB ULSD	SET	1991 DDC60	96.725	0.022	1.591	7.483	0.022	474.525	0.048
			96.788	0.032	1.589	7.376	0.022	469.362	0.048
			96.725	0.022	1.547	7.465	0.020	476.633	0.048
			96.700	0.024	1.518	7.435	0.020	475.701	0.048
B5 - Animal	FTP	2006 Cummins ISM	26.576	0.168	0.683	2.120	0.064	630.523	0.064
			26.534	0.168	0.674	2.105	0.065	630.943	0.064
			26.624	0.164	0.683	2.125	0.063	632.268	0.064
			26.642	0.164	0.672	2.114	0.064	630.484	0.064
			26.568	0.182	0.673	2.045	0.065	631.032	0.064
			26.633	0.188	0.689	2.059	0.065	628.851	0.064
			26.614	0.176	0.699	2.090	0.065	626.289	0.064
			26.567	0.173	0.658	2.094	0.063	629.711	0.064
CARB ULSD	FTP	2006 Cummins	26.503	0.151	0.688	2.115	0.068	634.665	0.064

		ISM							
			26.569	0.171	0.731	2.084	0.070	629.277	0.064
			26.529	0.180	0.746	2.100	0.072	628.960	0.064
			26.529	0.176	0.687	2.102	0.069	630.814	0.064
			26.528	0.181	0.698	2.061	0.068	632.022	0.064
			26.686	0.178	0.688	2.093	0.067	626.835	0.063
			26.581	0.177	0.677	2.157	0.069	629.277	0.064
			26.566	0.185	0.675	2.098	0.067	628.862	0.064
B5 - Animal	UDDS	2006 Cummins ISM	5.276	0.398	1.791	5.879	0.047	793.351	0.081
			5.261	0.404	1.910	6.131	0.066	801.409	0.082
			5.276	0.417	1.890	5.842	0.048	785.816	0.080
			5.391	0.402	2.031	5.796	0.071	778.393	0.079
			5.339	0.387	1.953	5.783	0.052	785.094	0.080
			5.316	0.404	1.799	5.866	0.068	789.823	0.080
			5.363	0.426	1.906	5.753	0.048	778.155	0.079
			5.311	0.423	1.813	5.838	0.068	791.837	0.081
CARB ULSD	UDDS	2006 Cummins ISM	5.407	0.384	1.856	5.901	0.065	772.271	0.078
			5.258	0.432	1.851	6.103	0.050	787.975	0.080
			5.230	0.431	2.213	6.220	0.069	807.599	0.082
			5.200	0.464	1.967	6.016	0.054	800.607	0.081
			5.306	0.351	1.853	5.990	0.056	787.114	0.080
			5.311	0.429	1.861	5.866	0.049	783.355	0.079
			5.432	0.422	1.862	5.786	0.066	777.663	0.079
			5.379	0.422	1.792	5.800	0.050	776.020	0.079
B5 - Animal	SET	2006 Cummins ISM	124.369	0.072	0.336	1.872	0.035	529.411	0.054
			124.429	0.070	0.354	1.805	0.036	529.477	0.054
			124.482	0.060	0.341	1.891	0.034	527.182	0.054
			124.577	0.061	0.343	1.870	0.035	528.558	0.054
CARB ULSD	SET	2006 Cummins ISM	124.284	0.069	0.356	1.866	0.039	535.371	0.054
			124.604	0.074	0.362	1.859	0.039	528.769	0.053
			124.719	0.072	0.357	1.830	0.038	529.177	0.053
			124.748	0.063	0.358	1.873	0.037	529.000	0.053
B5 -	FTP	1991	24.184	0.048	1.433	4.428	0.056	535.039	0.054

Animal		DDC60							
			24.091	0.048	1.456	4.456	0.057	539.868	0.055
			24.108	0.055	1.442	4.438	0.059	541.703	0.055
			24.045	0.054	1.450	4.425	0.059	544.376	0.055
			23.872	0.051	1.481	4.480	0.058	545.117	0.056
			24.105	0.051	1.409	4.434	0.056	542.039	0.055
			24.018	0.052	1.449	4.446	0.057	542.838	0.055
			24.071	0.051	1.426	4.419	0.057	542.198	0.055
CARB ULSD	FTP	1991 DDC60	24.018	0.052	1.591	4.476	0.063	541.193	0.055
			24.103	0.049	1.494	4.408	0.063	539.320	0.055
			24.066	0.049	1.511	4.412	0.064	535.697	0.054
			23.942	0.055	1.551	4.485	0.067	544.347	0.055
			24.117	0.052	1.514	4.453	0.062	551.908	0.056
			24.167	0.062	1.517	4.411	0.063	539.619	0.055
			24.113	0.053	1.522	4.417	0.063	540.678	0.055
			23.983	0.048	1.531	4.439	0.063	545.836	0.055
B5 - Animal	UDDS	1991 DDC60	3.914	0.188	1.955	11.164	0.029	684.679	0.070
			3.952	0.200	1.925	11.201	0.041	682.338	0.070
			3.932	0.266	2.049	11.114	0.036	676.580	0.069
			3.937	0.186	1.779	11.579	0.042	670.579	0.068
			3.980	0.183	1.840	10.813	0.033	670.036	0.068
			3.957	0.193	1.876	10.997	0.045	676.072	0.069
			3.879	0.214	1.884	11.208	0.026	680.907	0.069
			4.021	0.195	1.818	11.382	0.031	656.703	0.067
CARB ULSD	UDDS	1991 DDC60	3.824	0.196	2.213	11.417	0.035	696.574	0.071
			3.916	0.214	2.079	11.407	0.032	682.352	0.069
			4.051	0.200	1.885	11.370	0.041	661.985	0.067
			3.998	0.202	1.937	11.162	0.027	666.428	0.068
			3.978	0.182	1.985	10.971	0.035	663.656	0.067
			3.919	0.203	2.017	11.148	0.040	679.634	0.069
			3.929	0.217	1.886	11.558	0.041	684.333	0.069
			3.906	0.207	1.963	11.320	0.023	676.747	0.069
B5 - Animal	SET	1991 DDC60	96.721	0.023	1.439	7.463	0.019	470.279	0.048
			96.704	0.024	1.456	7.416	0.019	471.616	0.048
			96.746	0.022	1.433	7.446	0.019	471.109	0.048
			96.738	0.023	1.473	7.378	0.019	467.864	0.048
CARB ULSD	SET	1991 DDC60	96.632	0.024	1.500	7.451	0.019	472.005	0.048

			96.712	0.024	1.485	7.398	0.020	470.693	0.048
			96.574	0.024	1.496	7.462	0.020	474.082	0.048
			96.677	0.024	1.472	7.354	0.021	470.321	0.048
B10 - Animal	FTP	2006 Cummins ISM	26.651	0.160	0.638	2.104	0.057	630.806	0.064
			26.578	0.156	0.645	2.100	0.058	631.728	0.064
			26.605	0.171	0.658	2.090	0.058	627.752	0.064
			26.494	0.167	0.645	2.117	0.052	633.290	0.065
			26.508	0.181	0.644	2.091	0.058	627.280	0.064
			26.505	0.178	0.643	2.082	0.060	627.336	0.064
			26.598	0.170	0.640	2.095	0.058	626.243	0.064
			26.667	0.192	0.648	2.080	0.061	625.159	0.064
CARB ULSD	FTP	2006 Cummins ISM	26.525	0.153	0.682	2.097	0.068	634.590	0.064
			26.655	0.171	0.670	2.072	0.065	622.399	0.063
			26.560	0.175	0.673	2.086	0.067	626.814	0.063
			26.504	0.187	0.688	2.083	0.069	628.489	0.064
			26.544	0.181	0.719	2.109	0.072	636.609	0.064
			26.611	0.202	0.699	2.016	0.069	624.279	0.063
			26.610	0.193	0.667	2.067	0.067	624.932	0.063
			26.513	0.212	0.675	2.088	0.068	625.125	0.063
B10 - Animal	UDDS	2006 Cummins ISM	5.245	0.453	1.703	5.926	0.046	796.750	0.081
			5.340	0.464	1.715	5.737	0.063	784.883	0.080
			5.279	0.503	1.697	5.692	0.047	782.658	0.080
			5.262	0.488	1.764	5.981	0.055	796.833	0.081
			5.368	0.390	1.669	5.743	0.050	786.368	0.080
			5.213	0.420	1.786	5.994	0.068	814.041	0.083
			5.268	0.419	1.755	5.954	0.045	795.621	0.081
			5.174	0.428	1.752	5.950	0.067	813.832	0.083
CARB ULSD	UDDS	2006 Cummins ISM	5.300	0.440	1.911	5.813	0.059	781.133	0.079
			5.277	0.423	1.813	5.986	0.048	788.031	0.080
			5.285	0.443	1.900	5.860	0.065	790.256	0.080
			5.311	0.454	1.826	5.785	0.046	779.762	0.079
			5.357	0.410	1.934	5.792	0.052	786.706	0.080
			5.267	0.451	1.861	5.879	0.051	797.890	0.081
			5.233	0.460	1.971	6.181	0.066	811.293	0.082

			5.379	0.450	1.813	5.743	0.035	774.032	0.078
B10 - Animal	SET	2006 Cummins ISM	124.261	0.069	0.345	1.827	0.034	531.664	0.054
			124.348	0.064	0.333	1.867	0.033	529.263	0.054
			124.357	0.065	0.341	1.884	0.032	530.668	0.054
			124.476	0.064	0.329	1.873	0.032	528.502	0.054
CARB ULSD	SET	2006 Cummins ISM	124.729	0.058	0.369	1.853	0.037	527.956	0.053
			124.731	0.070	0.364	1.849	0.038	530.162	0.054
			124.532	0.067	0.368	1.858	0.037	534.031	0.054
			124.313	0.073	0.357	1.845	0.037	533.580	0.054
B10 - Animal	FTP	1991 DDC60	24.124	0.047	1.473	4.424	0.056	542.028	0.055
			24.060	0.048	1.453	4.452	0.054	544.795	0.056
			24.051	0.048	1.421	4.448	0.054	542.634	0.055
			24.006	0.048	1.386	4.457	0.053	544.899	0.056
			23.872	0.054	1.449	4.499	0.054	549.573	0.056
			24.088	0.053	1.450	4.461	0.054	544.840	0.056
			24.070	0.050	1.423	4.436	0.055	543.600	0.056
			24.151	0.050	1.395	4.423	0.054	542.167	0.055
CARB ULSD	FTP	1991 DDC60	24.166	0.050	1.652	4.391	0.066	543.834	0.055
			24.049	0.050	1.522	4.412	0.062	542.739	0.055
			24.091	0.050	1.531	4.421	0.062	543.979	0.055
			24.111	0.050	1.523	4.415	0.062	542.676	0.055
			24.034	0.057	1.596	4.429	0.064	546.817	0.055
			24.123	0.054	1.521	4.415	0.062	541.290	0.055
			24.125	0.051	1.519	4.411	0.062	542.416	0.055
			24.021	0.053	1.523	4.429	0.064	544.966	0.055
B10 - Animal	UDDS	1991 DDC60	3.964	0.204	1.909	10.964	0.027	674.078	0.069
			3.861	0.212	1.878	11.397	0.034	688.934	0.070
			3.940	0.204	1.811	11.029	0.025	677.519	0.069
			3.956	0.202	1.893	11.185	0.037	678.280	0.069
			4.004	0.187	1.949	10.819	0.027	670.699	0.069
			3.900	0.200	1.873	11.328	0.043	688.469	0.070
			3.827	0.207	1.983	11.625	0.020	703.553	0.072
			3.948	0.212	1.890	11.596	0.022	680.697	0.070
CARB	UDDS	1991	3.973	0.208	2.006	11.178	0.040	678.454	0.069

ULSD		DDC60							
			3.918	0.210	2.012	11.319	0.031	683.226	0.069
			3.965	0.215	1.920	11.300	0.040	673.661	0.068
			3.898	0.205	2.034	11.343	0.027	685.868	0.070
			3.972	0.188	1.960	11.107	0.025	675.660	0.068
			3.820	0.216	2.066	11.425	0.024	693.672	0.070
			4.011	0.199	1.840	11.435	0.029	672.133	0.068
			3.908	0.209	1.908	11.408	0.018	685.454	0.069
B10 - Animal	SET	1991 DDC60	96.519	0.022	1.415	7.531	0.019	476.564	0.049
			96.458	0.022	1.442	7.489	0.019	477.808	0.049
			96.573	0.022	1.435	7.488	0.019	476.079	0.049
			96.341	0.021	1.477	7.432	0.019	476.800	0.049
CARB ULSD	SET	1991 DDC60	96.834	0.022	1.536	7.484	0.020	475.231	0.048
			96.733	0.024	1.510	7.402	0.020	471.576	0.048
			96.747	0.023	1.580	7.485	0.021	474.469	0.048
			96.647	0.023	1.582	7.362	0.022	476.991	0.048
2010 Performance and emissions of diesel and alternative diesel fuels									
Raw data were not available to ARB, average data are shown below where available. Study is available in published literature.									
B5 - Soy	FTP	1991 DDC60	Not Avail.	Not Avail.	Not Avail.	4.514	Not Avail.	Not Avail.	Not Avail.
CARB ULSD	FTP	1991 DDC60	Not Avail.	Not Avail.	Not Avail.	4.596	Not Avail.	Not Avail.	Not Avail.
B5 - Soy	SET	1991 DDC60	Not Avail.	Not Avail.	Not Avail.	7.528	Not Avail.	Not Avail.	Not Avail.
CARB ULSD	SET	1991 DDC60	Not Avail.	Not Avail.	Not Avail.	7.532	Not Avail.	Not Avail.	Not Avail.
Thompson 2010 - Neat Fuel Influence on Biodiesel Blend Emissions									
Raw data were not available to ARB, average data are shown below where available. Study is available in published literature (BSFC is in g/bhp-hr)									
B10 - Soy	FTP	1992 DDC60	Not Avail.	0.086	2.685	4.500	0.201	Not Avail.	169.277
CARB Like	FTP	1992 DDC60	Not Avail.	0.087	2.811	4.370	0.223	Not Avail.	167.040
B10 - Soy	SET	1992 DDC60	Not Avail.	Not Avail.	Not Avail.	8.662	0.0729	Not Avail.	Not Avail.
CARB	SET	1992	Not	Not	Not	8.446	0.0855	Not Avail.	Not

Like		DDC60	Avail.	Avail.	Avail.				Avail.