Appendix G:
Spark-Ignition Marine Watercraft Test Data

December 2014

California Air Resources Board
Monitoring and Laboratory Division

Appendix G

This appendix contains the data used to generate the tables and figures in the staff report.

Appendix G1 details the data for the SIMW engine performance testing according to TP-1502. Staff performed three repeat hot soak tests on a 90 HP engine in a Sealed Housing for Evaporative Determination (SHED) to compare the hot soak emissions of fuel injection and carbureted engines. Background tests were performed so that they could be omitted from the final result.

Appendix G.2 details the data generated using 40 CFR 1060.520. Staff performed three repeat tests on a 33 gallon Moeller Marine fuel tank with a 1.5-L Delphi carbon canister. The test was performed with California Phase III E10 fuel with 7 psi RVP.

Appendix G.3 details the SHED results for a evaporative controlled 2006 Crestliner Sportangler 1750 over seven days. The Crestliner was fitted with low permeation hoses, low permeation fuel tank, and carbon canister. Staff performed seven continuous diurnals in a SHED following the California temperature profile (65ºF-105ºF - 65ºF) with Phase II E6 fuel and with Phase III E10 fuel. The tests compare storage evaporative emissions between the two different fuels, canister efficiency, and the effect of fuel aging.

Appendix G.4 details the permeation data generated for a 33 gallon Moeller Marine fuel tank at 28°C and 40°C. The fuel tank was soaked with fuel until the permeation rate was stabilized and then data was recorded for 14 days. The permeation rate was then calculated and the r2 coefficient was calculated for both temperatures.

Appendix G1

Spark-Ignition Marine Engine Performance Testing
on Outboard Honda 90 Hp Engine (Carbureted and Fuel Injected)

		Uncorrected HC (g)	**Date**	**Grams HC/hr**
Background	B1	1.52	10/22/2009	
	B2	1.20	10/23/2009	
	B3	0.90	10/26/2009	
Carb Engine*	C1	7.72	10/28/2009	2.20
	C2	6.80	10/29/2009	1.92
	C3	6.49	10/30/2009	1.84
			Average	**1.99**
Background	B4	0.59	11/2/2009	
Fuel Injected Engine*	FI1	1.04	11/4/2009	0.15
	FI2	1.69	11/5/2009	0.37
	FI3	2.12	11/6/2009	0.52
			Average	**0.35**
Background	B5	0.30	11/18/2009	

* Background emissions were subtracted from the test results

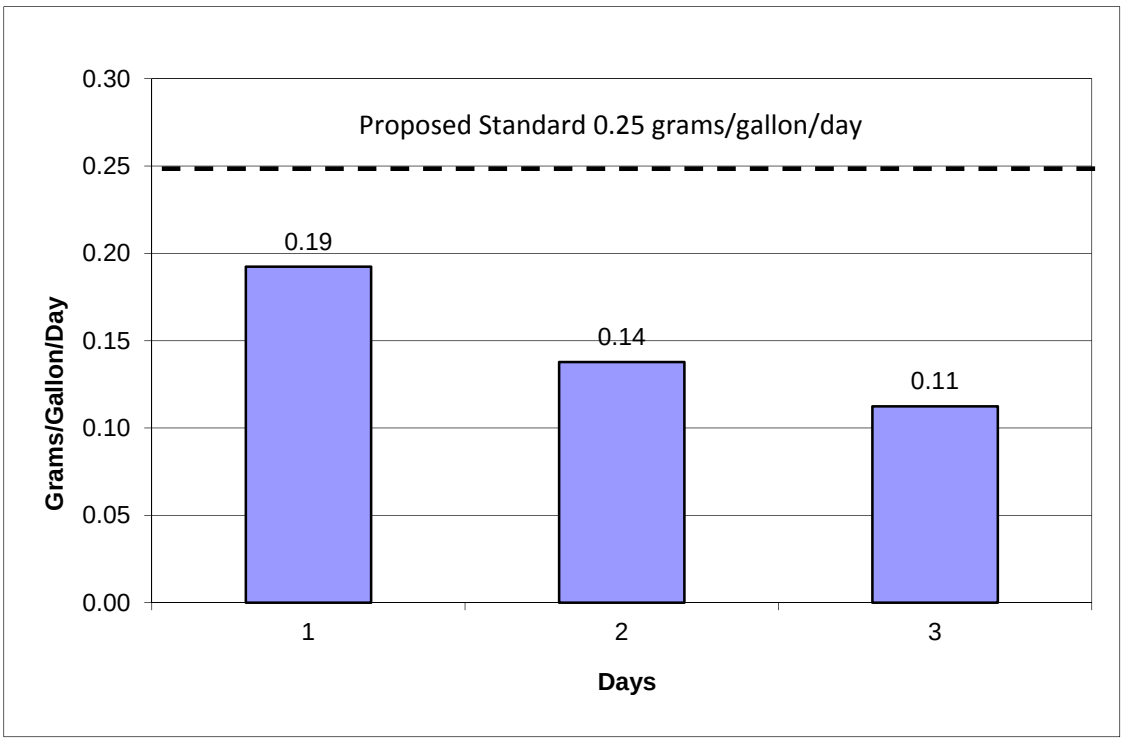
Appendix G2

Spark-Ignition Marine Watercraft Diurnal Venting Test Results

Fuel Tank: Moeller Marine Tank - 33 Gallon

Carbon Canister: Delphi Carbon canister - 1.5 Liter (marine grade carbon)

Day	Uncorrected grams HC	Uncorrected grams HC/gal/day
1	6.35	0.19
2	4.55	0.14
3	3.71	0.11



Appendix G3

Spark-Ignition Marine Watercraft Seven-Day Diurnal SHED Test Results

Controlled 7-Day Diurnal using E6 Fuel (65-105-65 deg. F)

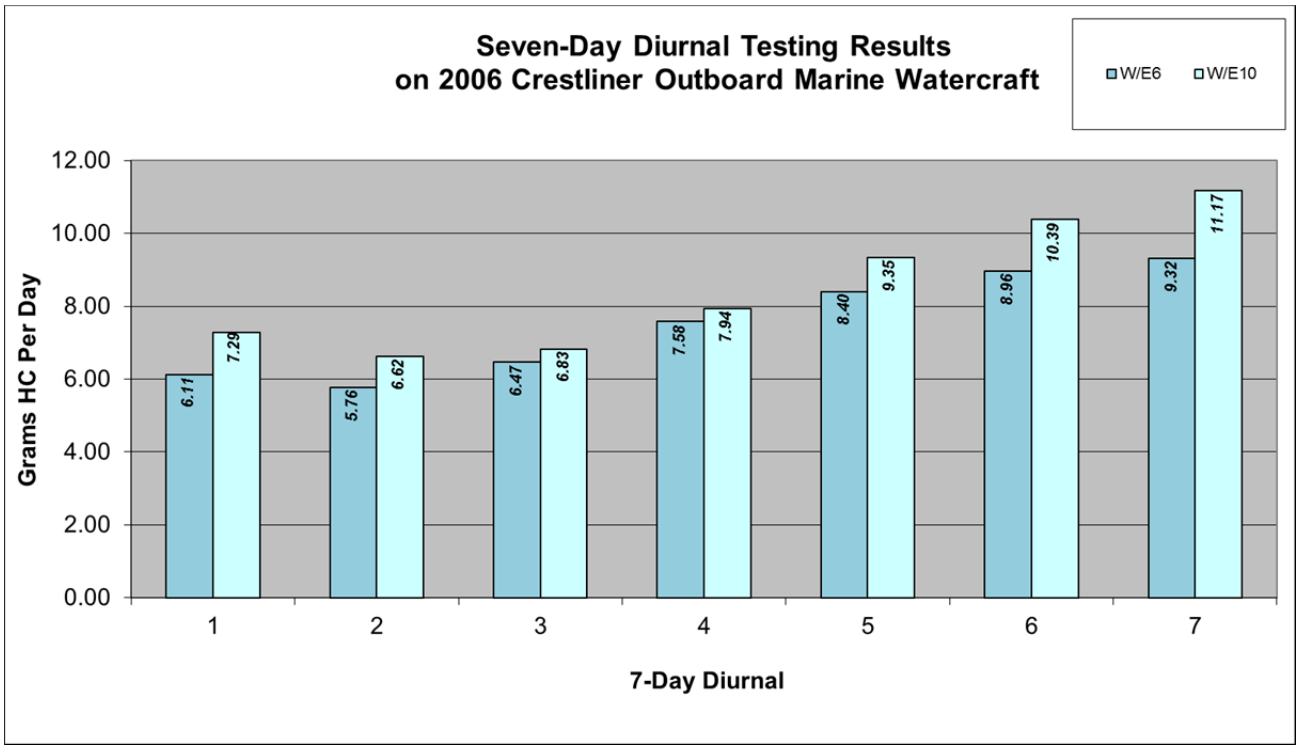
Day	Grams
1	***6.11***
2	***5.76***
3	***6.47***
4	***7.58***
5	***8.40***
6	***8.96***
7	***9.32***
Total	**52.61**

Average = 7.52 grams/day

Controlled 7-Day Diurnal using E10 Fuel (65-105-65 deg. F)

Day	Grams
1	***7.29***
2	***6.62***
3	***6.83***
4	***7.94***
5	***9.35***
6	***10.39***
7	***11.17***
Day	**59.57**

Average = 8.51 grams/day



Appendix G4

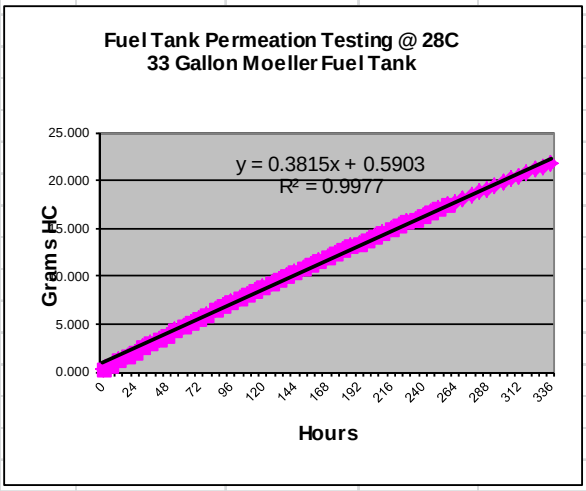
Moeller Tank Permeation @ 28C

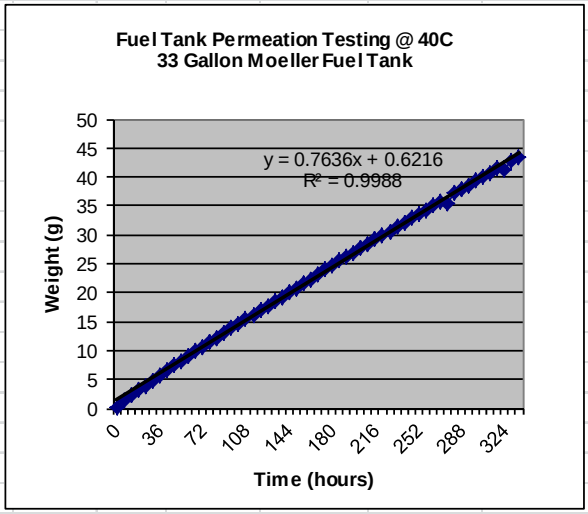
Day	Time	Weight	g/6 hr	Daily Perm Rate
	0	0.207		
	6	0.703	0.496	
	12	1.189	0.279	
	18	1.646	-0.246	
1	24	2.106	-0.729	0.715
	30	2.563	-1.189	0.700
	36	3.017	-1.652	0.688
	42	3.460	-2.120	0.683
2	48	3.898	-2.579	0.674
	54	4.332	-3.026	0.666
	60	4.766	-3.464	0.658
	66	5.192	-3.906	0.652
3	72	5.615	-4.343	0.646
	78	6.042	-4.765	0.643
	84	6.460	-5.197	0.637
	90	6.877	-5.625	0.634
4	96	7.279	-6.058	0.626
	102	7.694	-6.462	0.622
	108	8.074	-6.899	0.607
	114	8.463	-7.305	0.597
5	120	8.907	-7.630	0.613
	126	9.282	-8.088	0.597
	132	9.683	-8.506	0.605
	138	10.065	-8.900	0.603
6	144	10.445	-9.303	0.579
	150	10.835	-9.675	0.584
	156	11.217	-10.063	0.577
	162	11.608	-10.444	0.581
7	168	11.964	-10.861	0.572
	174	12.395	-11.177	0.587
	180	12.720	-11.639	0.566
	186	13.094	-12.021	0.559
8	192	13.456	-12.358	0.561
	198	13.826	-12.724	0.538
	204	14.201	-13.081	0.557
	210	14.573	-13.454	0.556
9	216	14.919	-13.855	0.550
	222	15.279	-14.213	0.547
	228	15.637	-14.561	0.540
	234	15.993	-14.923	0.534
10	240	16.345	-15.285	0.537
	246	16.711	-15.627	0.539
	252	17.069	-15.987	0.539
	258	17.414	-16.366	0.535

Permeation Rate

Slope	Surface Area	g/m2/6 hrs	g/m2/day
0.382	2.658	0.144	**0.574**

Day	Time	Weight	g/6 hr	Daily Perm Rate
11	264	17.732	-16.751	0.522
	270	18.073	-17.073	0.512
	276	18.429	-17.376	0.512
	282	18.756	-17.746	0.505
12	288	19.099	-18.086	0.514
	294	19.448	-18.407	0.517
	300	19.789	-18.758	0.512
	306	20.123	-19.114	0.514
13	312	20.460	-19.452	0.512
	318	20.787	-19.796	0.504
	324	21.155	-20.092	0.514
	330	21.468	-20.474	0.506
14	336	21.796	-20.827	0.503



Moeller Tank Permeation @ 40C

							Area	4119.5	in2		
								2.6577	m2		
					Daily						
Day	Time	Weight	g/6 hr	g/hr	Perm Rate			**Permeation Rate**			
	0	0.188				Slope	Surface	Area	g/m2/6 hr	g/m2/day	
	6	1.268	1.080	0.180		0.764	2.658		0.287	**1.149**	
	12	2.206	0.750	0.168							
	18	3.103	0.709	0.162							
1	24	3.983	0.692	0.158	1.428						Daily
	30	4.841	0.670	0.155	1.274	Day	Time	Weight	g/6 hr	g/hr	Perm Rate
	36	5.694	0.665	0.153	1.242	11	264	35.069	0.556	0.132	1.028
	42	6.528	0.646	0.151	1.218		270	35.813	0.556	0.132	1.037
2	48	7.374	0.658	0.150	1.205		276	35.515	-0.486	0.128	0.648
	54	8.219	0.657	0.149	1.200		282	37.220	1.517	0.131	1.019
	60	9.046	0.639	0.148	1.190	12	288	37.996	0.588	0.131	1.031
	66	9.842	0.608	0.146	1.176		294	38.640	0.456	0.131	0.993
3	72	10.666	0.636	0.146	1.168		300	39.397	0.569	0.131	1.390
	78	11.475	0.621	0.145	1.154		306	40.044	0.459	0.130	0.992
	84	12.268	0.605	0.144	1.142	13	312	40.725	0.493	0.130	0.956
	90	13.067	0.611	0.143	1.143		318	41.420	0.507	0.130	0.975
4	96	13.857	0.602	0.142	1.130		324	41.347	-0.261	0.127	0.663
	102	14.645	0.600	0.142	1.122		330	42.818	1.283	0.129	0.973
	108	15.417	0.584	0.141	1.114	14	336	43.516	0.510	0.129	0.979
	114	16.186	0.581	0.140	1.103						
5	120	16.998	0.624	0.140	1.111						
	126	17.755	0.569	0.139	1.099						
	132	18.522	0.579	0.139	1.098						
	138	19.305	0.595	0.139	1.103						
6	144	20.09	0.597	0.138	1.093						
	150	20.833	0.555	0.138	1.087						
	156	21.603	0.582	0.137	1.089						
	162	22.373	N/A	N/A	N/A						
7	168	23.143	N/A	N/A	N/A						
	174	23.949	0.618	0.137	1.102						
	180	24.718	0.581	0.136	1.101						
	186	25.476	0.570	0.136	1.097						
8	192	26.206	0.542	0.136	1.167						
	198	26.991	0.597	0.135	1.074						
	204	27.741	0.562	0.135	1.067						
	210	28.487	0.558	0.135	1.062						
9	216	29.188	0.513	0.134	1.051						
	222	29.931	0.555	0.134	1.035						
	228	30.652	0.533	0.134	1.025						
	234	31.431	0.591	0.134	1.037						
10	240	32.149	0.530	0.133	1.043						
	246	32.87	0.533	0.133	1.035						
	252	33.605	0.547	0.133	1.040						
	258	34.325	0.532	0.132	1.018