

Confidential

In-House ART Turbine Moving Platform Test Preliminary Analysis

NOT FOR RELEASE

Test Date Feb 3 2012 Jon and Drew Data Analysis Feb 4 2012 By Drew

Turbine #16 base mounted 1m above Van roof racks, centre of turbine .75m in front of Van
Wind sensor on self aligning mount 6 ft in front of Van and 1m below Turbine, Rotary position sensor mounted on bottom of turbine output shaft, reading 360 steps per rotation of turbine, Load cell mounted on brake arm 1m aft of turbine rotation centre. Load cell zero'ed in mount before test start. All sensor data logged at 30 hz via Vernier passthrough to Laptop.

Tests Conducted on Cowichan Valley Highway by Jon and Drew from aprox 1pm to 5:30 pm

All equipment functioned within acceptable limits. Improvements will be made to sensitivity of brake band adjustment for finer torque control and higher possible torque settings. Lack of fine adjustment meant that Jon often felt like a slightly higher C_p could have been reached but found that the servo motor would easily over tighten the brake band, pulling down C_p . This was true at all speeds, but most noticeable at the lower speeds in Run 1. It's also worth noting that we were generating well over 2000W of heat at our higher speed runs, and the heat dissipation capacity of the system may be close. We may not be able to exceed 18m/s without damaging the brake, unless we upgrade it.

Turbine # 16 is 1m dia at base of blade (1.1m disk base) 2.25 m tall, and 1.8 sq m swept area. TSR is calculated from blade base.



	Run 2		Run 4										Run 5									
	TSR 3	Calc Cp 3	Time (s)	Speed 2 (m/s)	Force (N)	Angle (rad)	Velocity (rad/s)	Acceleration (rad/s ²)	Calc Watts3	Calc WW3	TSR 3	Calc Cp 3	Time (s)	Speed 2 (m/s)	Force (N)	Angle (rad)	Velocity (rad/s)	Acceleration (rad/s ²)	Calc Watts3	Calc WW3	TSR 3	Calc Cp 3
6020	1.387	0.234	200.631327	13.4	14.17	-6280.15	-41.437	-1.18	681.042	2797.442	1.555	0.245	200.631327	13.4	20.40	-6044.15	-34.732	-1.77	692.582	2835.923	1.295	
6021	1.385	0.228	200.664660	13.4	22.83	-6281.53	-41.568	-1.76	691.139	2820.489	1.557	0.247	200.664660	13.4	17.76	-6045.31	-34.747	0.69	708.884	2820.489	1.294	
6022	1.385	0.221	200.697993	13.3	19.54	-6282.92	-41.612	-0.65	702.028	2774.521	1.556	0.247	200.697993	13.3	20.19	-6046.47	-34.616	1.33	721.556	2766.909	1.295	
6023	1.382	0.214	200.731326	13.3	13.69	-6284.30	-41.612	0.65	693.022	2744.155	1.556	0.244	200.731326	13.3	21.55	-6047.62	-34.587	-0.10	702.036	2782.147	1.295	
6024	1.381	0.212	200.764659	13.3	12.33	-6285.70	-41.568	1.76	670.214	2766.909	1.556	0.242	200.764659	13.4	23.01	-6048.77	-34.616	-1.83	717.217	2820.489	1.297	
6025	1.378	0.212	200.797992	13.4	19.33	-6287.08	-41.437	1.16	655.149	2812.793	1.557	0.242	200.797992	13.4	19.66	-6049.92	-34.761	-2.10	709.900	2828.199	1.298	
6026	1.376	0.216	200.831325	13.4	15.71	-6288.46	-41.437	-0.76	637.842	2805.110	1.555	0.241	200.831325	13.4	17.61	-6051.09	-34.805	-0.81	689.627	2812.793	1.297	
6027	1.376	0.220	200.864658	13.3	11.26	-6289.84	-41.554	-1.09	668.153	2774.521	1.554	0.241	200.864658	13.3	24.16	-6052.24	-34.805	0.23	691.391	2766.909	1.298	
6028	1.376	0.223	200.897991	13.3	19.33	-6291.23	-41.568	0.12	705.976	2744.155	1.553	0.243	200.897991	13.4	16.54	-6053.41	-34.776	0.68	684.058	2789.788	1.298	
6029	1.376	0.227	200.931324	13.4	15.50	-6292.61	-41.481	0.00	695.465	2812.793	1.553	0.245	200.931324	13.4	16.15	-6054.56	-34.689	-0.74	688.854	2843.662	1.299	
6030	1.375	0.230	200.964657	13.4	20.75	-6293.99	-41.568	-0.12	678.335	2828.199	1.553	0.247	200.964657	13.4	22.71	-6055.72	-34.820	-2.21	713.918	2843.662	1.299	
6031	1.375	0.235	200.997990	13.4	18.41	-6295.39	-41.554	1.09	705.683	2805.110	1.552	0.246	200.997990	13.4	22.35	-6056.89	-34.951	-0.74	700.720	2835.923	1.299	
6032	1.374	0.241	201.031323	13.3	14.88	-6296.76	-41.437	0.76	689.794	2774.521	1.551	0.244	201.031323	13.4	20.13	-6058.06	-34.863	0.68	714.149	2789.788	1.298	
6033	1.374	0.247	201.064656	13.3	9.90	-6298.14	-41.437	-1.16	671.008	2782.147	1.551	0.243	201.064656	13.4	22.12	-6059.21	-34.834	0.23	722.287	2812.793	1.300	
6034	1.372	0.251	201.097989	13.4	20.45	-6299.52	-41.568	-1.77	673.027	2835.923	1.552	0.245	201.097989	13.4	18.29	-6060.38	-34.834	-0.82	707.322	2835.923	1.302	
6035	1.372	0.255	201.131322	13.4	18.14	-6300.92	-41.612	-0.74	672.216	2835.923	1.552	0.246	201.131322	13.5	20.22	-6061.53	-34.878	-2.17	694.880	2859.181	1.303	
6036	1.370	0.256	201.164655	13.4	12.65	-6302.30	-41.612	0.23	693.908	2812.793	1.552	0.247	201.164655	13.4	19.30	-6062.70	-35.023	-2.17	687.807	2828.199	1.304	
6037	1.368	0.257	201.197988	13.3	19.15	-6303.69	-41.583	0.61	734.830	2774.521	1.553	0.248	201.197988	13.3	20.28	-6063.87	-35.067	-0.82	685.767	2774.521	1.304	
6038	1.365	0.256	201.231321	13.4	17.04	-6305.07	-41.496	-1.07	712.737	2789.788	1.554	0.249	201.231321	13.4	19.12	-6065.04	-35.067	0.23	701.147	2812.793	1.306	
6039	1.364	0.256	201.264654	13.4	19.54	-6306.45	-41.641	-2.86	687.338	2835.923	1.556	0.248	201.264654	13.4	18.56	-6066.21	-35.038	0.68	697.945	2835.923	1.308	
6040	1.361	0.254	201.297987	13.4	17.76	-6307.85	-41.801	-1.50	690.422	2835.923	1.556	0.247	201.297987	13.4	21.41	-6067.38	-34.951	-0.74	707.504	2843.662	1.309	
6041	1.361	0.256	201.331320	13.4	14.34	-6309.24	-41.801	1.41	684.700	2805.110	1.555	0.244	201.331320	13.4	22.38	-6068.53	-35.081	-2.22	704.017	2828.199	1.308	
6042	1.361	0.256	201.364653	13.3	11.73	-6310.64	-41.641	2.45	672.314	2774.521	1.555	0.243	201.364653	13.3	18.29	-6069.71	-35.212	-0.81	694.464	2774.521	1.309	
6043	1.362	0.257	201.397986	13.4	16.30	-6312.02	-41.510	-0.01	679.253	2828.199	1.556	0.246	201.397986	13.4	20.72	-6070.88	-35.125	0.34	708.530	2805.110	1.310	
6044	1.362	0.258	201.431319	13.4	20.84	-6313.40	-41.641	-2.52	690.262	2843.662	1.557	0.249	201.431319	13.4	18.70	-6072.05	-35.111	-0.50	698.137	2843.662	1.313	
6045	1.362	0.260	201.464652	13.4	14.91	-6314.79	-41.801	-1.75	708.281	2828.199	1.556	0.249	201.464652	13.4	17.67	-6073.22	-35.140	-1.92	690.405	2835.923	1.314	
6046	1.361	0.262	201.497985	13.4	18.97	-6316.19	-41.816	0.78	737.568	2789.788	1.555	0.249	201.497985	13.4	23.33	-6074.39	-35.285	-2.11	708.951	2812.793	1.315	
6047	1.361	0.267	201.531318	13.3	17.13	-6317.59	-41.685	1.76	724.816	2774.521	1.554	0.248	201.531318	13.3	18.85	-6075.58	-35.329	-0.80	703.822	2774.521	1.315	
6048	1.361	0.270	201.564651	13.4	17.82	-6318.96	-41.641	1.05	673.935	2843.662	1.554	0.245	201.564651	13.4	19.63	-6076.75	-35.329	0.30	717.514	2805.110	1.316	
6049	1.359	0.273	201.597984	13.5	17.76	-6320.36	-41.627	0.41	668.945	2866.475	1.552	0.241	201.597984	13.4	21.85	-6077.93	-35.300	1.02	718.792	2835.923	1.318	
6050	1.359	0.276	201.631317	13.4	13.96	-6321.74	-41.627	0.07	665.115	2843.662	1.550	0.238	201.631317	13.4	19.12	-6079.10	-35.198	0.00	700.342	2835.923	1.318	
6051	1.358	0.277	201.664650	13.4	9.95	-6323.14	-41.627	-0.06	653.031	2812.793	1.549	0.236	201.664650	13.4	22.00	-6080.27	-35.300	-1.03	701.314	2812.793	1.318	
6052	1.356	0.279	201.697983	13.4	16.95	-6324.51	-41.627	-0.34	671.751	2828.199	1.549	0.238	201.697983	13.3	17.64	-6081.46	-35.329	-0.39	699.124	2774.521	1.317	
6053	1.353	0.278	201.731316	13.5	21.17	-6325.91	-41.641	-0.74	679.796	2859.181	1.551	0.241	201.731316	13.4	18.88	-6082.63	-35.329	0.39	693.883	2789.788	1.318	
6054	1.352	0.274	201.764649	13.5	14.82	-6327.29	-41.670	-1.19	694.989	2859.181	1.551	0.241	201.764649	13.4	19.63	-6083.82	-35.300	1.03	707.440	2820.489	1.319	
6055	1.350	0.266	201.797982	13.4	19.09	-6328.69	-41.772	-0.41	712.871	2828.199	1.552	0.241	201.797982	13.4	20.81	-6084.99	-35.198	-0.01	702.308	2828.199	1.319	
6056	1.350	0.257	201.831315	13.4	15.95	-6330.08	-41.685	0.04	702.699	2797.442	1.552	0.240	201.831315	13.4	20.34	-6086.16	-35.300	-1.10	722.987	2820.489	1.320	
6057	1.348	0.243	201.864648	13.5	16.84	-6331.46	-41.699	-1.12	657.845	2851.414	1.554	0.237	201.864648	13.3	22.06	-6087.34	-35.329	-0.73	722.312	2766.909	1.321	
6058	1.349	0.229	201.897981	13.5	14.11	-6332.86	-41.816	-0.85	647.796	2866.475	1.554	0.235	201.897981	13.3	18.88	-6088.51	-35.343	-0.34	707.217	2774.521	1.322	
6059	1.349	0.216	201.931314	13.4	16.66	-6334.25	-41.816	0.75	650.725	2835.923	1.554	0.233	201.931314	13.3	22.53	-6089.70	-35.343	-0.07	706.865	2774.521	1.324	
6060	1.348	0.210	201.964647	13.4	11.73	-6335.65	-41.699	0.69	644.043	2805.110	1.554	0.232	201.964647	13.4	17.99	-6090.87	-35.343	-0.02	704.060	2805.110	1.326	
6061	1.346	0.212	201.997980	13.4	14.91	-6337.03	-41.699	-1.19	659.879	2828.199	1.555	0.235	201.997980	13.4	16.57	-6092.05	-35.343	-0.07	688.405	2789.788	1.326	
6062	1.346	0.219	202.031313	13.5	20.60	-6338.42	-41.830	-1.84	680.901	2859.181	1.557	0.238	202.031313	13.3	21.67	-6093.22	-35.343	-0.33	699.525	2729.056	1.328	
6063	1.345	0.229	202.064646	13.5	14.49	-6339.82	-41.874	-1.07	684.951	2866.475	1.558	0.239	202.064646	13.3	21.38	-6094.41	-35.358	-0.65	697.559	2729.056	1.328	
6064	1.345	0.240	202.097979	13.4	18.38	-6341.22	-41.888	-0.41	705.081	2828.199	1.558	0.239	202.097979	13.3	17.88	-6095.58	-35.387	-0.78	709.565	2766.909	1.329	
6065	1.345	0.249	202.131312	13.4	16.15	-6342.61	-41.888	-0.07	695.521	2789.788	1.559	0.237	202.131312	13.3	20.75	-6096.77	-35.474	0.64	720.934	2774.521	1.330	
6066	1.344	0.254	202.164645	13.4	17.04	-6344.01	-41.888	0.06	644.393	2828.199	1.559	0.234	202.164645	13.3	21.05	-6097.95	-35.343	1.79	711.208	2766.909	1.330	
6067	1.344	0.255	202.197978	13.5	15.71	-6345.41	-41.888	0.33	637.057	2859.181	1.559	0.232	202.197978	13.2	21.17	-6099.12						











