APPENDIX A
Instrumentation Calibration Information

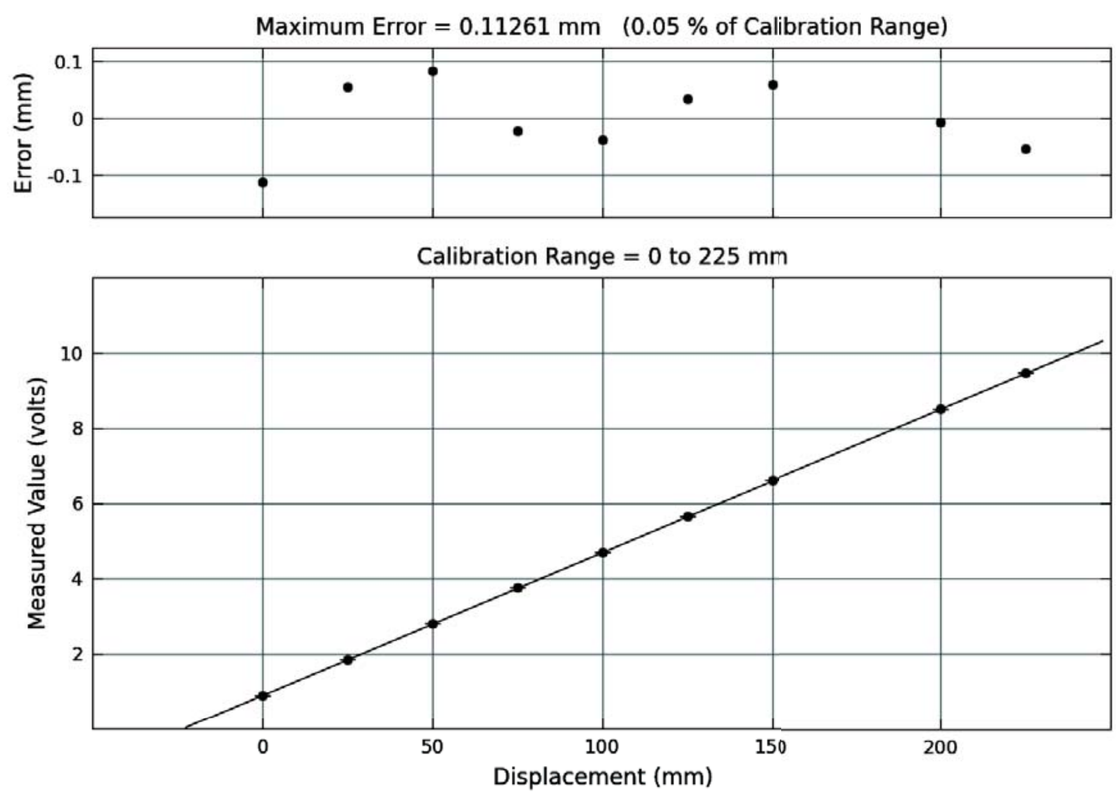
JSS

Calibration of Sinkage

Calibrated 2012-05-31 11:10Z

Test Facility: CWT	**Serial #:** A56015	**Filter Frequency:** 10
Data Source: daspc49:50001 Channel 1	**Programmable Gain:**	**Excitation:** 10
Sensor Model: PT101-0010-111-1110	**Plug-In Gain:**	

Data Point #	Physical Value (mm)	Measured Value (volts)	Fitted Curve Value (mm)	Error (mm)	Definition of Calibration Curve
1	0.0000	0.89254	-0.11261	-0.11261	Polynomial Degree = 1 (Linear Fit)
2	25.000	1.8502	25.056	0.055555	$Y = C_0 + C_1 \cdot V$
3	50.000	2.8026	50.084	0.083767	where *Y(t)* = Displacement (mm),
4	75.000	3.7498	74.977	-0.022728	*V(t)* = measured value (volts),
5	100.00	4.7005	99.962	-0.037969	C_0 = -23.569 mm,
6	125.00	5.6546	125.03	0.034499	C_1 = 26.28 mm/volt,
7	150.00	6.6068	150.06	0.059648	
8	200.00	8.5069	199.99	-0.0067488	
9	225.00	9.4564	224.95	-0.053413	



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JSS
Calibration of Thrust
Calibrated 2012-05-18 15:25Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:**
Data Source: daspc49:50001 Channel 2	**Programmable Gain:**	**Excitation:**
Sensor Model:	**Plug-In Gain:**	

Data Point #	Physical Value (N)	Measured Value (volts)	Fitted Curve Value (N)	Error (N)
1	0.0000	-1.3327	0.024033	0.024033
2	9.8082	-1.6540	9.8298	0.021621
3	19.616	-1.9749	19.624	0.0077156
4	29.425	-2.2963	29.433	0.0079857
5	39.234	-2.6175	39.236	0.0023079
6	49.007	-2.9374	48.998	-0.0090418
7	58.815	-3.2585	58.797	-0.017610
8	68.623	-3.5799	68.605	-0.018216
9	78.431	-3.9011	78.410	-0.021140
10	88.240	-4.2224	88.215	-0.025588
11	98.049	-4.5429	97.996	-0.052831
12	107.73	-4.8614	107.72	-0.011190
13	117.53	-5.1839	117.56	0.023531
14	127.34	-5.5050	127.36	0.012640
15	137.15	-5.8267	137.18	0.024478

Table truncated (1 points not displayed).

Definition of Calibration Curve

Polynomial Degree = 1 (Linear Fit)

$Y = C_0 + C_1 \cdot V$

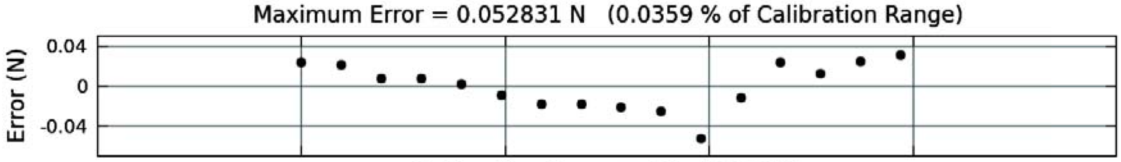
where $Y(t)$ = Force (N),

$V(t)$ = measured value (volts),

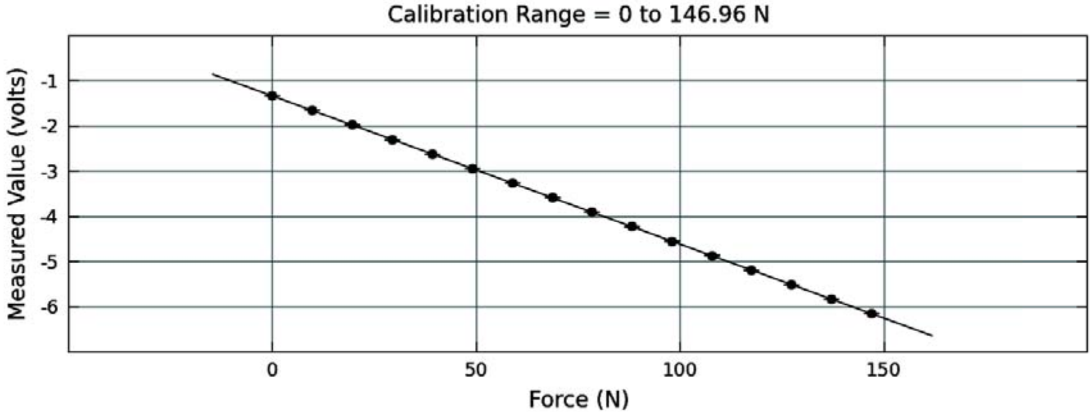
C_0 = -40.647 N,

C_1 = -30.519 N/volt,

Maximum Error = 0.052831 N (0.0359 % of Calibration Range)



Calibration Range = 0 to 146.96 N



JSS
Calibration of Torque
Calibrated 2012-05-18 14:31Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:** 10
Data Source: daspc49:50001 Channel 3	**Programmable Gain:**	**Excitation:** +/-15V
Sensor Model:	**Plug-In Gain:**	

Data Point #	Physical Value (Nm)	Measured Value (volts)	Fitted Curve Value (Nm)	Error (Nm)
1	-4.9041	-3.4407	-4.9055	-0.0014364
2	-4.4137	-3.0912	-4.4151	-0.0014571
3	-3.9233	-2.7411	-3.9240	-0.00075121
4	-3.4329	-2.3911	-3.4331	-0.00027909
5	-2.9425	-2.0413	-2.9424	5.3042e-05
6	-2.4520	-1.6912	-2.4513	0.00076318
7	-1.9616	-1.3413	-1.9605	0.0011771
8	-1.4712	-0.99192	-1.4704	0.00085123
9	-0.98082	-0.64187	-0.97934	0.0014762
10	-0.49041	-0.29245	-0.48918	0.0012321
11	0.0000	0.057022	0.0010462	0.0010462
12	0.0000	0.055761	-0.00072226	-0.00072226
13	0.49041	0.40592	0.49047	6.2798e-05
14	0.98082	0.75584	0.98133	0.00051009
15	1.4712	1.1052	1.4713	0.00011274

Table truncated (7 points not displayed).

Definition of Calibration Curve

Polynomial Degree = 1 (Linear Fit)

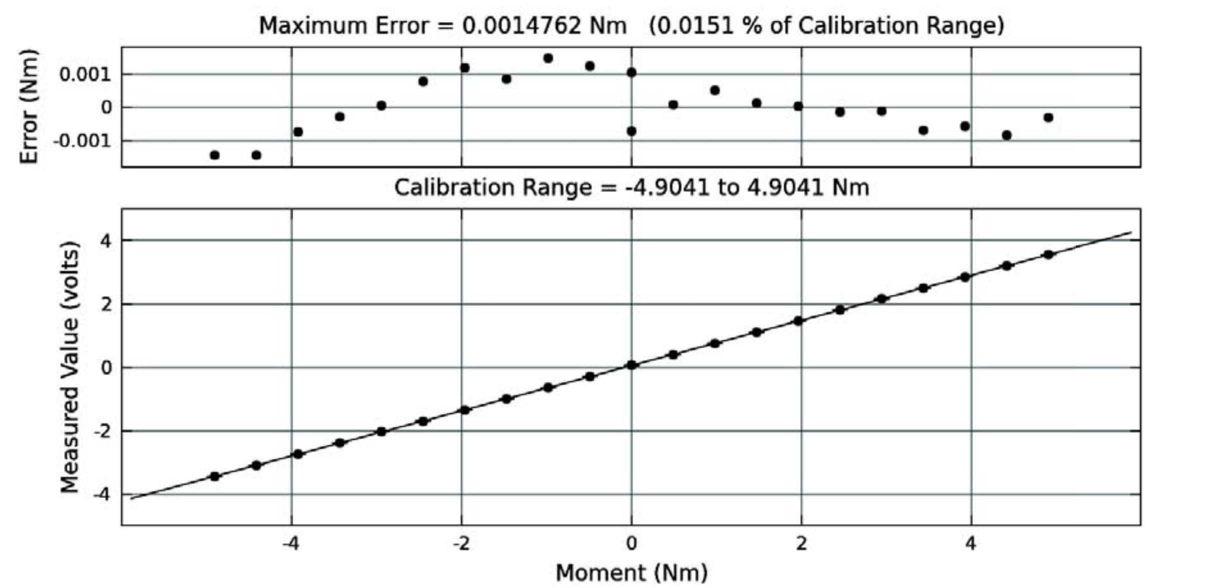
$Y = C_0 + C_1 \cdot V$

where $Y(t)$ = Moment (Nm),

$V(t)$ = measured value (volts),

C_0 = -0.078942 Nm,

C_1 = 1.4028 Nm/volt,



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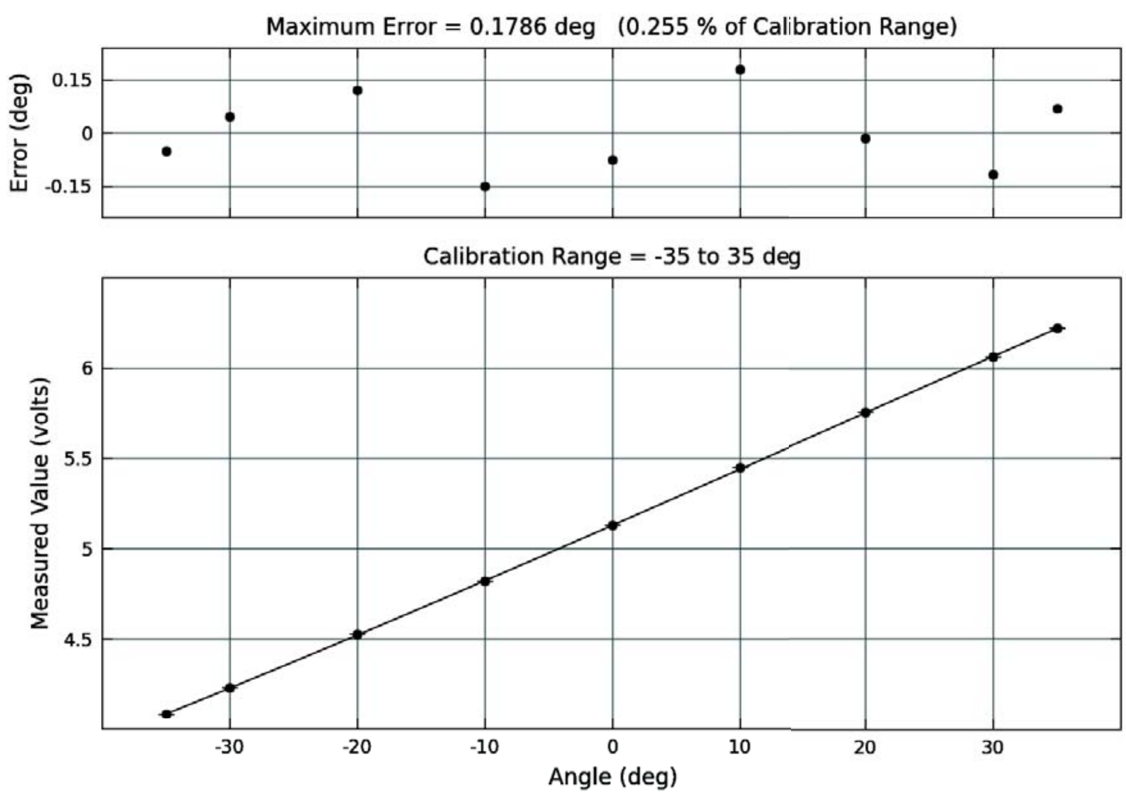
JSS
Calibration of Rudder Angle
Calibrated 2012-06-07 20:23Z

Test Facility: CWT	**Serial #:** 1392909	**Filter Frequency:** 10
Data Source: daspc49:50001 Channel 5	**Programmable Gain:**	**Excitation:**
Sensor Model: 60001A50-1000	**Plug-In Gain:** 496	

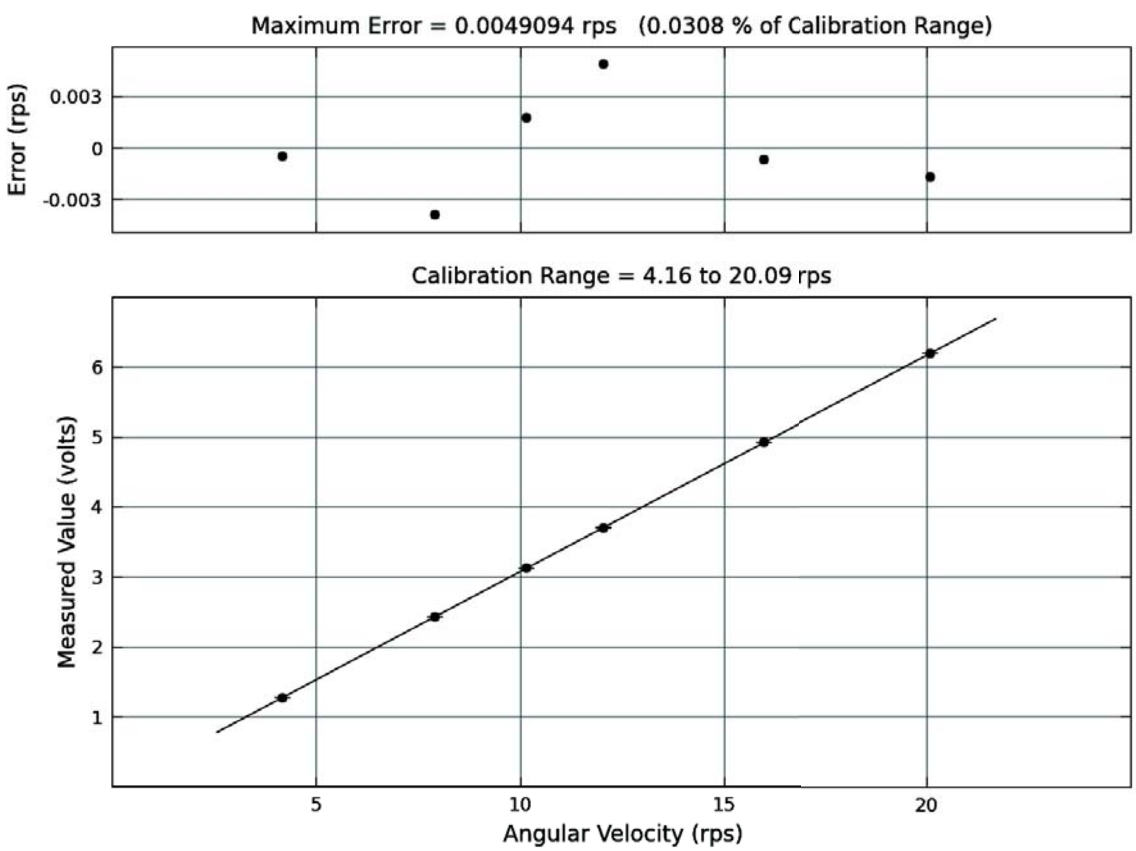
Data Point #	Physical Value (deg)	Measured Value (volts)	Fitted Curve Value (deg)	Error (deg)	Definition of Calibration Curve
1	-35.000	4.0837	-35.051	-0.051328	Polynomial Degree = 3
2	-30.000	4.2301	-29.956	0.044360	$Y = C_0 + \sum (C_i \cdot V^i)$
3	-20.000	4.5261	-19.880	0.11982	where $Y(t)$ = Angle (deg),
4	-10.000	4.8191	-10.150	-0.15000	$V(t)$ = measured value (volts),
5	0.0000	5.1283	-0.076463	-0.076463	C_0 = -240.2 deg,
6	10.000	5.4470	10.179	0.17860	C_1 = 72.467 deg/volt,
7	20.000	5.7532	19.984	-0.016094	C_2 = -7.1774 deg/volt^2,
8	30.000	6.0614	29.884	-0.11609	C_3 = 0.42448 deg/volt^3,
9	35.000	6.2217	35.067	0.067199	



JSS
Calibration of Shaft Speed
Calibrated 2012-05-25 17:18Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:**
Data Source: daspc49:50001 Channel 6	**Programmable Gain:**	**Excitation:**
Sensor Model:	**Plug-In Gain:**	

Data Point #	Physical Value (rps)	Measured Value (volts)	Fitted Curve Value (rps)	Error (rps)	Definition of Calibration Curve
1	4.1600	1.2790	4.1596	-0.00044708	Polynomial Degree = 1 (Linear Fit)
2	7.9100	2.4356	7.9061	-0.0038819	$Y = C_0 + C_1 \cdot V$
3	10.150	3.1289	10.152	0.0017632	where $Y(t)$ = Angular Velocity (rps),
4	12.020	3.7071	12.025	0.0049094	$V(t)$ = measured value (volts),
5	15.960	4.9217	15.959	-0.00065271	C_0 = 0.016423 rps,
6	20.090	6.1963	20.088	-0.0016909	C_1 = 3.2393 rps/volt,



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Calibration of PMM Yaw

Calibrated 2012-06-12 17:45Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:**
Data Source: daspc49:50001 Channel 8	**Programmable Gain:**	**Excitation:**
Sensor Model:	**Plug-In Gain:**	

Data Point #	Physical Value (deg)	Measured Value (volts)	Fitted Curve Value (deg)	Error (deg)
1	0.0000	4.4585	0.0062555	0.0062555
2	10.000	4.0525	10.005	0.0049287
3	20.000	3.6478	19.971	-0.028507
4	30.000	3.2399	30.017	0.017322

Definition of Calibration Curve

Polynomial Degree = 1 (Linear Fit)

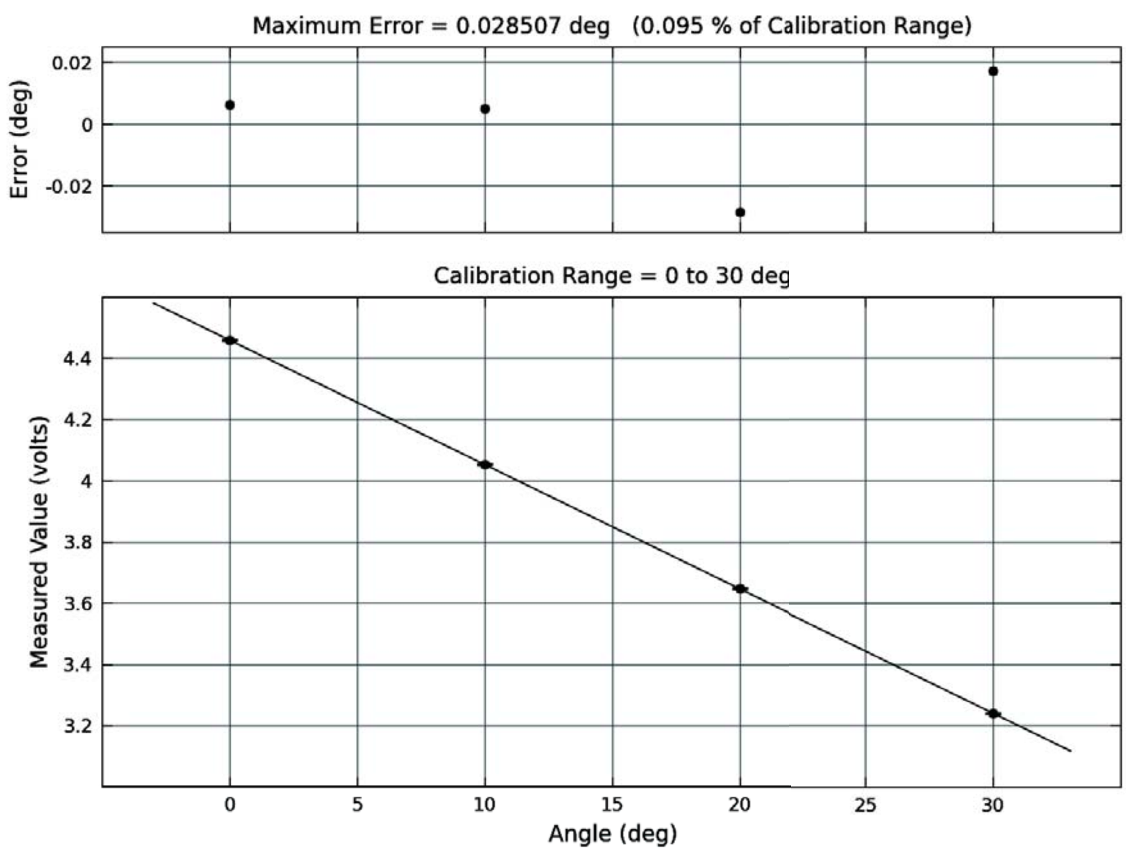
$Y = C_0 + C_1 \cdot V$

where $Y(t)$ = Angle (deg),

$V(t)$ = measured value (volts),

C_0 = 109.81 deg,

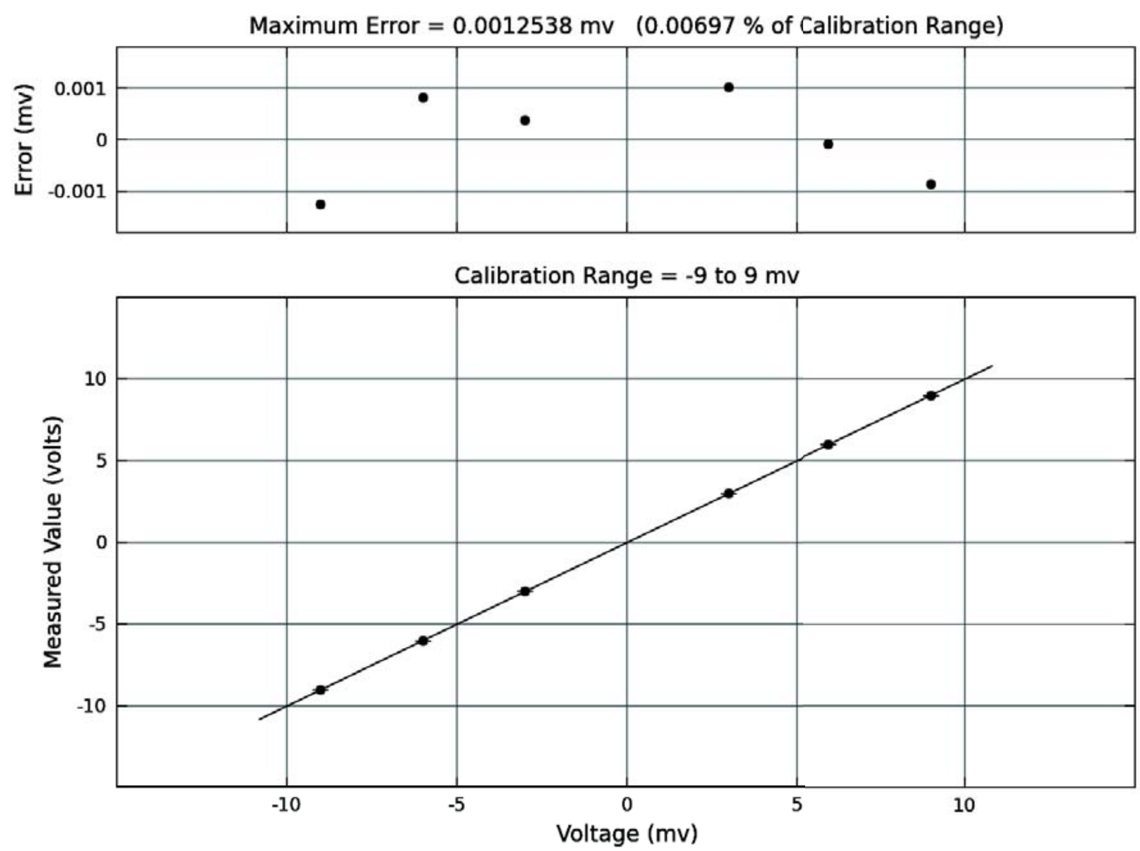
C_1 = -24.628 deg/volt,



JSS
Calibration of Z1
Calibrated 2011-12-03 01:49Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:**
Data Source: daspc49:50001 Channel 17	**Programmable Gain:**	**Excitation:**
Sensor Model:	**Plug-In Gain:**	

Data Point #	Physical Value (mv)	Measured Value (volts)	Fitted Curve Value (mv)	Error (mv)	Definition of Calibration Curve
1	-9.0000	-9.0367	-9.0013	-0.0012538	Polynomial Degree = 1 (Linear Fit)
2	-6.0000	-6.0333	-5.9992	0.00081146	$Y = C_0 + C_1 \cdot V$
3	-3.0000	-3.0324	-2.9996	0.00038204	where $Y(t)$ = Voltage (mv),
4	3.0000	2.9710	3.0010	0.0010155	$V(t)$ = measured value (volts),
5	6.0000	5.9712	5.9999	-9.2368e-05	C_0 = 0.031386 mv,
6	9.0000	8.9717	8.9991	-0.00086283	C_1 = 0.99956 mv/volt,



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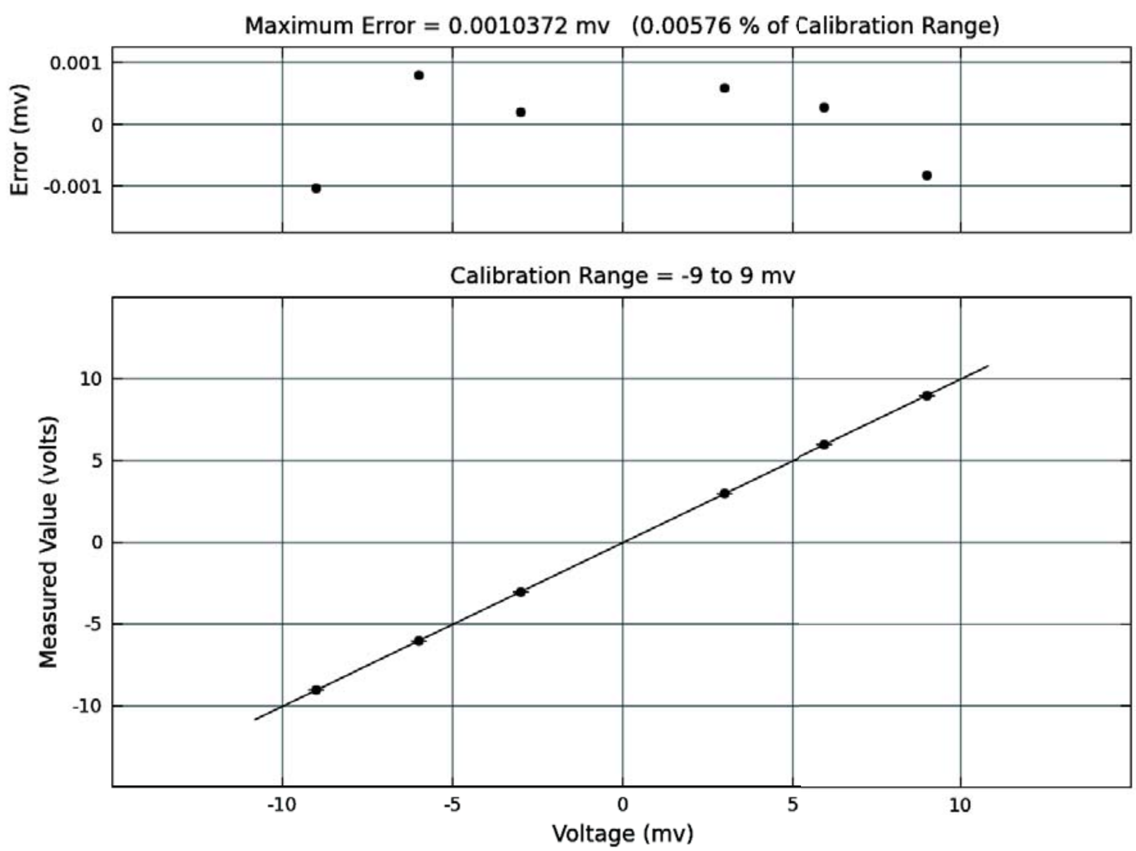
JSS
Calibration of Z2
Calibrated 2011-12-03 01:53Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:**
Data Source: daspc49:50001 Channel 18	**Programmable Gain:**	**Excitation:**
Sensor Model:	**Plug-In Gain:**	

Data Point #	Physical Value (mv)	Measured Value (volts)	Fitted Curve Value (mv)	Error (mv)	Definition of Calibration Curve
1	-9.0000	-9.0499	-9.0010	-0.0010372	Polynomial Degree = 1 (Linear Fit)
2	-6.0000	-6.0445	-5.9992	0.00079177	$Y = C_0 + C_1 \cdot V$
3	-3.0000	-3.0416	-2.9998	0.00020349	where $Y(t)$ = Voltage (mv),
4	3.0000	2.9658	3.0006	0.00058580	$V(t)$ = measured value (volts),
5	6.0000	5.9690	6.0003	0.00027979	C_0 = 0.038274 mv,
6	9.0000	8.9714	8.9992	-0.00082364	C_1 = 0.99883 mv/volt,



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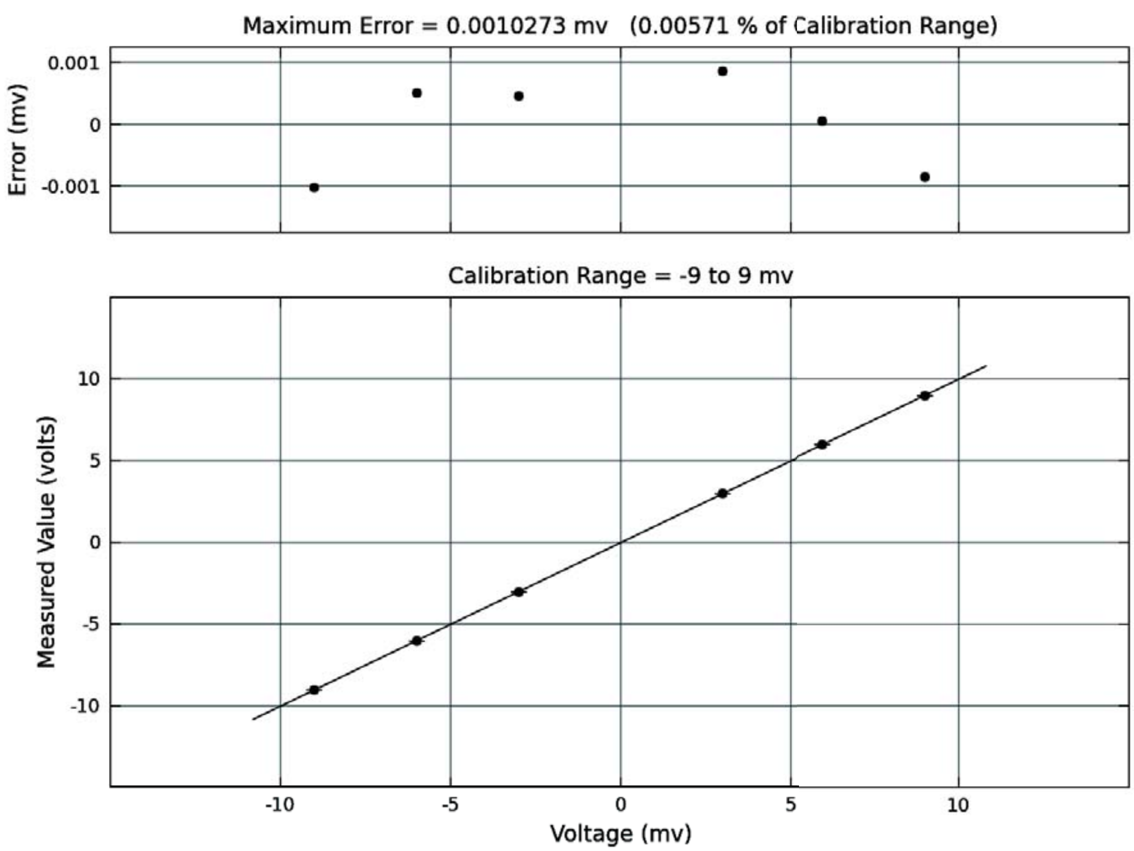
JSS
Calibration of Z3
Calibrated 2011-12-03 01:57Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:**
Data Source: daspc49:50001 Channel 19	**Programmable Gain:**	**Excitation:**
Sensor Model:	**Plug-In Gain:**	

Data Point #	Physical Value (mv)	Measured Value (volts)	Fitted Curve Value (mv)	Error (mv)	Definition of Calibration Curve
1	-9.0000	-9.0392	-9.0010	-0.0010273	Polynomial Degree = 1 (Linear Fit)
2	-6.0000	-6.0363	-5.9995	0.00051385	$Y = C_0 + C_1 \cdot V$
3	-3.0000	-3.0349	-2.9995	0.00045418	where $Y(t)$ = Voltage (mv),
4	3.0000	2.9683	3.0009	0.00085950	$V(t)$ = measured value (volts),
5	6.0000	5.9690	6.0001	5.9817e-05	C_0 = 0.033925 mv,
6	9.0000	8.9695	8.9991	-0.00086005	C_1 = 0.99953 mv/volt,



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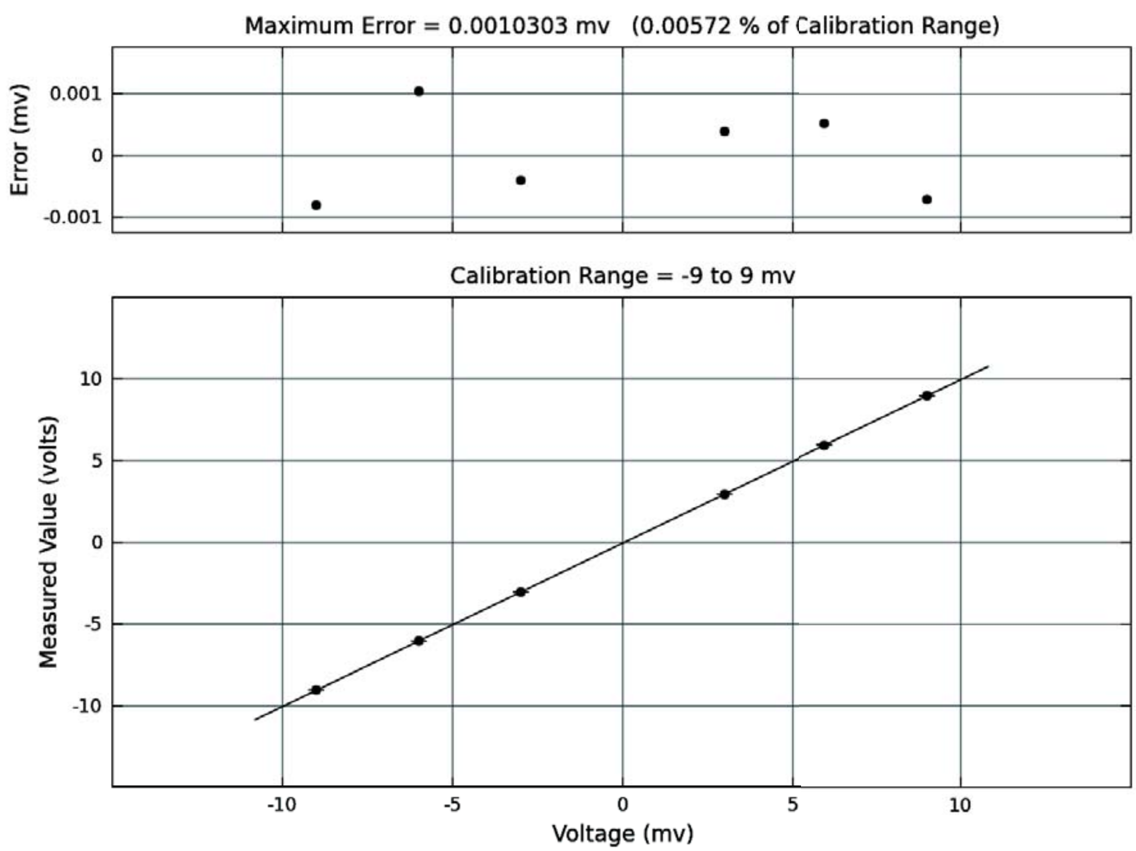
JSS
Calibration of Y1
Calibrated 2011-12-03 02:05Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:**
Data Source: daspc49:50001 Channel 20	**Programmable Gain:**	**Excitation:**
Sensor Model:	**Plug-In Gain:**	

Data Point #	Physical Value (mv)	Measured Value (volts)	Fitted Curve Value (mv)	Error (mv)	Definition of Calibration Curve
1	-9.0000	-9.0617	-9.0008	-0.00080516	Polynomial Degree = 1 (Linear Fit)
2	-6.0000	-6.0597	-5.9990	0.0010303	$Y = C_0 + C_1 \cdot V$
3	-3.0000	-3.0611	-3.0004	-0.00040022	where $Y(t)$ = Voltage (mv),
4	3.0000	2.9398	3.0004	0.00038374	$V(t)$ = measured value (volts),
5	6.0000	5.9401	6.0005	0.00051389	C_0 = 0.060616 mv,
6	9.0000	8.9389	8.9993	-0.00072253	C_1 = 0.99997 mv/volt,



JSS
Calibration of Y2
Calibrated 2011-12-03 02:09Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:**
Data Source: daspc49:50001 Channel 21	**Programmable Gain:**	**Excitation:**
Sensor Model:	**Plug-In Gain:**	

Data Point #	Physical Value (mv)	Measured Value (volts)	Fitted Curve Value (mv)	Error (mv)
1	-9.0000	-9.0203	-9.0011	-0.0011193
2	-6.0000	-6.0227	-5.9995	0.00045032
3	-3.0000	-3.0269	-2.9996	0.00038259
4	3.0000	2.9659	3.0012	0.0012348
5	6.0000	5.9611	6.0005	0.00046605
6	9.0000	8.9551	8.9986	-0.0014145

Definition of Calibration Curve

Polynomial Degree = 1 (Linear Fit)

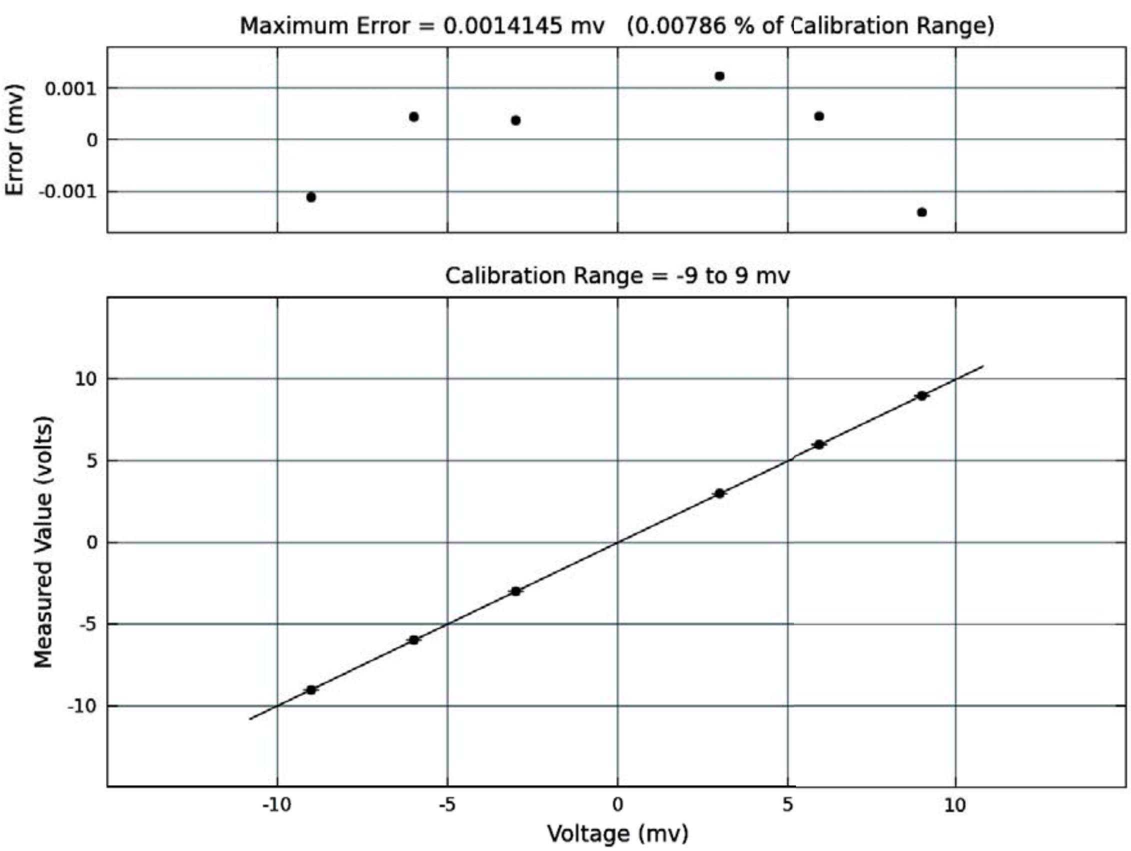
$Y = C_0 + C_1 \cdot V$

where $Y(t)$ = Voltage (mv),

$V(t)$ = measured value (volts),

C_0 = 0.031336 mv,

C_1 = 1.0014 mv/volt,



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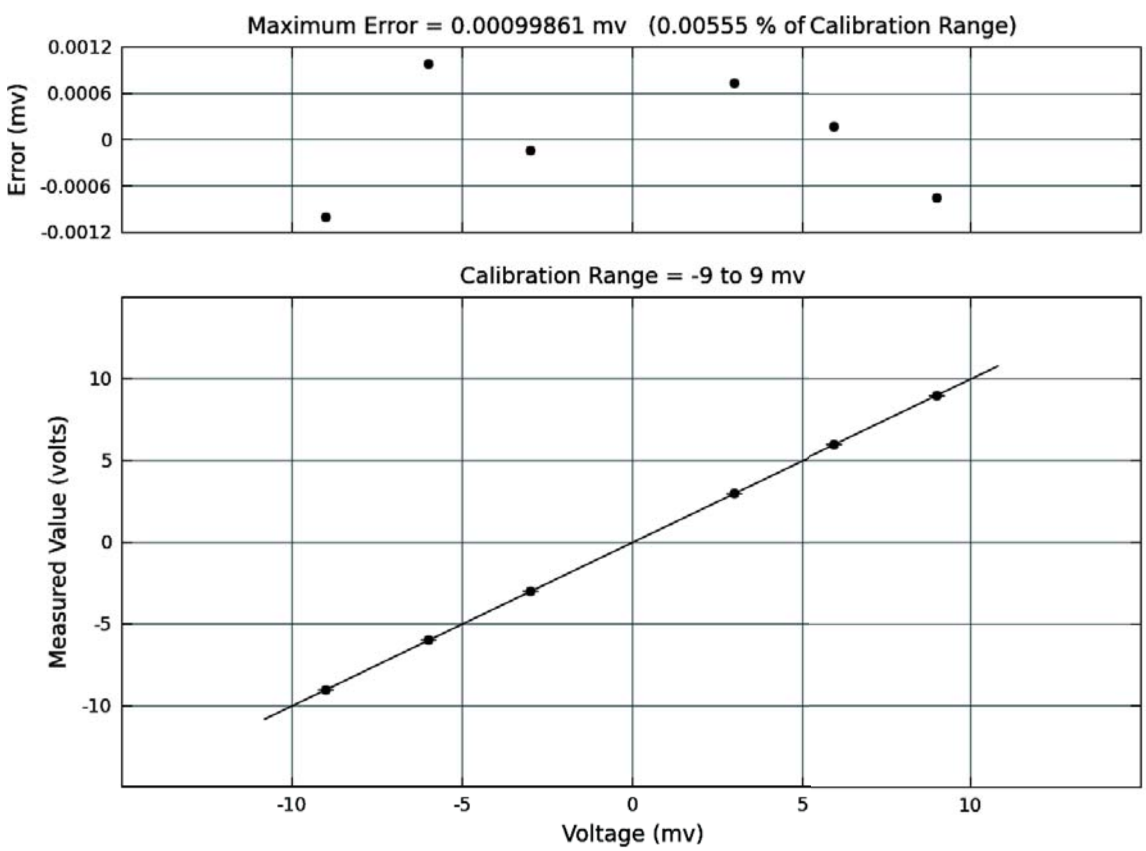
JSS
Calibration of X1
Calibrated 2011-12-03 02:15Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:**
Data Source: daspc49:50001 Channel 22	**Programmable Gain:**	**Excitation:**
Sensor Model:	**Plug-In Gain:**	

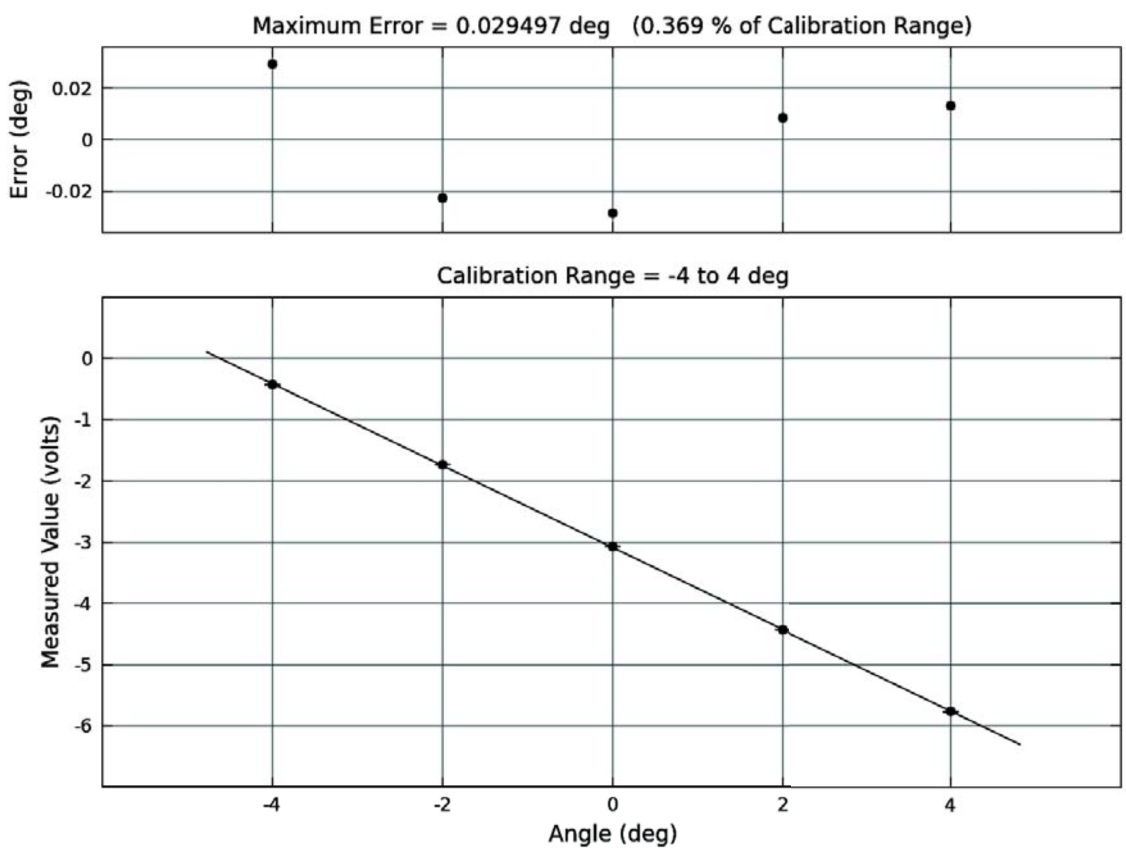
Data Point #	Physical Value (mv)	Measured Value (volts)	Fitted Curve Value (mv)	Error (mv)	Definition of Calibration Curve
1	-9.0000	-9.0236	-9.0010	-0.00099861	Polynomial Degree = 1 (Linear Fit)
2	-6.0000	-6.0221	-5.9990	0.00098186	$Y = C_0 + C_1 \cdot V$
3	-3.0000	-3.0238	-3.0001	-0.00014071	where $Y(t)$ = Voltage (mv),
4	3.0000	2.9760	3.0007	0.00073734	$V(t)$ = measured value (volts),
5	6.0000	5.9749	6.0002	0.00017153	C_0 = 0.024188 mv,
6	9.0000	8.9734	8.9992	-0.00075141	C_1 = 1.0002 mv/volt,



JSS
Calibration of PMM Pitch
Calibrated 2012-06-07 21:06Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:**
Data Source: daspc49:50001 Channel 23	**Programmable Gain:**	**Excitation:**
Sensor Model:	**Plug-In Gain:**	

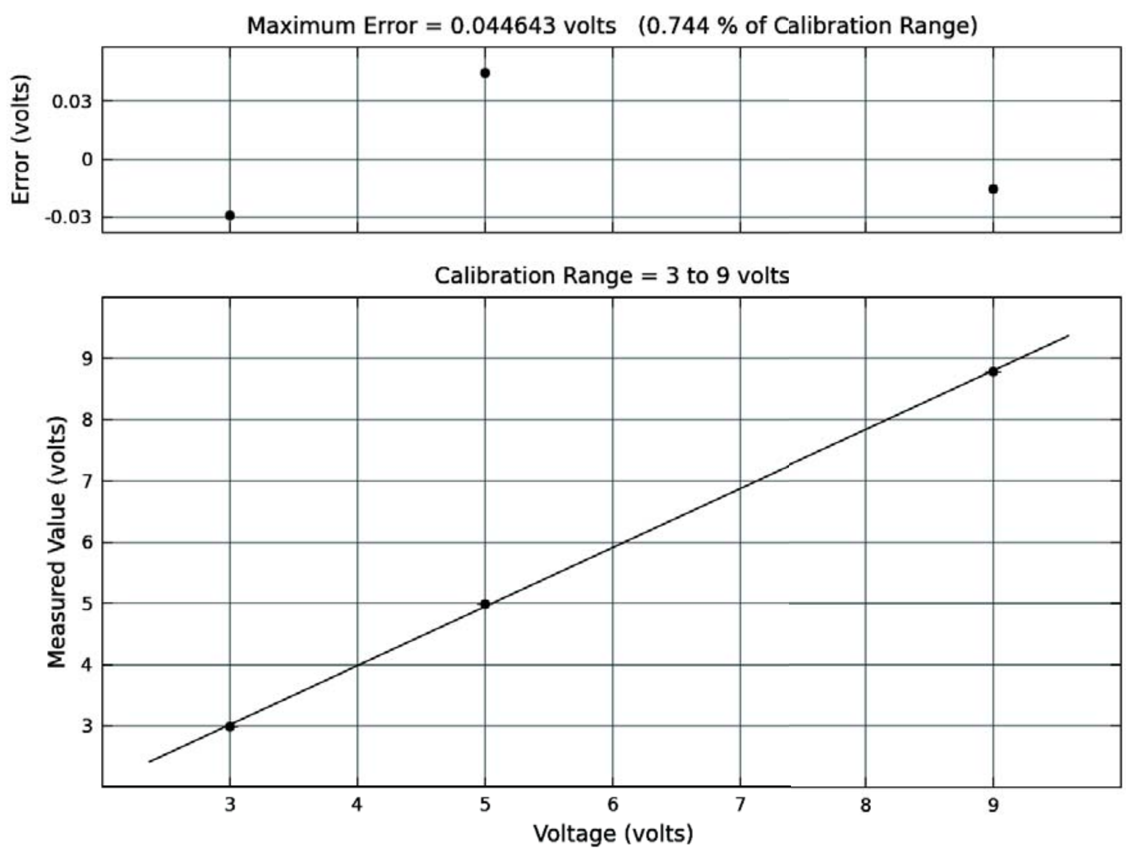
Data Point #	Physical Value (deg)	Measured Value (volts)	Fitted Curve Value (deg)	Error (deg)	Definition of Calibration Curve
1	-4.0000	-0.43472	-3.9705	0.029497	Polynomial Degree = 1 (Linear Fit)
2	-2.0000	-1.7364	-2.0227	-0.022707	$Y = C_0 + C_1 \cdot V$
3	0.0000	-3.0690	-0.028597	-0.028597	where $Y(t)$ = Angle (deg),
4	2.0000	-4.4303	2.0086	0.0085528	$V(t)$ = measured value (volts),
5	4.0000	-5.7700	4.0133	0.013254	C_0 = -4.621 deg,
					C_1 = -1.4964 deg/volt,



JSS
Calibration of PMM Start
Calibrated 2012-06-12 18:11Z

Test Facility: CWT **Data Source:** daspc49:50001 Channel 24 **Sensor Model:**	**Serial #:** **Programmable Gain:** **Plug-In Gain:**	**Filter Frequency:** **Excitation:**

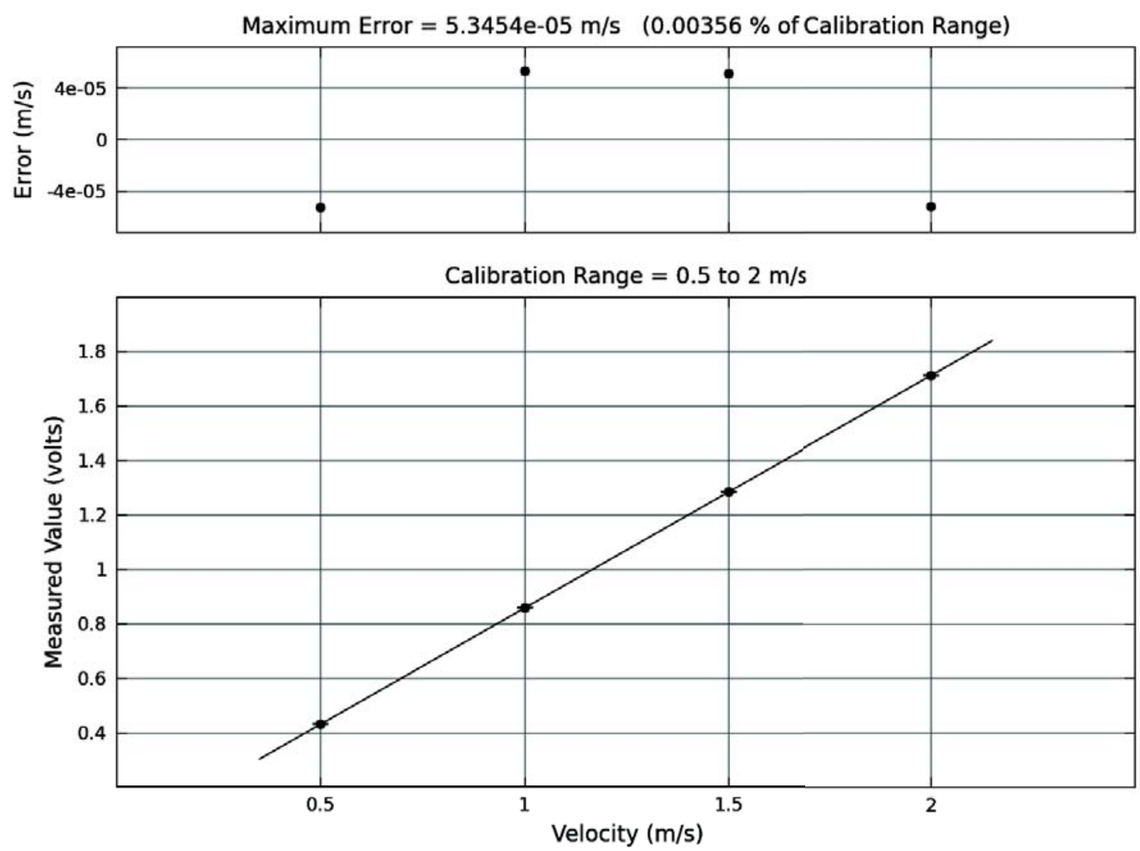
Data Point #	Physical Value (volts)	Measured Value (volts)	Fitted Curve Value (volts)	Error (volts)	Definition of Calibration Curve
1	3.0000	2.9939	2.9708	-0.029247	Polynomial Degree = 1 (Linear Fit)
2	5.0000	4.9913	5.0446	0.044643	$Y = C_0 + C_1 \cdot V$
3	9.0000	8.7861	8.9846	-0.015395	where $Y(t)$ = Voltage (volts),
					$V(t)$ = measured value (volts),
					C_0 = -0.13771 volts,
					C_1 = 1.0383 volts/volt,



JSS
Calibration of Tachogenerator
Calibrated 2011-12-13 17:20Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:** 10
Data Source: towdas:50001 Channel 1	**Programmable Gain:** 1	**Excitation:**
Sensor Model:	**Plug-In Gain:**	

Data Point #	Physical Value (m/s)	Measured Value (volts)	Fitted Curve Value (m/s)	Error (m/s)	Definition of Calibration Curve
1	0.50000	0.43194	0.49995	-5.2873e-05	Polynomial Degree = 1 (Linear Fit)
2	1.0000	0.85853	1.0001	5.3454e-05	$Y = C_0 + C_1 \cdot V$
3	1.5000	1.2850	1.5001	5.1733e-05	where $Y(t)$ = Velocity (m/s),
4	2.0000	1.7114	1.9999	-5.2314e-05	$V(t)$ = measured value (volts),
					C_0 = -0.0064425 m/s,
					C_1 = 1.1724 m/s/volt,



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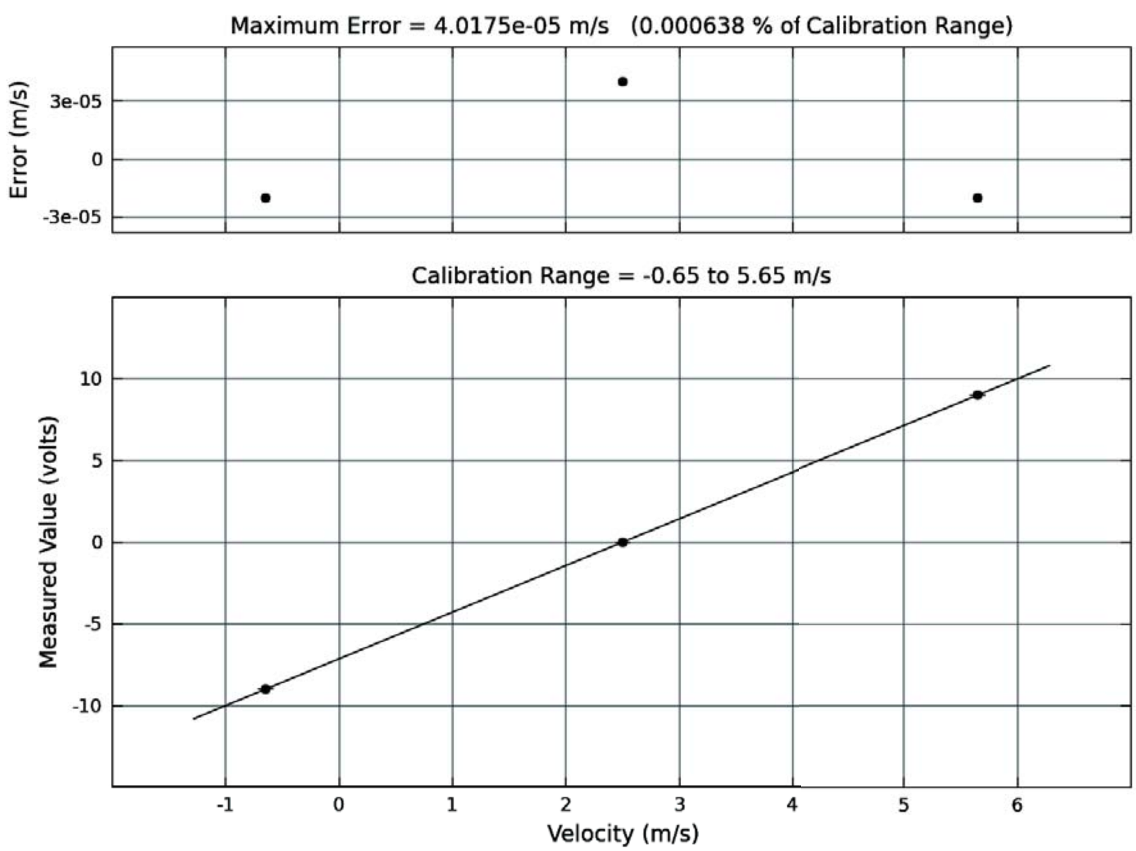
JSS
Calibration of Carriage Speed
Calibrated 2012-04-16 11:49Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:** 10
Data Source: towdas:50001 Channel 2	**Programmable Gain:** 1	**Excitation:**
Sensor Model:	**Plug-In Gain:** 1	

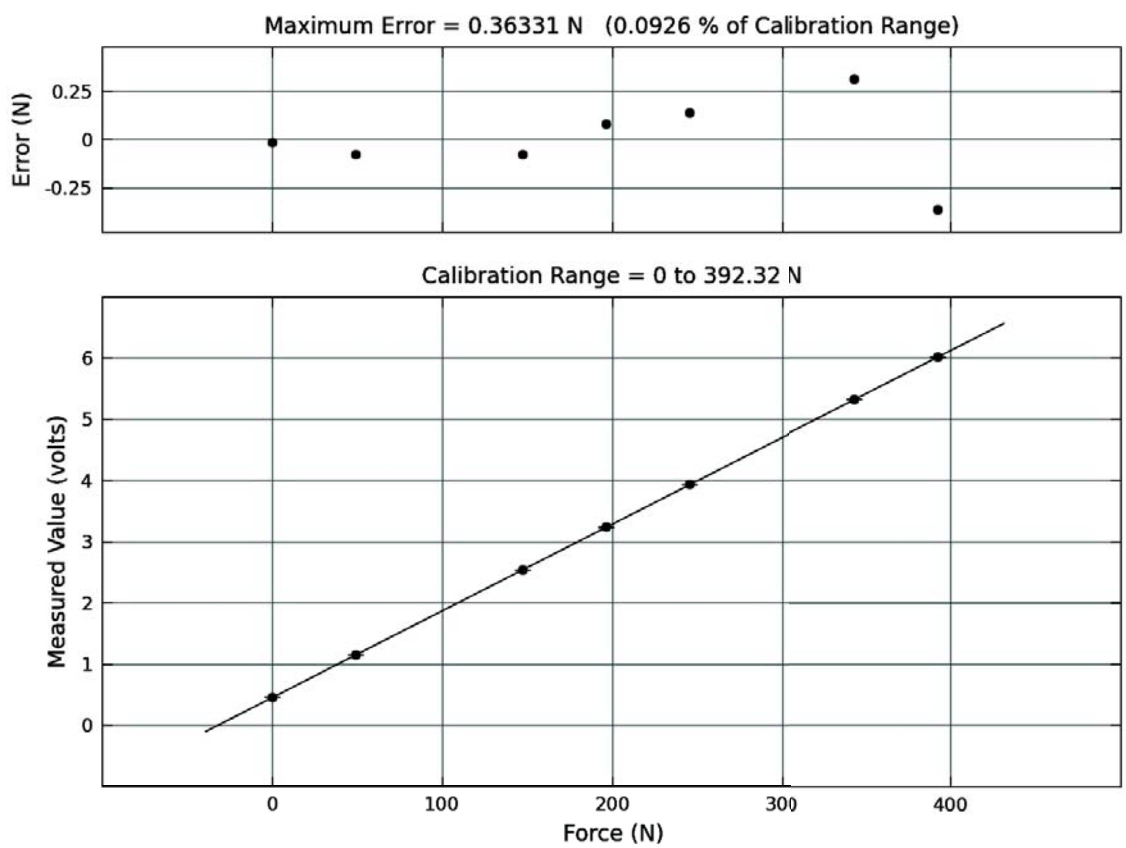
Data Point #	Physical Value (m/s)	Measured Value (volts)	Fitted Curve Value (m/s)	Error (m/s)	Definition of Calibration Curve
1	-0.65000	-8.9975	-0.65002	-2.0087e-05	Polynomial Degree = 1 (Linear Fit)
2	2.5000	-0.00031922	2.5000	4.0175e-05	$Y = C_0 + C_1 \cdot V$
3	5.6500	8.9965	5.6500	-2.0088e-05	where $Y(t)$ = Velocity (m/s),
					$V(t)$ = measured value (volts),
					C_0 = 2.5002 m/s,
					C_1 = 0.35012 m/s/volt,



JSS
Calibration of Inline Load
Calibrated 2012-04-19 16:43Z

Test Facility: CWT	**Serial #:** A10656	**Filter Frequency:** 10
Data Source: towdas:50001 Channel 10	**Programmable Gain:** 1	**Excitation:** 10v
Sensor Model: Sensotronics 0001A100-1000	**Plug-In Gain:** 200	

Data Point #	Physical Value (N)	Measured Value (volts)	Fitted Curve Value (N)	Error (N)	Definition of Calibration Curve
1	0.0000	0.45865	-0.016217	-0.016217	Polynomial Degree = 1 (Linear Fit)
2	49.040	1.1524	48.965	-0.075335	$Y = C_0 + C_1 \cdot V$
3	147.12	2.5415	147.04	-0.077776	where $Y(t)$ = Force (N),
4	196.16	3.2383	196.24	0.080099	$V(t)$ = measured value (volts),
5	245.20	3.9337	245.34	0.13925	C_0 = -32.399 N,
6	343.28	5.3254	343.59	0.31329	C_1 = 70.604 N/volt,
7	392.32	6.0104	391.96	-0.36331	



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JSS
Calibration of Yaw Velocity
Calibrated 2012-06-12 12:57Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:** 10
Data Source: towdas:50001 Channel 33	**Programmable Gain:** 1	**Excitation:** 10
Sensor Model:	**Plug-In Gain:** 1	

Data Point #	Physical Value (deg/s)	Measured Value (volts)	Fitted Curve Value (deg/s)	Error (deg/s)
1	0.0000	-0.0023175	0.00048828	0.00048828
2	9.0000	2.9967	8.9992	-0.00082192
3	18.000	5.9966	18.000	0.00017910
4	27.000	8.9960	27.000	0.00015454

Definition of Calibration Curve

Polynomial Degree = 1 (Linear Fit)

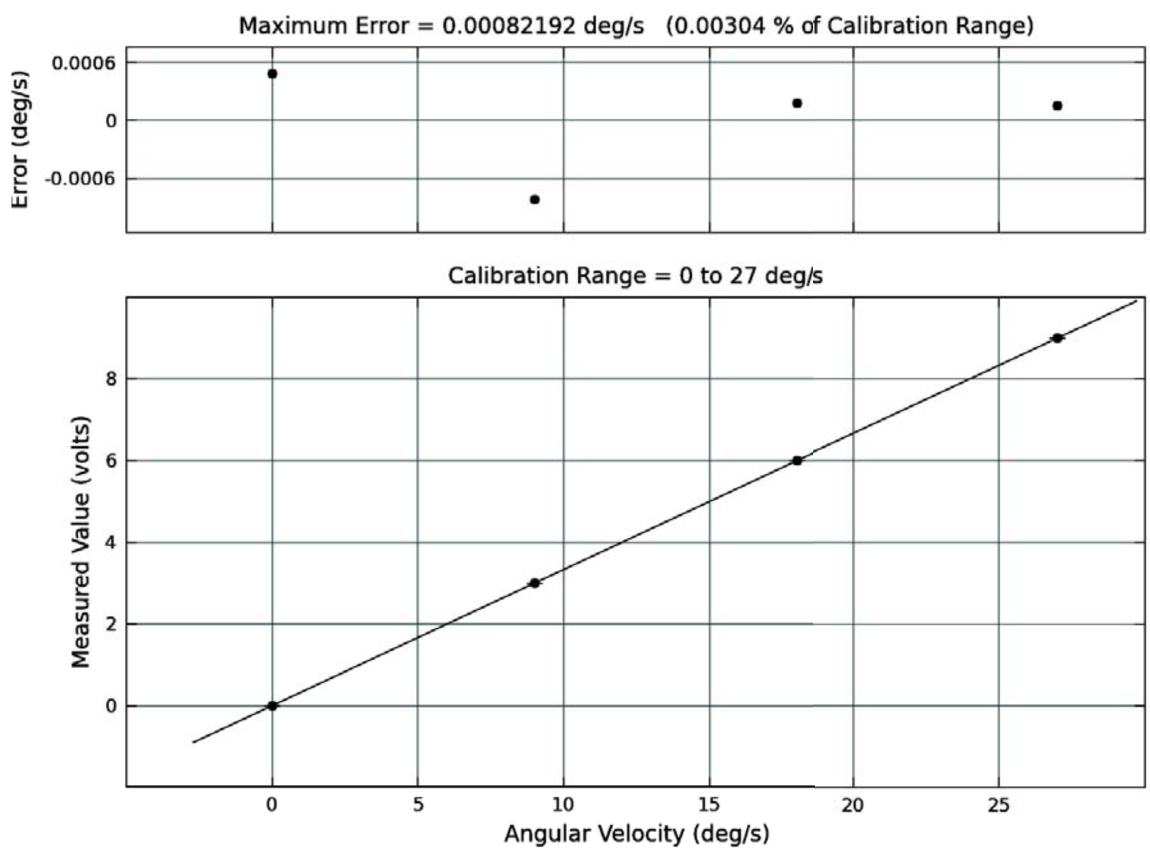
$Y = C_0 + C_1 \cdot V$

where $Y(t)$ = Angular Velocity (deg/s),

$V(t)$ = measured value (volts),

C_0 = 0.0074421 deg/s,

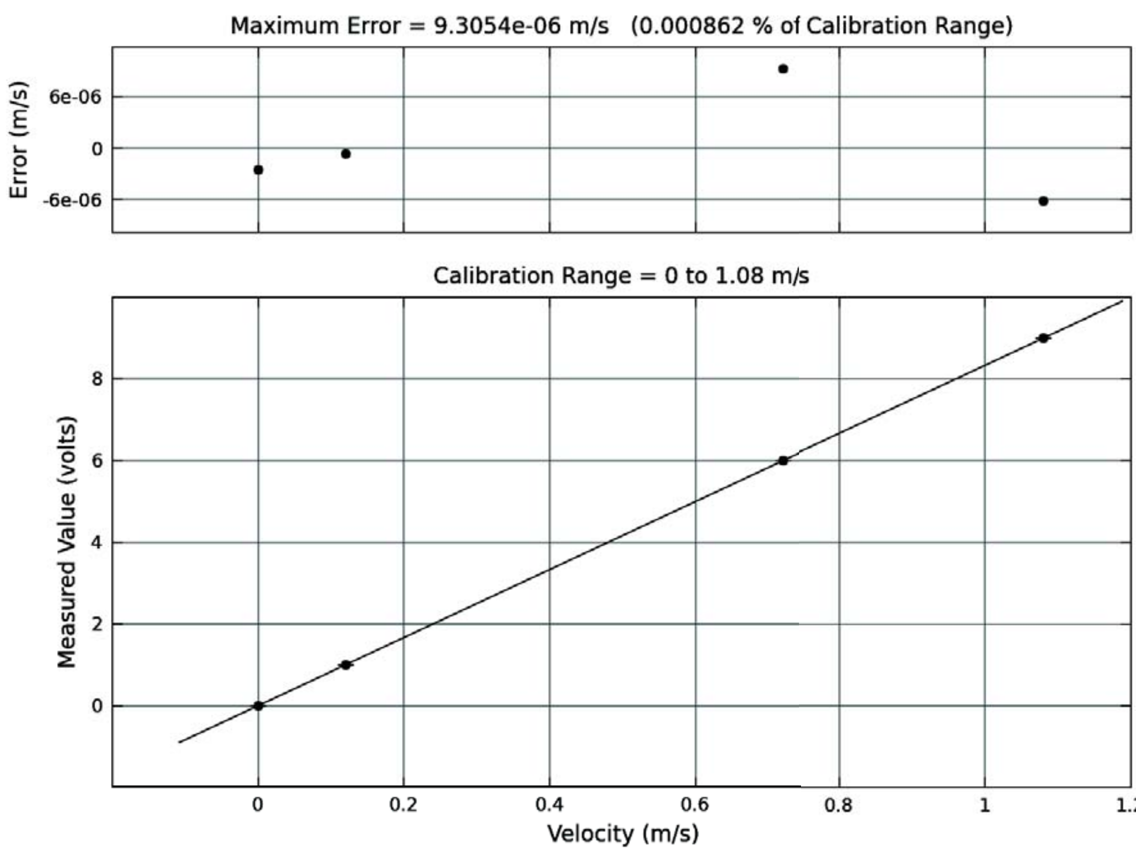
C_1 = 3.0005 deg/s/volt,



JSS
Calibration of Sway Velocity
Calibrated 2012-06-12 13:00Z

Test Facility: CWT **Data Source:** towdas:50001 Channel 34 **Sensor Model:**	**Serial #:** **Programmable Gain:** 1 **Plug-In Gain:** 1	**Filter Frequency:** 10 **Excitation:** 10v

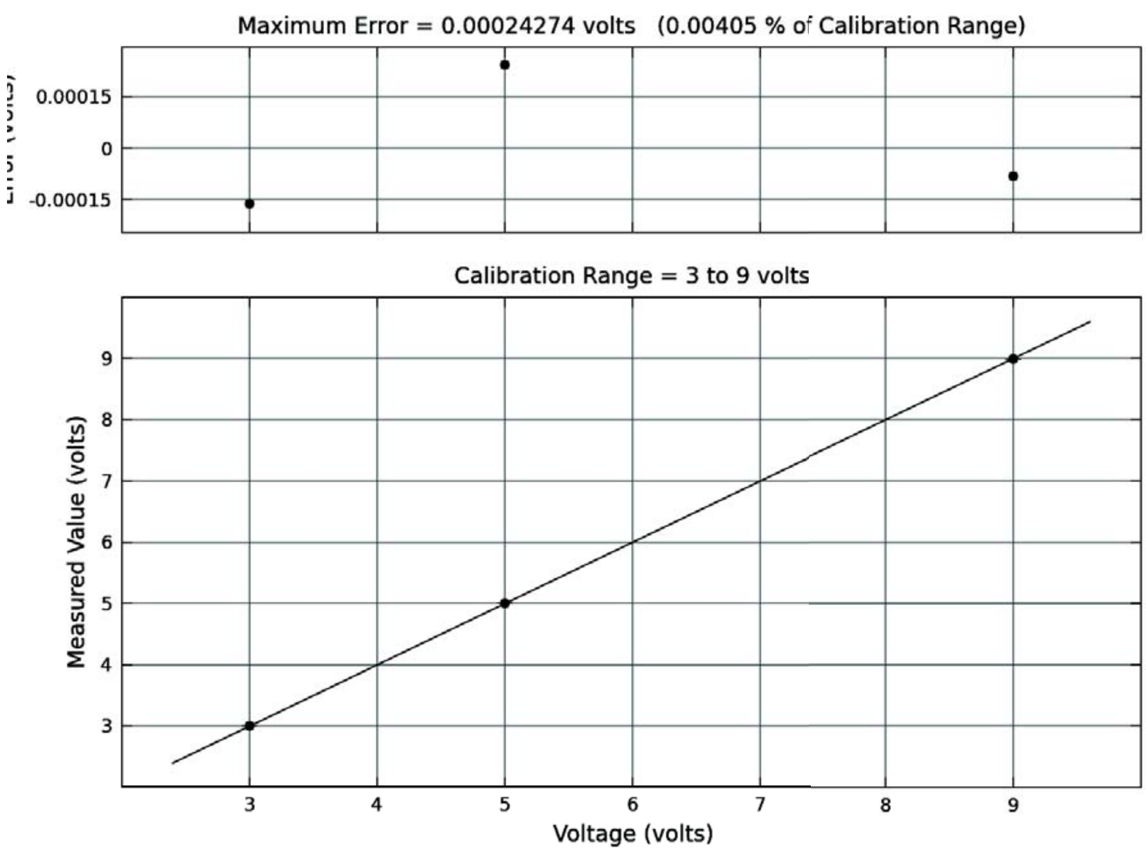
Data Point #	Physical Value (m/s)	Measured Value (volts)	Fitted Curve Value (m/s)	Error (m/s)	Definition of Calibration Curve
1	0.0000	-0.0024860	-2.5301e-06	-2.5301e-06	Polynomial Degree = 1 (Linear Fit)
2	0.12000	0.99729	0.12000	-6.4300e-07	$Y = C_0 + C_1 \cdot V$
3	0.72000	5.9962	0.72001	9.3054e-06	where $Y(t)$ = Velocity (m/s),
4	1.0800	8.9954	1.0800	-6.1323e-06	$V(t)$ = measured value (volts),
					C_0 = 0.00029586 m/s,
					C_1 = 0.12003 m/s/volt,



JSS
Calibration of DAS Trigger
Calibrated 2012-06-12 18:11Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:** 10
Data Source: towdas:50001 Channel 35	**Programmable Gain:** 1	**Excitation:** 10v
Sensor Model:	**Plug-In Gain:** 1	

Data Point #	Physical Value (volts)	Measured Value (volts)	Fitted Curve Value (volts)	Error (volts)	Definition of Calibration Curve
1	3.0000	2.9964	2.9998	-0.00016181	Polynomial Degree = 1 (Linear Fit)
2	5.0000	4.9964	5.0002	0.00024274	$Y = C_0 + C_1 \cdot V$
3	9.0000	8.9952	8.9999	-8.0927e-05	where $Y(t)$ = Voltage (volts),
					$V(t)$ = measured value (volts),
					C_0 = 0.0028737 volts,
					C_1 = 1.0002 volts/volt,



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JSS
Calibration of Sway Displacement
Calibrated 2012-06-11 17:08Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:** 10
Data Source: towdas:50001 Channel 39	**Programmable Gain:** 1	**Excitation:** 10v
Sensor Model:	**Plug-In Gain:** 1	

Data Point #	Physical Value (m)	Measured Value (volts)	Fitted Curve Value (m)	Error (m)
1	-29.995	7.4662	-29.998	-0.0034051
2	-28.996	6.6897	-28.994	0.0024796
3	-27.996	5.9162	-27.993	0.0034695
4	-26.997	5.1457	-26.995	0.0016671
5	-25.995	4.3761	-25.999	-0.0043928
6	-23.994	2.8280	-23.996	-0.0019574
7	-22.996	2.0535	-22.994	0.0022623
8	-21.981	1.2710	-21.981	-0.00012325

Definition of Calibration Curve

Polynomial Degree = 1 (Linear Fit)

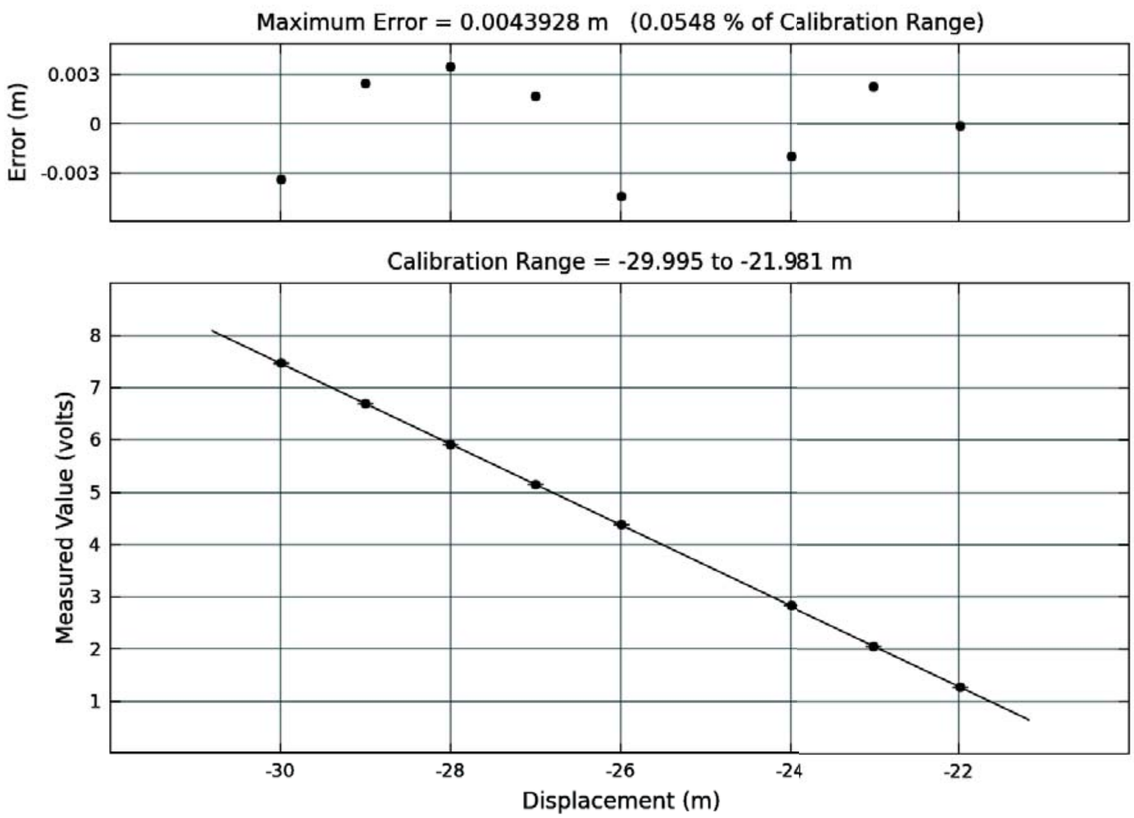
$$Y = C_0 + C_1 \cdot V$$

where $Y(t)$ = Displacement (m),

$V(t)$ = measured value (volts),

C_0 = -20.336 m,

C_1 = -1.2941 m/volt,



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APPENDIX B
PMM Balance: Calibration Matrix and Calculation of Forces and Moments

The measurements of individual load cells X1, Y1, Y2, Z1, Z2, Z3 in mV/V, with the correct signs (positive forward, to starboard, and down), were multiplied by their load cell sensitivities:

X1: 296.814 N/(mV/V)
Y1: 1070.24 N/(mV/V)
Y2: 1031.442 N/(mV/V)
Z1: 1089.97 N/(mV/V)
Z2: 1098.48 N/(mV/V)
Z3: 1107.46 N/(mV/V)

The crosstalk matrix was then applied to correct the individual load cell measurements. The crosstalk matrix represents the interferences between individual balance load cells and departures from the nominal balance geometry. The following crosstalk matrix was determined by doing a balance calibration in December 2011, using the Cussons procedure. The crosstalk matrix was derived from the force and moments measurements by reversing the exact same steps as presented in this appendix, only using the different Y1 and Y2 load cells that were in the balance at that time and their sensitivities.

	X1	Y1	Y2	Z1	Z2	Z3
X1	1.0049	0.0029	0.0030	-0.0027	0.0003	0.0000
Y1	-0.0055	0.9923	-0.0008	-0.0007	0.0003	-0.0003
Y2	-0.0012	0.0019	1.0008	0.0000	-0.0011	0.0007
Z1	-0.0104	-0.0007	-0.0028	0.9943	0.0009	-0.0001
Z2	0.0078	-0.0037	-0.0031	0.0003	0.9934	-0.0005
Z3	0.0086	0.0066	0.0037	-0.0006	-0.0010	0.9945

The longitudinal force X1 was corrected for the effect of the balance weight when the model has some trim angle, subtracting 17.245*Trim[deg], as determined by performing a longitudinal inclining experiment at the start of the June 2012 test session

Then the nominal geometry matrix was applied to obtain forces and moments FX, FY, FZ, MX, MY, MZ at the balance centre P:

	X1	Y1	Y2	Z1	Z2	Z3
FX	1	0	0	0	0	0
FY	0	1	1	0	0	0
FZ	0	0	0	1	1	1
MX	0	0.067	0.067	-0.1	-0.1	0.15
MY	-0.067	0	0	0.44	-0.44	0
MZ	0	-0.5	0.5	0	0	0

Finally, the moments were transferred to model origin O.

APPENDIX C
Test Log

DATE	TIME	WAIT TIME ACTUAL	Speed (m/s)	FILENAME(.DAQ)	PMM DRIVE SIGNAL (VORG00??).MDF	RUN DESCRIPTION	RPS	Video Track #	Yaw Angle	COMMENTS
										Test data saved on "Testdata on 'Knarr' Y:\Test_PJ2517\CWT\June_2012"
08-Jun-12	8:00									
"	to									Decomission model and start PMM install
"	16:00									
11-Jun-12	8:00									
"	to									PMM install and calibrations
"	16:00									
12-Jun-12	12:00									Received model form model prep shop around noon.
"	13:00									Begin ballasting of model
"	14:00									connect model to pmm
						Rudder command at 0.75: means rudder on CL Rudder command at -0.75: means aligned flow with props on (zero yaw moment)				
13-Jun-12	8:20									Check excitations of dyno channels @model
"	8:43			dyno_sign_chk_001		dyno sign check, pos y, pos x, pos z.				
"	9:07			friction_001		friction_001				
"	9:26			xpull_PMM_001		0-30kg, steps of 10kg				
"										Video drives installed: HDT-320-001 & HDT-320-002
"	9:54			Incline_001		120kg placed aft of dyno, fwd of dyno, and on bow.				
"										remove dummy hub and install prop.
"	10:56		1.697	Alignment_001		Yaw 0, Rudder set to program 0.75 deg / physically aligned to 0 deg.				
"	11:09									rezero sinkage and pitch
"										0.75 degrees programed on the laptop will be 0 degrees aligned on the model, therefore a +0.75 degree offset is used
"	11:12	0:10	1.697	Alignment_002		Model yawed +5 deg. For alignment check				
"	11:22	0:35	1.697	Alignment_003		Model yawed -5 deg. For alignment check				
"	11:57	0:08	1.697	Alignment_004		Yaw 0, prop on @ 9.96 rps, rudder sweep -2, 0, 2 deg				Wrong inputs in program, repeat run
"	12:05	0:12	1.697	Alignment_005		Yaw 0, prop on @ 9.96 rps, rudder sweep -1, 0, 1 deg				
"	12:17	0:16		Insitu_001		Bollard, carriage at 90m				
"	12:33	0:13	1.697	yaw_sweep_001	46	yaw sweep @0, 10, 20deg	6.00	N/A		
"	12:46	0:13	1.697	yaw_sweep_002	47	yaw sweep @0, -10, -20deg	6.00	N/A		Determined from the RUDDER sweep that -1.5 deg on the rudder is needed to keep the ship forward traveling = -0.75 offset
"	12:59	0:10	1.695	Run_001	21	yaw amp.: 1.7deg/s, period: 14s, Rudder command: -0.75deg offset	9.96	1		Pure Harmonic Yaw
"	13:09	0:10	1.690	Run_002	22	yaw amp.: 3.3deg/s, period: 14s, Rudder command: -0.75deg offset	9.96	2		"
"	13:19	0:11	1.681	Run_003	23	yaw amp.: 5deg/s, period: 14s, Rudder command: -0.75deg offset	9.96	3		"
"	13:30	0:10	1.668	Run_004	24	yaw amp.: 6.7deg/s, period: 14s, Rudder command: -0.75deg offset	9.96	4		"
"	13:40	0:10	1.653	Run_005	25	yaw amp.: 8.3deg/s, period: 14s, Rudder command: -0.75deg offset	9.96	5		"
"	13:50	0:10	1.633	Run_006	26	yaw amp.: 10deg/s, period: 14s, Rudder command: -0.75deg offset	9.96	6		"
"	14:00	0:11	1.655	Run_007	27	yaw amp.: 6.7deg/s, period: 17s, Rudder command: -0.75deg offset	9.96	7		"
"										
"	14:11	0:12	1.697	Run_008	39	sway amp.: 0.085m/s, period: 16s, Rudder command: -0.75deg offset	9.96	8	0	Pure Harmonic Sway
"	14:23	0:10	1.697	Run_009	14	sway amp.: 0.170m/s, period: 16s, Rudder command: -0.75deg offset	9.96	9	0	"
"	14:33	0:10	1.697	Run_010	15	sway amp.: 0.290m/s, period: 16s, Rudder command: -0.75deg offset	9.96	10	0	"
"	14:43	0:11	1.697	Run_011	16	sway amp.: 0.410m/s, period: 16s, Rudder command: -0.75deg offset	9.96	11	0	"
"	14:54	0:11	1.697	Run_012	17	sway amp.: 0.510m/s, period: 16s, Rudder command: -0.75deg offset	9.96	12	0	"
"	15:05	0:11	1.697	Run_013	18	sway amp.: 0.620m/s, period: 16s, Rudder command: -0.75deg offset	9.96	13	0	"
"	15:16	0:11	1.697	Run_014	19	sway amp.: 0.510m/s, period: 20s, Rudder command: -0.75deg offset	9.96	14	0	"
"										
"	15:27	0:10	1.697	Run_015	N/A	angles = -35, -30, -20 deg	9.96	15	0	Rudder Sweep
"	15:37	0:10	1.697	Run_016	N/A	angles = -10, -7.5, -5 deg	9.96	16	0	"
"	15:47	0:10	1.697	Run_017	N/A	angles = -2.5, 0, 2.5 deg	9.96	17	0	"
"	15:57	0:10	1.697	Run_018	N/A	angles = 5, 7.5, 10 deg	9.96	18	0	"
"	16:07	########	1.697	Run_019	N/A	angles = 20, 30, 35 deg	9.96	19	0	"
"										Charge model
14-Jun-12										
"	8:23			xpull_PMM_002		x pull				

DATE	TIME	WAIT TIME ACTUAL	Speed (m/s)	FILENAME(.DAQ)	PMM DRIVE SIGNAL (VORG00??).MDF	RUN DESCRIPTION	RPS	Video Track #	Yaw Angle	COMMENTS
"										rezero rudder angle and pmm yaw
"										rezero sinkage and pmm sway
"	8:50	0:14	0.00	Insitu_002		Bollard, carriage at 90m				
"	9:04	0:11	1.697	yaw_sweep_003	46	yaw sweep @0, 10, 20deg	6.00	N/A		rudder comanded to +0.75deg offset
"	9:15	0:10	1.697	yaw_sweep_004	47	yaw sweep @0, -10, -20deg	6.00	N/A		"
"	9:25	0:16	1.697	Run_020	N/A	Rudder angles = 35, 30, 20 deg	9.96	N/A	4	repeat for check
"	9:41	0:10	1.697	Run_021	4	Rudder angles = 0, 10, 20 deg	9.96	N/A	4	video missed
"	9:51	0:10	1.697	Run_022	4	Rudder angles = 25, 30, 35 deg	9.96	20	4	
"	10:01	0:11	1.697	Run_023	4	Rudder angles = 0, -10, -20 deg	9.96	21	4	
"										
"	10:12	0:10	1.697	Run_024	5	Rudder angles = -35, -30, -20 deg	9.96	22	8	
"	10:22	0:10	1.697	Run_025	5	Rudder angles = -10, 0, 10 deg	9.96	23	8	
"	10:32	0:10	1.697	Run_026	5	Rudder angles = 20, 30, 35 deg	9.96	24	8	wrong angles used, repeat with new angles, will be Run_030
"										
"	10:42	0:14	1.697	Run_027	6	Rudder angles = -35, -30, -20 deg	9.96	25	12	
"	10:56	0:09	1.697	Run_028	6	Rudder angles = -10, 0, 10 deg	9.96	26	12	
"	11:05	0:10	1.697	Run_029	6	Rudder angles = 20, 30, 35 deg	9.96	27	12	
"										
"	11:15	0:13	1.697	Run_030	5	Rudder angles = -25, 30, 35 deg	9.96	28	8	This is a repeat run / fill in run for Run_026
"	11:28	0:19	1.697	Run_031	4	Rudder angles = -25, 30, 35 deg	9.96	29	4	Fill ins for drive signal 4
"	11:37	0:10	1.697	Run_032	4	Rudder angles = -25, -30, -35 deg	9.96	30	4	Fill ins for drive signal 4
"										
"	11:47	0:10	1.697	Run_033	7	Rudder angles = -35, -30, -20 deg	9.96	31	16	
"	11:57	0:10	1.697	Run_034	7	Rudder angles = -10, 0, 10 deg	9.96	32	16	
"	12:07	0:10	1.697	Run_035	7	Rudder angles = 20, 30, 35 deg	9.96	33	16	
"										
"	12:17	0:10	1.697	Run_036	8	Rudder angles = -35, -30, -20 deg	9.96	34	20	
"	12:27	0:11	1.697	Run_037	8	Rudder angles = -10, 0, 10 deg	9.96	35	20	
"	12:38	0:11	1.697	Run_038	8	Rudder angles = 20, 30, 35 deg	9.96	36	20	
"										
"	12:49	0:12	1.697	Run_039	12	Rudder angles = -35, -30, -20 deg	9.96	37	-4	
"	13:01	0:11	1.697	Run_040	12	Rudder angles = -10, 0, 10 deg	9.96	38	-4	
"	13:12	0:10	1.697	Run_041	12	Rudder angles = 20, 30, 35 deg	9.96	39	-4	
"										
"	13:22	0:10	1.697	Run_042	11	Rudder angles = -35, -30, -20 deg	9.96	40	-8	
"	13:32	0:10	1.697	Run_043	11	Rudder angles = -10, 0, 10 deg	9.96	41	-8	
"	13:42	0:11	1.697	Run_044	11	Rudder angles = 20, 30, 35 deg	9.96	42	-8	wrong rudder angle set for first angle(-35deg), repeat run
"	13:53	0:10	1.697	Run_045	11	Rudder angles = -25, 20, 25 deg	9.96	43	-8	2 fill in angles included
"										
"	14:03	0:10	1.697	Run_046	10	Rudder angles = -35, -30, -20 deg	9.96	44	-12	
"	14:13	0:10	1.697	Run_047	10	Rudder angles = -10, 0, 10 deg	9.96	45	-12	
"	14:23	0:10	1.697	Run_048	10	Rudder angles = 20, 30, 35 deg	9.96	46	-12	
"										
"	14:33	0:10	1.697	Run_049	9	Rudder angles = -35, -30, -20 deg	9.96	47	-16	
"	14:43	0:30	1.697	Run_050	9	Rudder angles = -10, 0, 10 deg	9.96	48	-16	OCC using tank in between runs, wait times may be a little longer than 10 min
"	15:13	0:22	1.697	Run_051	9	Rudder angles = 20, 30, 35 deg	9.96	49	-16	
"										
"	15:35	0:09	1.697	Run_052	13	Rudder angles = -35, -30, -20 deg	9.96	50	-20	
"	15:44	0:10	1.697	Run_053	13	Rudder angles = -10, 0, 10 deg	9.96	51	-20	
"	15:54	0:12	1.697	Run_054	13	Rudder angles = 20, 30, 35 deg	9.96	52	-20	
"	16:06	########	1.697	Run_055	13	Rudder angles = 20, 30, 35 deg	9.96		-20	Repeat run with Optical isolation box installed on the PMM Das trigger
"										Model on charge
"										

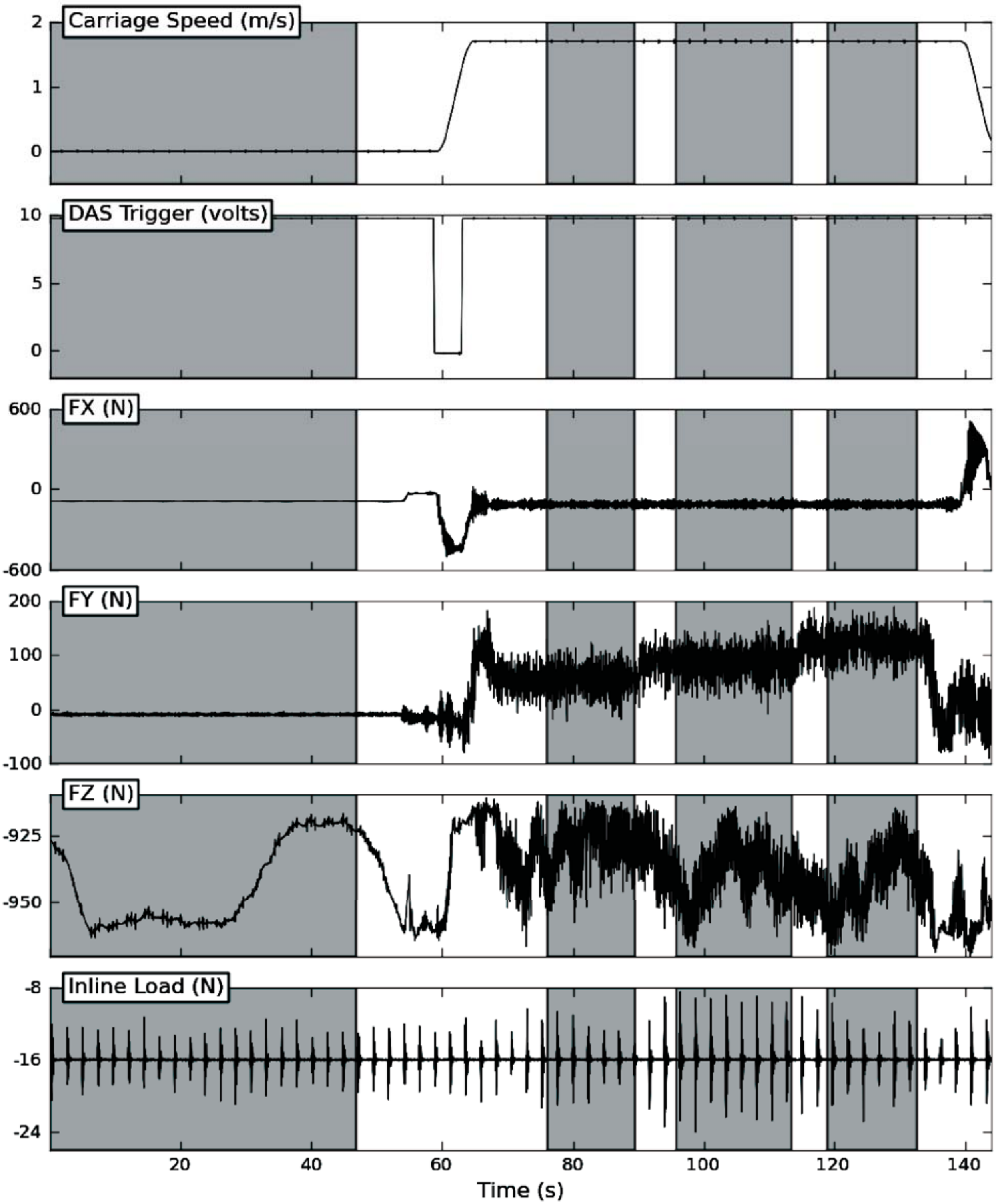
15-Jun-12										
"	8:23			xpull_PMM_003		x pull				
"										rezero rudder angle and pmm yaw
"										rezero sinkage and pmm sway
"	8:51		0.00	Insitu_003		Bollard, carriage at 90m				
"	9:00		1.697	yaw_sweep_005	46	yaw sweep @0, 10, 20deg	6.00	N/A	N/A	rudder comanded to +0.75deg offset
"	9:09		1.697	yaw_sweep_006	47	yaw sweep @0, -10, -20deg	6.00	N/A	N/A	rudder comanded to +0.75deg offset
"										
"	9:28	0:13	1.358	Run_056	N/A	Self propulsion determination runs, rudder programmed to 0.75 deg	various	53	0	8.96, 9.16, 9.36, 9.56, 9.76 rps
"	9:41	0:19	1.018	Run_057	N/A	Self propulsion determination runs, rudder programmed to 0.75 deg	various	54	0	8.52, 8.62, 8.67, 8.72, 8.81, 8.91 rps
"	10:00	0:24	0.594	Run_058	N/A	Self propulsion determination runs, rudder programmed to 0.75 deg	various	55	0	8.05, 8.12, 8.17, 8.22, 8.27, 8.34 rps

DATE	TIME	WAIT TIME ACTUAL	Speed (m/s)	FILENAME(.DAQ)	PMM DRIVE SIGNAL (VORG00??).MDF	RUN DESCRIPTION	RPS	Video Track #	Yaw Angle	COMMENTS
"										
"	10:24	0:12	0.594	Run_059	N/A	Reduced speed runs	9.96	56	0	-10, 0, 10, 20, 30, 35 deg, labeled run_058 on annotator
"	10:36	0:11	1.018	Run_060	N/A	Reduced speed runs	9.96	57	0	
"	10:47	0:11	1.358	Run_061	N/A	Reduced speed runs	9.96	58	0	
"	10:58	0:11	0.594	Run_062	N/A	Reduced speed runs	8.05	59	0	
"	11:09	0:13	0.594	Run_063	N/A	Reduced speed runs	8.05	60	0	
"	11:22	0:10	1.018	Run_064	N/A	Reduced speed runs	8.71	61	0	
"	11:32	0:12	1.018	Run_065	N/A	Reduced speed runs	8.71	62	0	
"	11:44	0:10	1.358	Run_066	N/A	Reduced speed runs	9.27	63	0	
"	11:54	0:14	1.358	Run_067	N/A	Reduced speed runs	9.27	64	0	
"										
"	12:08	0:10	1.697	Run_068	33	Combined sway / yaw, Rudder command: -0.75deg offset	9.96	65		
"	12:18	0:11	1.697	Run_069	32	Combined sway / yaw, Rudder command: -0.75deg offset	9.96	66		
"	12:29	0:11	1.697	Run_070	34	Combined sway / yaw, Rudder command: -0.75deg offset	9.96	67		
"	12:40	0:20	1.697	Run_071	35	Combined sway / yaw, Rudder command: -0.75deg offset	9.96	68		
"										Shaft speed(Solist) was unplugged to see if it made a difference to the noise issue.
"	13:00	0:11	1.697	Run_072	36	Combined sway / yaw, Rudder command: -0.75deg offset	9.96	69		
"										Shaft speed(Solist) unplugged made no difference.
"	13:11	0:11	1.697	Run_073	37	Combined sway / yaw, Rudder command: -0.75deg offset	9.96	70		shaft speed missed, repeat run
"	13:22	0:09	1.697	Run_074	37	Combined sway / yaw, Rudder command: -0.75deg offset	9.96	71		
"										
"	13:31	0:16	1.690	Run_075	22	Harmonic Yaw & Rudder, Rudder: 10, 20deg	9.96	72		
"	13:47	0:10	1.690	Run_076	22	Harmonic Yaw & Rudder, Rudder: -10, -20deg	9.96	73		
"	13:57	0:10	1.690	Run_077	22	Harmonic Yaw & Rudder, Rudder: 30, 35deg	9.96	74		
"	14:07	0:10	1.690	Run_078	22	Harmonic Yaw & Rudder, Rudder: -30, -35deg	9.96	75		
"	14:17	0:10	1.668	Run_079	24	Harmonic Yaw & Rudder, Rudder: 10, 20deg	9.96	76		
"	14:27	0:12	1.668	Run_080	24	Harmonic Yaw & Rudder, Rudder: -10, -20deg	9.96	77		
"	14:39	0:12	1.668	Run_081	24	Harmonic Yaw & Rudder, Rudder: 30, 35deg	9.96	78		
"	14:51	0:12	1.668	Run_082	24	Harmonic Yaw & Rudder, Rudder: -30, -35deg	9.96	79		
"	15:03	0:12	1.633	Run_083	26	Harmonic Yaw & Rudder, Rudder: 10, 20deg	9.96	80		
"	15:15	0:12	1.633	Run_084	26	Harmonic Yaw & Rudder, Rudder: -10, -20deg	9.96	81		
"	15:27	0:12	1.633	Run_085	26	Harmonic Yaw & Rudder, Rudder: 30, 35deg	9.96	82		
"	15:39	########	1.633	Run_086	26	Harmonic Yaw & Rudder, Rudder: -30, -35deg	9.96	83		
"										Charge model
"										

18-Jun-12	8:30			xpull_PMM_004		x pull				
"	8:45									rezero rudder angle and pmm yaw
"										rezero sinkage and pmm sway
"	8:52		0.00	Insitu_004		Bollard, carriage at 90m				
"	9:01		1.697	yaw_sweep_007	46	yaw sweep @0, 10, 20deg	6.00	N/A	N/A	rudder comanded to +0.75deg offset
"	9:13		1.697	yaw_sweep_008	47	yaw sweep @0, -10, -20deg	6.00	N/A	N/A	rudder comanded to +0.75deg offset
"										
"	9:26	0:12	1.681	Run_087	31	Harmonic Yaw & Drift, Yaw amp.: 5deg/s, Period = 14, Static Yaw: 4deg	9.96	84	4	rudder comanded to +0.75deg offset
"	9:38	0:12	1.681	Run_088	30	Harmonic Yaw & Drift, Yaw amp.: 5deg/s, Period = 14, Static Yaw: 8deg	9.96	85	8	rudder comanded to +0.75deg offset
"	9:50	0:13	1.681	Run_089	38	Harmonic Yaw & Drift, Yaw amp.: 5deg/s, Period = 14, Static Yaw: -8deg	9.96	86	-8	rudder comanded to +0.75deg offset
"	10:03	0:12	1.681	Run_090	29	Harmonic Yaw & Drift, Yaw amp.: 5deg/s, Period = 14, Static Yaw: 12deg	9.96	87	12	rudder comanded to +0.75deg offset
"	10:15	0:12	1.653	Run_091	40	Harmonic Yaw & Drift, Yaw amp.: 8.3deg/s, Period = 14, Static Yaw: 4deg	9.96	88	4	rudder comanded to +0.75deg offset
"	10:27	0:12	1.653	Run_092	41	Harmonic Yaw & Drift, Yaw amp.: 8.3deg/s, Period = 14, Static Yaw: 8deg	9.96	89	8	rudder comanded to +0.75deg offset
"	10:39	0:12	1.653	Run_093	42	Harmonic Yaw & Drift, Yaw amp.: 8.3deg/s, Period = 14, Static Yaw: -8deg	9.96	90	-8	rudder comanded to +0.75deg offset
"	10:51	0:12	1.653	Run_094	43	Harmonic Yaw & Drift, Yaw amp.: 8.3deg/s, Period = 14, Static Yaw: 12deg	9.96	91	12	rudder comanded to +0.75deg offset
"										
"	11:03	0:12	1.668	Run_095	24	yaw amp.: 6.7deg/s, period: 14s, Rudder command: -0.75deg offset	9.96	92		Repeatabillty check runs
"	11:15	0:12	1.697	Run_096	16	sway amp.: 0.410m/s, period: 16s, Rudder command: -0.75deg offset	9.96	93	0	"
"	11:27	0:12	1.697	Run_097	36	Combined sway / yaw, Rudder command: -0.75deg offset	9.96	94	0	"
"	11:39	0:12	1.653	Run_098	40	Harmonic Yaw & Drift, Yaw amp.: 8.3deg/s, Period = 14, Static Yaw: 4deg	9.96	95		rudder comanded to **+0.75**deg offset
"	11:51	0:12	1.653	Run_099	40	Harmonic Yaw & Drift, Yaw amp.: 8.3deg/s, Period = 14, Static Yaw: 4deg	9.96	96		rudder comanded to **-0.75**deg offset
"	12:03	0:12	1.668	Run_100	24	Harmonic Yaw & Rudder, Rudder: -10, -20deg	9.96	97		
"	12:15	0:12	1.697	Run_101	N/A	angles = -20, -10, 20 deg	9.96	98	0	Rudder Sweep
"	12:27	0:12	1.697	Run_102	6	Rudder angles = -10, 0, 10 deg	9.96	99	12	
"	12:39	1:00	1.697	Run_103	N/A	angles = -10, -7.5, 10 deg	9.96	N/A	0	
"	13:39			friction_002						

APPENDIX D
Example SWEET Output Files

JSS
RUN_118



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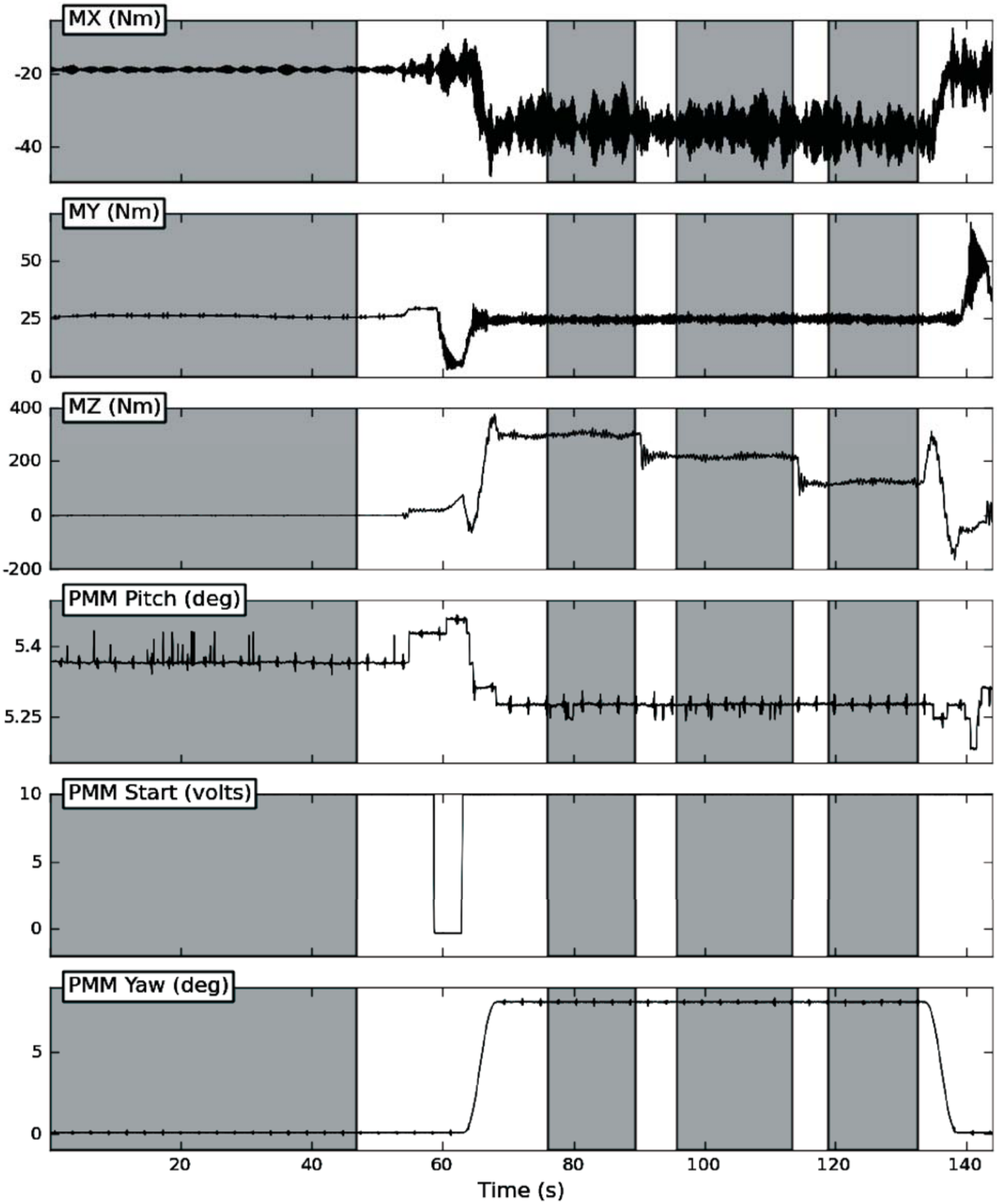
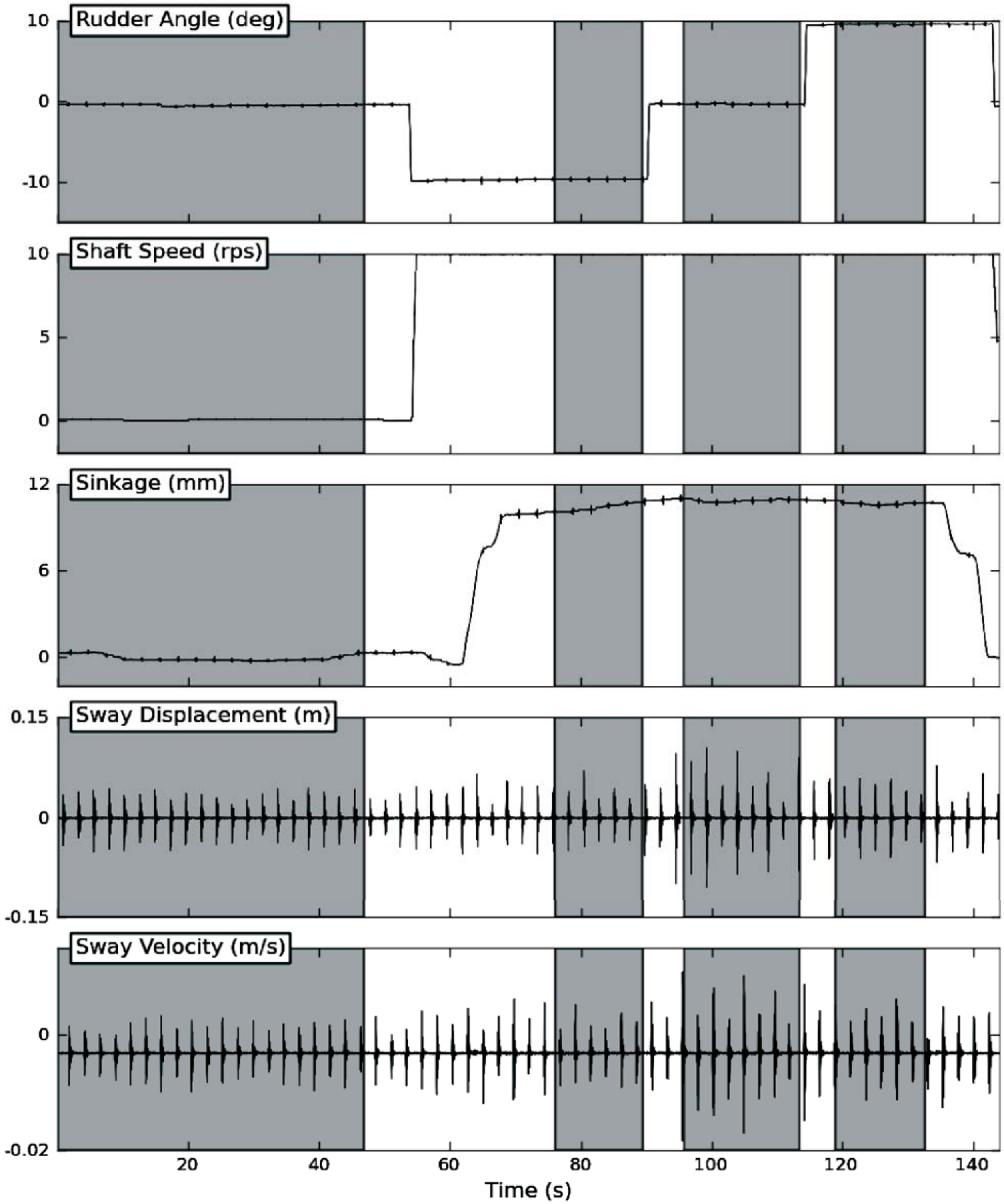
JSS
RUN_118



MX (Nm)
-20
-40
MY (Nm)
50
25
0
MZ (Nm)
400
200
0
-200
PMM Pitch (deg)
5.4
5.25
PMM Start (volts)
10
5
0
PMM Yaw (deg)
5
0
20
40
60
80
100
120
140
Time (s)

JSS
RUN_118



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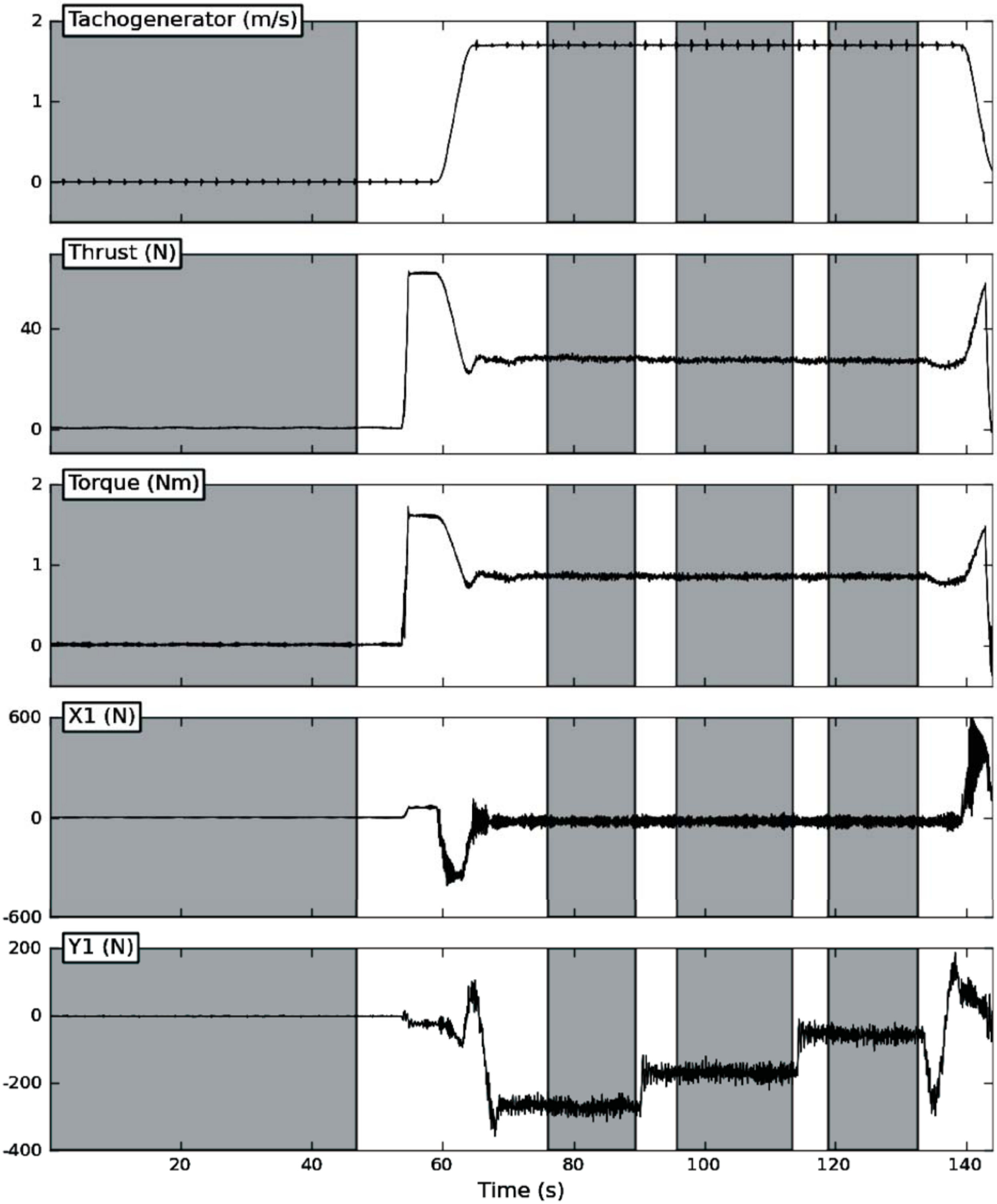
JSS
RUN_118



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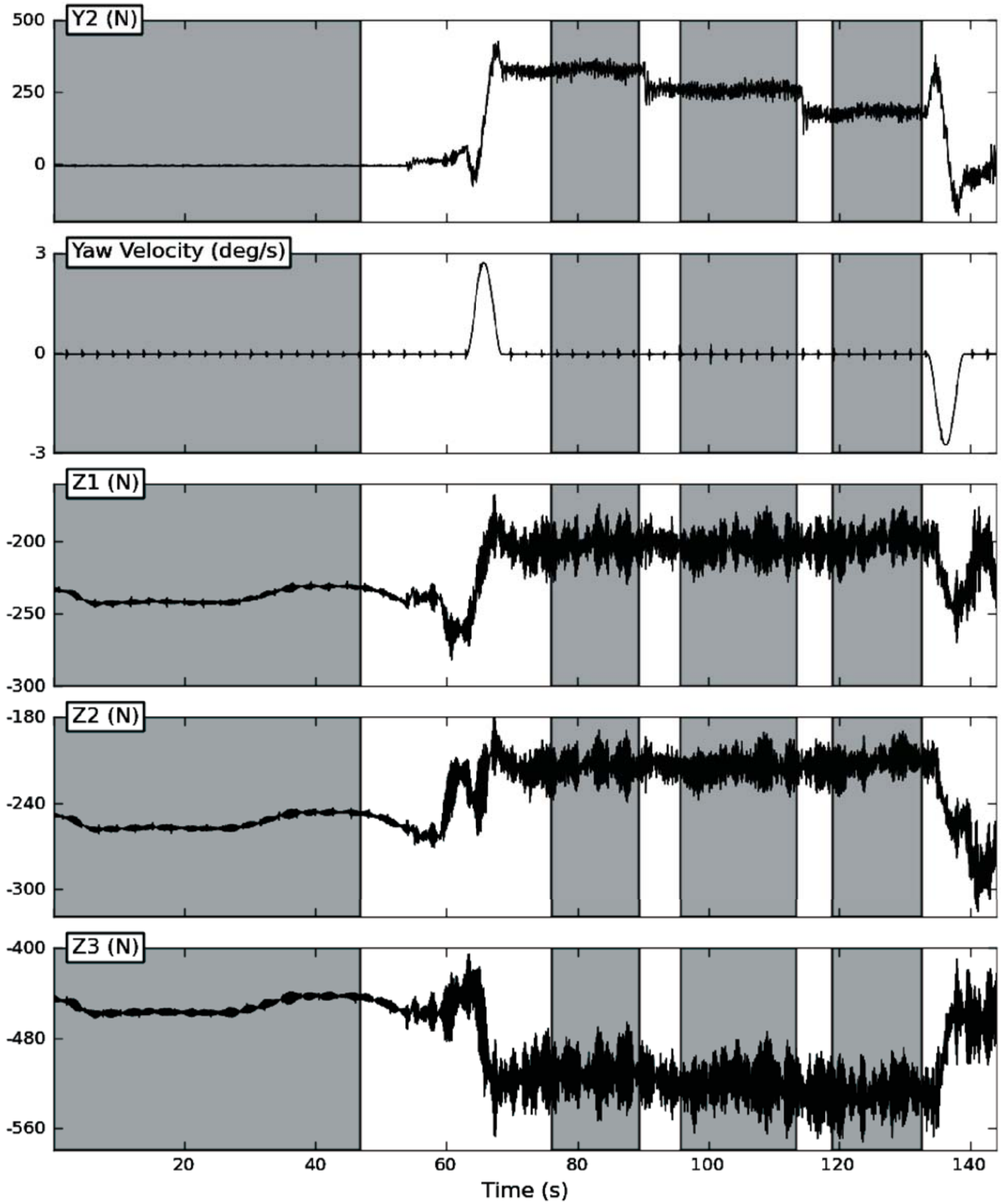
JSS
RUN_118


Y2 (N)
500
250
0
Yaw Velocity (deg/s)
3
0
-3
Z1 (N)
-200
-250
-300
Z2 (N)
-180
-240
-300
Z3 (N)
-400
-480
-560
20
40
60
80
100
120
140
Time (s)

JSS
RUN_118
Segment 1, After Taring (0.00 to 46.87 s)

Channel	Units	Min	Max	Mean	SD
Carriage Speed	m/s	-0.010207	0.026549	0.0073013	0.0027407
DAS Trigger	volts	-0.048511	0.059544	0.0000	0.0077435
FX	N	-3.8869	3.7878	0.0000	1.4227
FY	N	-5.0447	4.9655	0.0000	1.5942
FZ	N	-19.100	26.870	0.0000	15.566
Inline Load	N	-4.9593	4.6507	0.0000	0.66055
MX	Nm	-1.3948	1.3291	0.0000	0.44627
MY	Nm	-1.5399	1.5869	0.0000	0.37457
MZ	Nm	-1.9190	2.0100	0.0000	0.36270
PMM Pitch	deg	5.3395	5.4336	5.3665	0.0082734
PMM Start	volts	-0.011390	0.0098401	0.0000	0.0014548
PMM Yaw	deg	-0.095113	0.23559	0.073135	0.022332
Rudder Angle	deg	-0.83138	-0.10015	-0.50083	0.085774
Shaft Speed	rps	-0.012740	0.12269	0.075014	0.030900
Sinkage	mm	-0.35332	0.56900	0.0000	0.20118
Sway Displacement	m	-0.050236	0.044550	0.0000	0.0078285
Sway Velocity	m/s	-0.0067011	0.0064858	0.0000	0.0010471
Tachogenerator	m/s	-0.048124	0.051339	-0.00057763	0.0069949
Thrust	N	-0.30889	0.38964	0.0000	0.094562
Torque	Nm	-0.026500	0.041568	0.011034	0.010395
X1	N	-3.9109	3.7953	0.0000	1.4167
Y1	N	-3.5730	4.1674	0.0000	0.90573
Y2	N	-3.5429	3.1491	0.0000	0.84596
Yaw Velocity	deg/s	-0.13751	0.13537	0.0000	0.021444
Z1	N	-7.8274	10.579	0.0000	4.7510
Z2	N	-7.8964	10.246	0.0000	4.7806
Z3	N	-10.073	13.070	0.0000	6.5007

JSS
RUN_118
Segment 2, After Taring (76.06 to 89.46 s)

Channel	Units	Min	Max	Mean	SD
Carriage Speed	m/s	1.6816	1.7253	1.7016	0.0035104
DAS Trigger	volts	-0.056142	0.055271	0.0019775	0.0085869
FX	N	-64.452	16.810	-22.366	17.320
FY	N	-12.691	137.35	66.150	25.526
FZ	N	-13.533	32.087	15.703	9.1613
Inline Load	N	-5.0239	5.2971	0.022127	0.79343
MX	Nm	-26.650	-3.4304	-15.411	4.3271
MY	Nm	-4.4211	0.90950	-1.5202	0.97478
MZ	Nm	283.13	326.09	302.68	7.4699
PMM Pitch	deg	5.2427	5.3057	5.2743	0.0084021
PMM Start	volts	-0.012974	0.012692	-0.00086561	0.0023991
PMM Yaw	deg	7.8268	8.3003	8.0696	0.033690
Rudder Angle	deg	-10.061	-9.3091	-9.7008	0.051501
Shaft Speed	rps	9.9126	9.9857	9.9487	0.0062742
Sinkage	mm	9.9687	10.899	10.454	0.25069
Sway Displacement	m	-0.048656	0.071011	0.00042825	0.0075692
Sway Velocity	m/s	-0.0059319	0.0083539	1.0447e-05	0.0011258
Tachogenerator	m/s	1.6470	1.7612	1.6964	0.0091308
Thrust	N	25.639	29.737	27.615	0.63418
Torque	Nm	0.80102	0.92302	0.85921	0.020626
X1	N	-65.956	15.226	-23.955	17.310
Y1	N	-312.56	-226.15	-268.35	14.661
Y2	N	279.61	372.98	334.50	14.890
Yaw Velocity	deg/s	-0.12285	0.16834	-0.0020982	0.024400
Z1	N	8.2885	64.199	35.748	9.8742
Z2	N	14.071	64.362	39.287	8.9136
Z3	N	-101.49	-13.754	-59.332	16.594

JSS

RUN_118

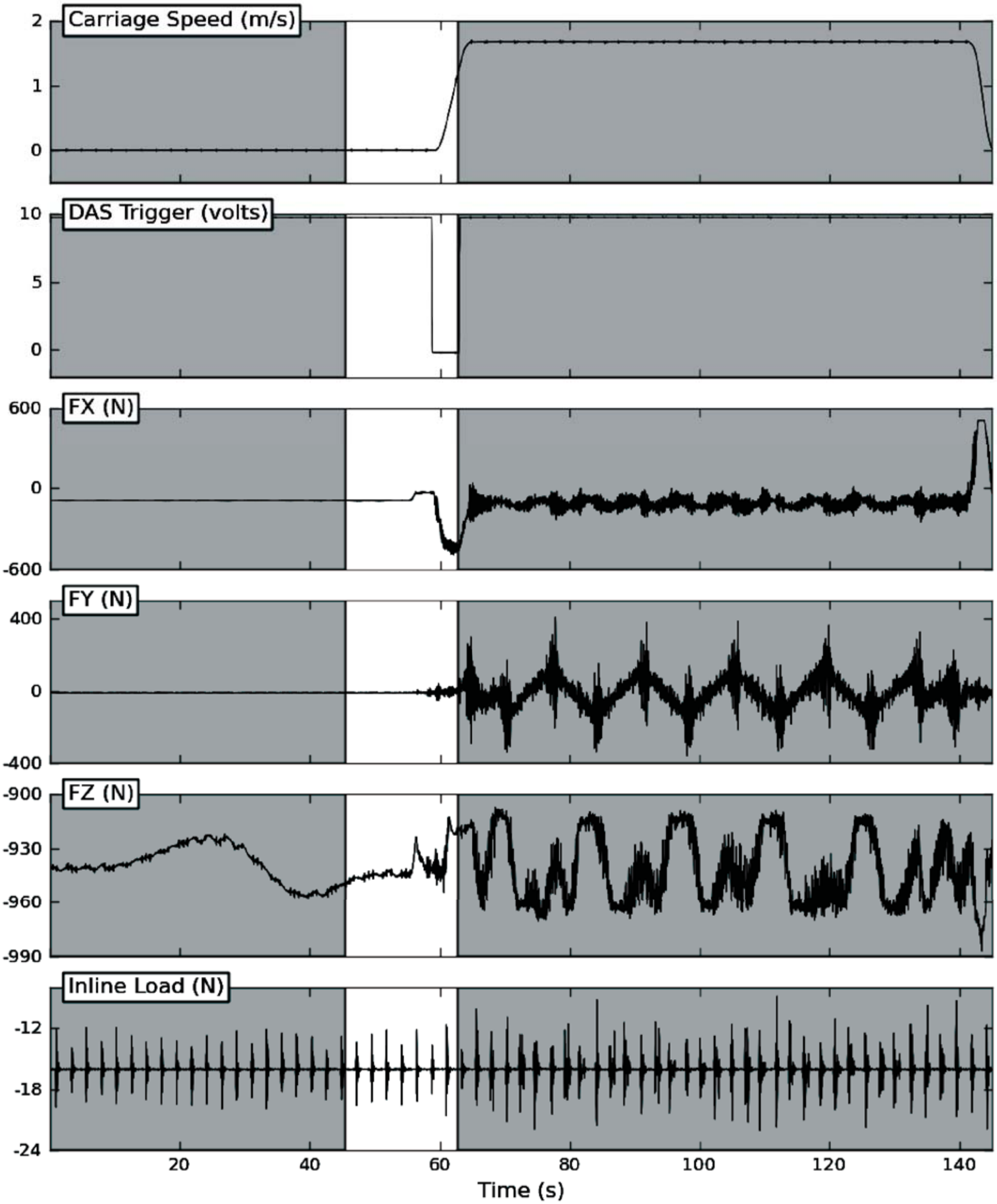
Segment 3, After Taring (95.77 to 113.52 s)

Channel	Units	Min	Max	Mean	SD
Carriage Speed	m/s	1.6689	1.7344	1.7015	0.0051587
DAS Trigger	volts	-0.10986	0.097089	0.0016829	0.014029
FX	N	-73.883	30.246	-21.513	19.419
FY	N	1.3370	172.35	97.244	27.365
FZ	N	-22.888	29.508	4.5687	10.928
Inline Load	N	-8.0189	7.4949	0.0053910	1.3801
MX	Nm	-27.600	-5.2686	-16.092	4.2744
MY	Nm	-4.4099	1.8624	-1.2309	1.0868
MZ	Nm	196.87	235.84	217.01	6.7111
PMM Pitch	deg	5.2422	5.2984	5.2751	0.0066623
PMM Start	volts	-0.014875	0.0095232	-0.00090246	0.0022989
PMM Yaw	deg	7.8268	8.3228	8.0684	0.032722
Rudder Angle	deg	-0.76218	-0.080392	-0.38056	0.068516
Shaft Speed	rps	9.9086	9.9827	9.9490	0.0063045
Sinkage	mm	10.618	11.196	10.946	0.097353
Sway Displacement	m	-0.10316	0.10458	7.0476e-05	0.015144
Sway Velocity	m/s	-0.013881	0.013409	-1.8380e-05	0.0019019
Tachogenerator	m/s	1.6188	1.7708	1.6962	0.014072
Thrust	N	25.304	28.834	26.957	0.55733
Torque	Nm	0.79117	0.91147	0.85220	0.020247
X1	N	-75.458	28.694	-23.087	19.419
Y1	N	-219.10	-119.43	-166.54	15.138
Y2	N	220.44	306.95	263.78	15.316
Yaw Velocity	deg/s	-0.29501	0.28738	-0.0021410	0.040101
Z1	N	9.9426	62.829	34.806	9.7192
Z2	N	15.848	62.672	38.140	8.6796
Z3	N	-117.23	-22.024	-68.377	17.055

JSS
RUN_118
Segment 4, After Taring (119.04 to 132.65 s)

Channel	Units	Min	Max	Mean	SD
Carriage Speed	m/s	1.6729	1.7242	1.7016	0.0039574
DAS Trigger	volts	-0.064994	0.069312	0.0014416	0.010473
FX	N	-67.312	20.254	-23.591	20.169
FY	N	63.395	197.97	132.23	24.295
FZ	N	-25.345	29.027	3.3574	11.808
Inline Load	N	-6.8338	6.2236	-0.0036873	0.99088
MX	Nm	-26.735	-7.1840	-17.546	3.9193
MY	Nm	-4.3758	1.4195	-1.2934	1.1320
MZ	Nm	104.66	138.12	123.38	6.3951
PMM Pitch	deg	5.2550	5.2988	5.2765	0.0040581
PMM Start	volts	-0.012340	0.010791	-0.00072439	0.0024346
PMM Yaw	deg	7.8418	8.2402	8.0674	0.030686
Rudder Angle	deg	9.2273	9.9125	9.5697	0.066668
Shaft Speed	rps	9.9155	9.9808	9.9494	0.0064313
Sinkage	mm	10.402	10.987	10.725	0.087747
Sway Displacement	m	-0.060109	0.059162	6.0293e-05	0.010415
Sway Velocity	m/s	-0.0081664	0.0093796	-1.0887e-05	0.0014507
Tachogenerator	m/s	1.6284	1.7633	1.6962	0.011984
Thrust	N	24.624	28.303	26.698	0.54889
Torque	Nm	0.78946	0.91147	0.85535	0.019110
X1	N	-68.887	18.695	-25.142	20.170
Y1	N	-102.49	-18.166	-54.758	13.501
Y2	N	146.62	219.79	186.98	13.920
Yaw Velocity	deg/s	-0.19794	0.17200	-0.0019256	0.031306
Z1	N	9.7128	62.764	38.267	9.4572
Z2	N	18.042	63.521	41.866	8.2287
Z3	N	-120.69	-36.664	-76.776	15.736

JSS
RUN_132



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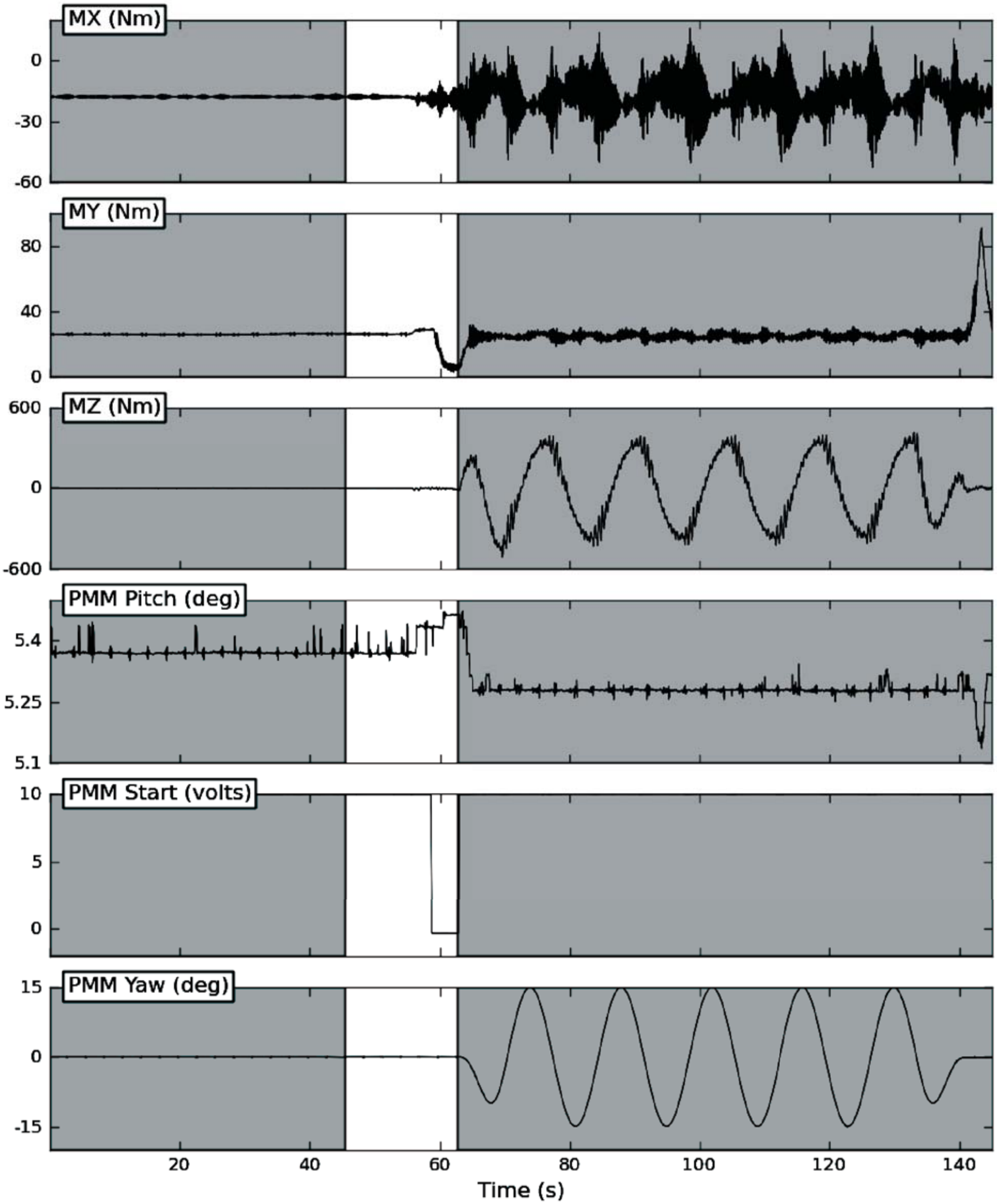

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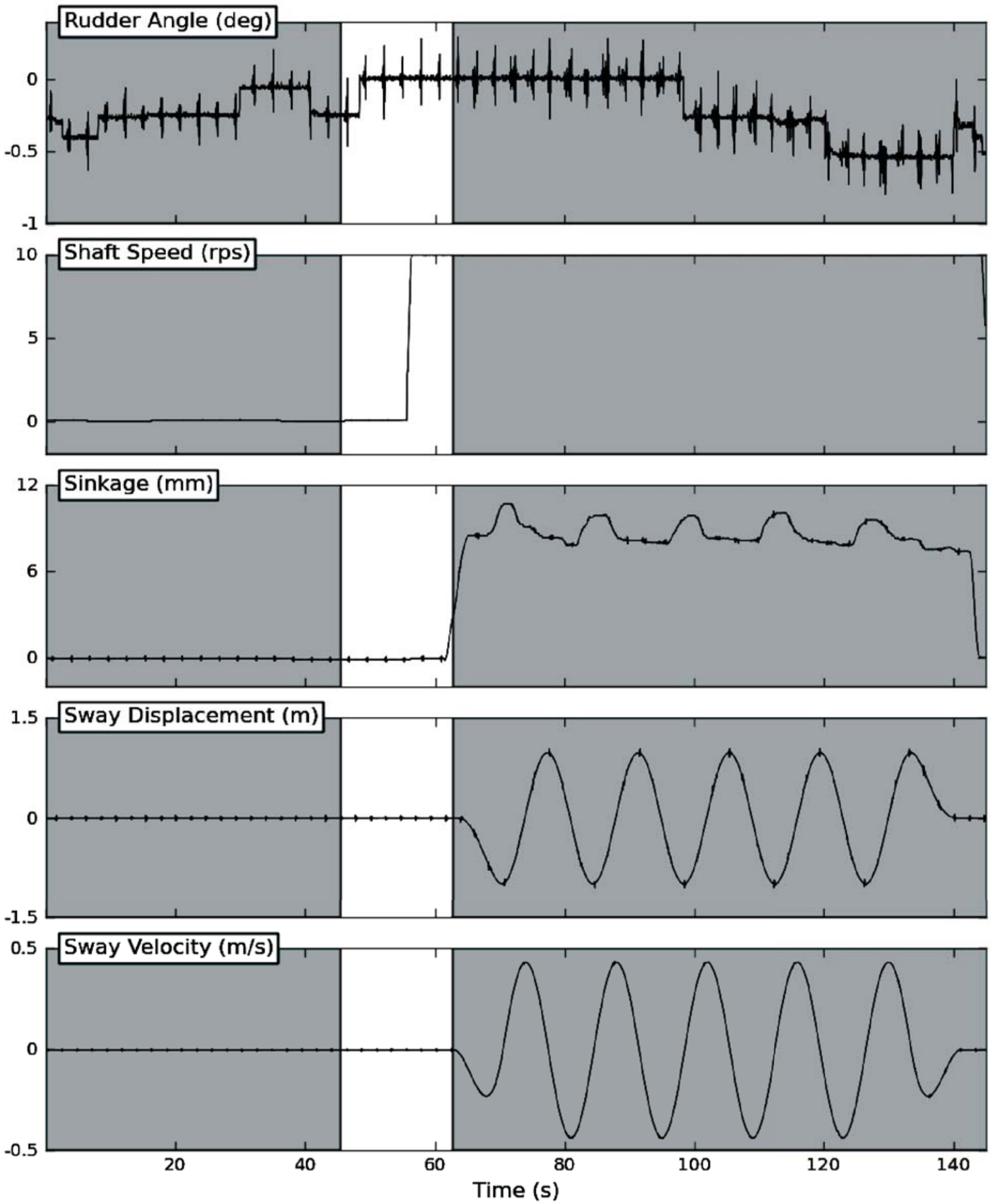
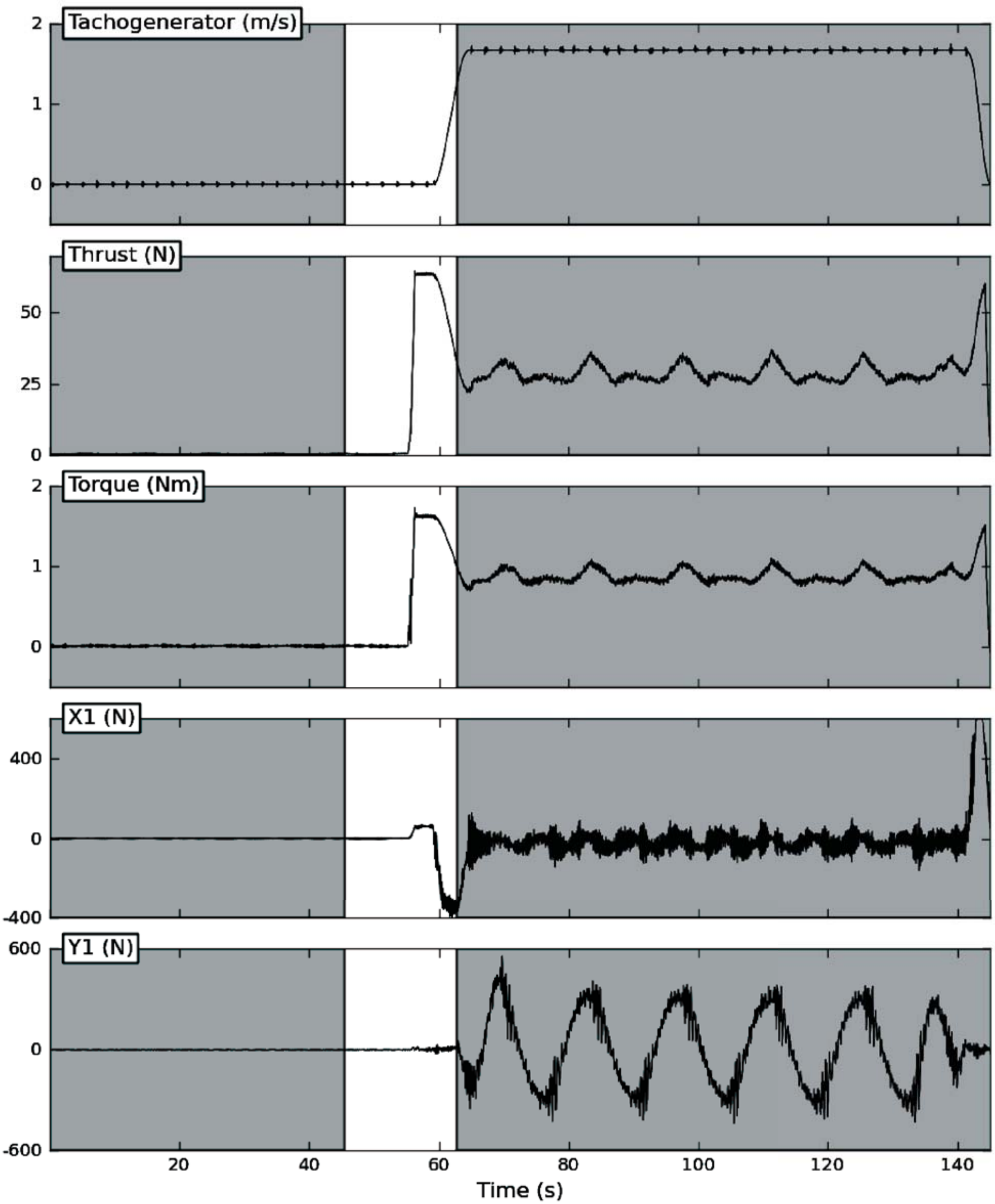


Rudder Angle (deg)
0
-0.5
-1
Shaft Speed (rps)
10
5
0
Sinkage (mm)
12
6
0
Sway Displacement (m)
1.5
0
-1.5
Sway Velocity (m/s)
0.5
0
-0.5
20
40
60
80
100
120
140
Time (s)

JSS
RUN_132



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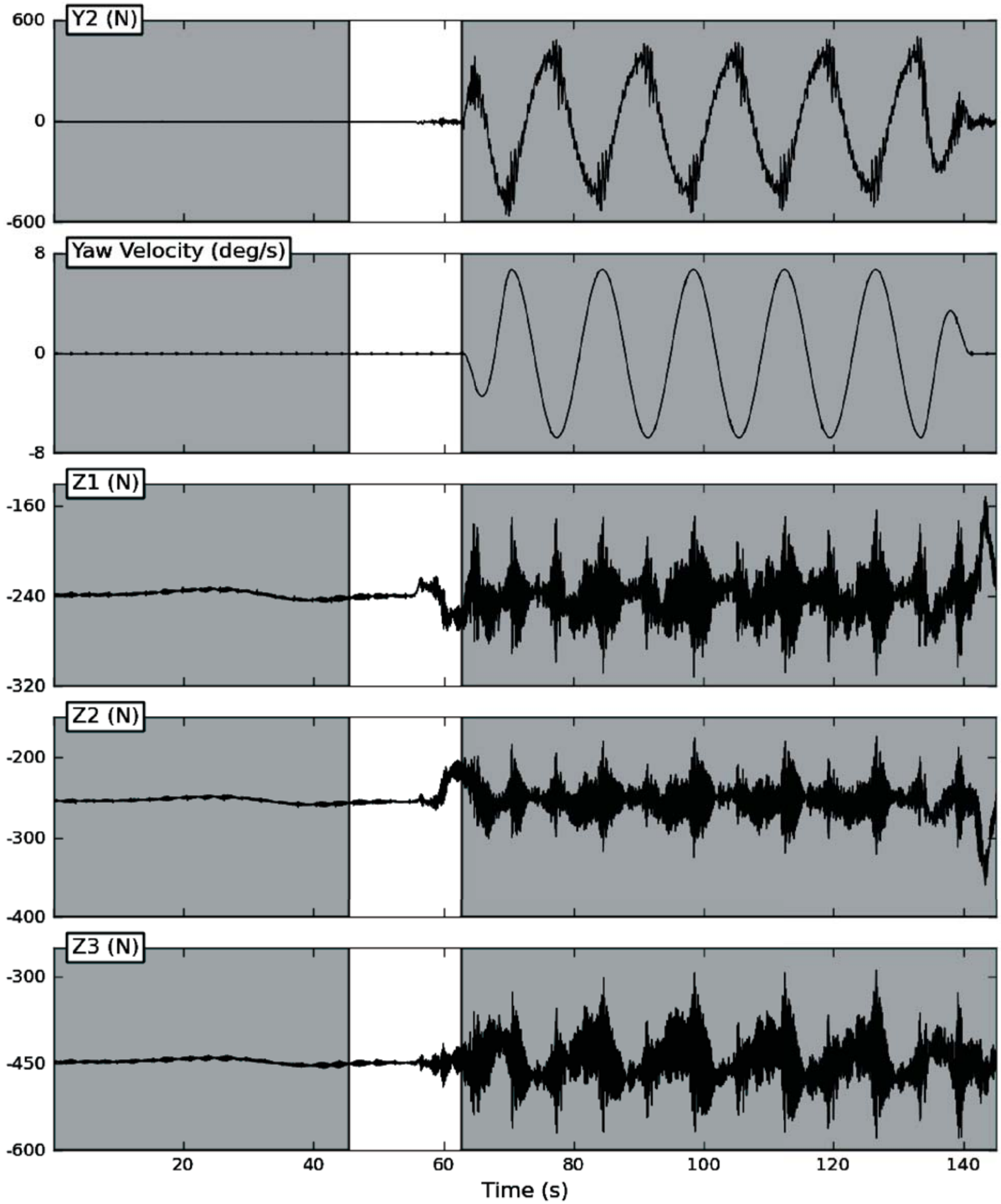

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RUN_132

Channel	Units	Min	Max	Mean	SD
Carriage Speed	m/s	-0.010527	1.7004	0.94444	0.81307
DAS Trigger	volts	-0.24391	9.8324	9.4647	1.6624
FX	N	-491.77	507.26	-99.650	91.510
FY	N	-357.96	405.47	-8.6443	64.195
FZ	N	-986.95	-907.18	-940.70	15.263
Inline Load	N	-22.064	-8.8988	-16.071	0.67565
MX	Nm	-52.374	16.743	-17.851	6.7940
MY	Nm	2.6699	91.163	25.611	6.3258
MZ	Nm	-511.84	416.43	-10.066	180.94
PMM Pitch	deg	5.1367	5.4728	5.3243	0.054431
PMM Start	volts	-0.33812	9.9842	9.6669	1.7238
PMM Yaw	deg	-15.007	14.982	-0.085603	7.2387
Rudder Angle	deg	-0.80104	0.29383	-0.20077	0.19183
Shaft Speed	rps	-0.0028543	9.9986	6.1271	4.7982
Sinkage	mm	-0.31042	10.701	4.6976	4.3223
Sway Displacement	m	-1.0460	1.0341	-0.0022409	0.48728
Sway Velocity	m/s	-0.44178	0.43724	-0.0032428	0.20913
Tachogenerator	m/s	-0.047766	1.7426	0.93781	0.81390
Thrust	N	0.13440	64.576	19.458	16.477
Torque	Nm	-0.065029	1.7296	0.57409	0.47100
X1	N	-397.54	596.15	-7.8337	91.222
Y1	N	-437.97	554.86	5.5794	162.81
Y2	N	-567.71	500.51	-14.224	201.24
Yaw Velocity	deg/s	-6.7042	6.6705	-0.022959	3.2761
Z1	N	-312.78	-151.57	-239.67	15.959
Z2	N	-358.65	-174.54	-253.86	16.688
Z3	N	-578.53	-288.43	-447.17	29.348

JSS
RUN_132
Segment 1, After Taring (0.00 to 45.38 s)

Channel	Units	Min	Max	Mean	SD
Carriage Speed	m/s	-0.0087107	0.023344	0.0071393	0.0019307
DAS Trigger	volts	9.7033	9.8022	9.7506	0.0075004
FX	N	-3.4957	3.1827	0.0000	1.1545
FY	N	-4.4361	5.7407	0.0000	1.4063
FZ	N	-18.950	16.868	0.0000	9.9959
Inline Load	N	-3.9034	4.1120	0.0000	0.48021
MX	Nm	-1.3812	1.4565	0.0000	0.40593
MY	Nm	-1.3010	1.4407	0.0000	0.24004
MZ	Nm	-1.5161	1.4536	0.0000	0.38176
PMM Pitch	deg	-0.025848	0.073707	0.0000	0.010296
PMM Start	volts	9.9525	9.9731	9.9625	0.0015998
PMM Yaw	deg	-0.15524	0.10782	-0.032345	0.016341
Rudder Angle	deg	-0.63327	0.20511	-0.22607	0.10897
Shaft Speed	rps	-0.0028543	0.11577	0.059580	0.037180
Sinkage	mm	-0.22104	0.22007	0.0000	0.035718
Sway Displacement	m	-0.048864	0.043552	0.0000	0.0052570
Sway Velocity	m/s	-0.0070298	0.0066699	0.0000	0.00075040
Tachogenerator	m/s	-0.047766	0.045972	-0.00051623	0.0049455
Thrust	N	-0.35086	0.32904	0.0000	0.098277
Torque	Nm	-0.025644	0.036858	0.0089337	0.0078295
X1	N	-3.2248	3.2174	0.0000	1.1399
Y1	N	-2.8057	3.4213	0.0000	0.81067
Y2	N	-3.3287	3.4289	0.0000	0.78927
Yaw Velocity	deg/s	-0.12498	0.12684	0.0000	0.014603
Z1	N	-7.4594	6.3374	0.0000	3.1190
Z2	N	-8.1416	6.5942	0.0000	3.1232
Z3	N	-11.321	10.203	0.0000	4.3353

JSS
RUN_132
Segment 2, After Taring (62.77 to 145.13 s)

Channel	Units	Min	Max	Mean	SD
Carriage Speed	m/s	0.023985	1.7004	1.6391	0.18814
DAS Trigger	volts	-0.18592	9.8324	9.7369	0.40054
FX	N	-369.85	598.50	-5.5415	105.43
FY	N	-349.62	413.81	-0.79319	85.165
FZ	N	-48.108	31.658	-2.9616	18.375
Inline Load	N	-5.9935	7.1717	-0.0015147	0.79372
MX	Nm	-34.566	34.551	0.028990	8.9770
MY	Nm	-21.523	65.254	0.030765	7.6007
MZ	Nm	-509.22	419.04	-12.831	240.16
PMM Pitch	deg	-0.23500	0.10111	-0.089275	0.027108
PMM Start	volts	-0.33463	9.9842	9.9587	0.28501
PMM Yaw	deg	-15.007	14.982	-0.12653	9.6135
Rudder Angle	deg	-0.80104	0.29383	-0.22167	0.22295
Shaft Speed	rps	5.7408	9.9986	9.9293	0.25466
Sinkage	mm	0.043628	10.791	8.4284	1.5097
Sway Displacement	m	-1.0453	1.0348	-0.0027004	0.64713
Sway Velocity	m/s	-0.43850	0.44052	6.0847e-05	0.27775
Tachogenerator	m/s	-0.0073370	1.7426	1.6308	0.20083
Thrust	N	3.3280	59.657	28.737	4.6527
Torque	Nm	-0.065029	1.5168	0.87961	0.10831
X1	N	-368.24	594.76	-7.0811	105.16
Y1	N	-436.26	556.57	12.420	216.07
Y2	N	-561.08	507.13	-13.213	267.11
Yaw Velocity	deg/s	-6.6814	6.6933	-0.00024106	4.3510
Z1	N	-74.114	87.102	-1.0937	20.622
Z2	N	-104.75	79.364	-0.84681	21.024
Z3	N	-132.27	157.84	-1.0211	38.680

APPENDIX E
Static Tests: Table of Measured Data

Uref = 1.6969 m/s (18 kts)

Model configuration	Test Name	PMM Yaw	Rudder Angle	Acquisition Time	TEMP	FX	FY	FZ (N)	MX	MY	MZ	PMM Pitch	Shaft Speed	Sinkage	Carriage Speed (Tachogenerator)	Thrust	Torque	Time selection length	Calculated non-dimensional quantities: Δu'	v'	r'	d'	1000*X'	1000*Y'	1000*K'	1000*N'
		[deg]	[deg]	[date, time]	[Celsius]	[N]	[N]	[N]	[Nm]	[Nm]	[Nm]	[deg]	[rps]	[mm]	[m/s]	[N]	[Nm]	[Model lengths]	[n.d.]	[n.d.]	[n.d.]	[n.d.]	[n.d.]	[n.d.]	[n.d.]	[n.d.]
contract design	RUN_016	0.0	-10.6	13/06/2012 18:06	18.2	-15.6	-25.7	-0.3	0.0	-1.0	90.6	-0.156	9.96	6.9	1.697	28.9	0.91	3.1	0.000	0.000	0.000	-0.185	-0.315	-0.519	0.000	0.311
contract design	RUN_017	0.0	-0.8	13/06/2012 18:16	18.2	-12.5	4.8	14.5	-0.9	-1.1	1.7	-0.156	9.96	6.7	1.697	28.8	0.90	3.3	0.000	0.000	0.000	-0.014	-0.253	0.096	-0.003	0.006
contract design	RUN_018	0.0	9.2	13/06/2012 18:26	18.2	-14.5	34.8	19.7	-1.6	-1.2	-86.4	-0.152	9.96	7.0	1.697	28.8	0.90	2.4	0.000	0.000	0.000	0.161	-0.293	0.703	-0.006	-0.297
contract design	RUN_023	4.0	-10.3	14/06/2012 12:30	18.2	-18.2	8.0	6.0	-5.4	-1.3	181.9	-0.159	9.96	7.4	1.696	28.1	0.88	2.7	-0.003	-0.070	0.000	-0.179	-0.367	0.162	-0.019	0.626
contract design	RUN_021	4.0	-0.5	14/06/2012 12:10	18.2	-16.4	46.3	1.4	-7.5	-1.0	106.7	-0.152	9.96	8.1	1.696	27.3	0.88	3.0	-0.003	-0.070	0.000	-0.009	-0.331	0.935	-0.026	0.367
contract design	RUN_023	4.0	-0.5	14/06/2012 12:30	18.2	-16.5	39.3	4.2	-6.5	-1.1	92.8	-0.155	9.96	7.4	1.696	27.3	0.87	3.2	-0.003	-0.070	0.000	-0.008	-0.332	0.793	-0.022	0.319
contract design	RUN_021	4.0	9.6	14/06/2012 12:10	18.2	-19.7	81.4	7.6	-8.9	-1.2	16.5	-0.151	9.96	8.2	1.696	26.7	0.87	2.7	-0.003	-0.070	0.000	0.167	-0.398	1.643	-0.031	0.057
contract design	RUN_025	8.0	-10.2	14/06/2012 12:51	18.2	-22.1	64.3	-9.2	-15.3	-1.3	303.4	-0.161	9.96	10.5	1.696	27.5	0.89	2.6	-0.010	-0.139	0.000	-0.179	-0.446	1.298	-0.053	1.043
contract design	RUN_025	8.0	-0.4	14/06/2012 12:51	18.2	-20.4	97.0	-0.4	-15.8	-1.3	209.7	-0.154	9.96	10.4	1.696	27.1	0.89	2.4	-0.010	-0.139	0.000	-0.008	-0.412	1.959	-0.054	0.721
contract design	RUN_025	8.0	9.5	14/06/2012 12:51	18.2	-22.9	132.4	-2.6	-17.4	-1.3	115.5	-0.155	9.96	10.4	1.696	26.7	0.89	2.4	-0.010	-0.139	0.000	0.166	-0.463	2.674	-0.060	0.397
contract design	RUN_028	12.0	-10.2	14/06/2012 13:25	18.2	-30.0	127.6	6.3	-28.3	-1.8	420.3	-0.185	9.96	14.3	1.696	23.7	0.81	2.7	-0.022	-0.208	0.000	-0.179	-0.606	2.577	-0.097	1.445
contract design	RUN_028	12.0	-0.5	14/06/2012 13:25	18.2	-28.2	161.2	13.3	-28.9	-1.8	319.2	-0.184	9.96	14.4	1.696	23.5	0.81	2.6	-0.022	-0.208	0.000	-0.009	-0.569	3.254	-0.099	1.098
contract design	RUN_028	12.0	9.5	14/06/2012 13:25	18.2	-31.1	198.9	11.8	-30.1	-1.9	216.7	-0.182	9.96	14.5	1.696	23.5	0.82	2.5	-0.022	-0.208	0.000	0.165	-0.628	4.016	-0.103	0.745
contract design	RUN_034	16.0	-10.2	14/06/2012 14:26	18.2	-32.5	221.5	-3.1	-46.2	-1.9	534.5	-0.249	9.96	19.1	1.696	22.8	0.79	2.8	-0.039	-0.276	0.000	-0.178	-0.656	4.472	-0.159	1.838
contract design	RUN_034	16.0	-0.5	14/06/2012 14:26	18.2	-30.6	256.8	-0.5	-46.2	-1.8	428.6	-0.248	9.96	19.0	1.696	22.6	0.79	2.9	-0.039	-0.276	0.000	-0.008	-0.618	5.186	-0.159	1.474
contract design	RUN_034	16.0	9.6	14/06/2012 14:26	18.2	-33.5	288.4	-4.3	-45.9	-1.9	314.4	-0.234	9.96	18.7	1.696	22.5	0.79	2.3	-0.039	-0.276	0.000	0.167	-0.677	5.824	-0.158	1.081
contract design	RUN_037	20.0	-10.2	14/06/2012 14:56	18.2	-36.7	351.8	5.1	-68.2	-2.3	687.3	-0.330	9.96	25.4	1.696	21.4	0.76	2.6	-0.061	-0.342	0.000	-0.178	-0.741	7.101	-0.235	2.363
contract design	RUN_037	20.0	-0.5	14/06/2012 14:56	18.2	-36.2	405.7	7.4	-71.5	-2.2	602.9	-0.326	9.96	26.3	1.696	20.4	0.74	2.6	-0.061	-0.342	0.000	-0.009	-0.731	8.190	-0.246	2.073
contract design	RUN_037	20.0	9.5	14/06/2012 14:56	18.2	-40.3	434.6	-12.1	-70.4	-2.0	472.0	-0.279	9.96	26.3	1.696	20.2	0.75	2.0	-0.061	-0.342	0.000	0.166	-0.813	8.774	-0.242	1.623
contract design	RUN_040	-4.0	-10.2	14/06/2012 15:30	18.2	-19.5	-66.2	14.9	6.4	-1.4	-2.2	-0.153	9.96	7.6	1.696	27.0	0.88	2.7	-0.003	0.070	0.000	-0.178	-0.393	-1.337	0.022	-0.008
contract design	RUN_040	-4.0	-0.4	14/06/2012 15:30	18.2	-16.7	-34.3	13.0	5.5	-1.1	-102.2	-0.154	9.96	8.0	1.696	26.9	0.87	2.4	-0.003	0.070	0.000	-0.007	-0.337	-0.693	0.019	-0.351
contract design	RUN_040	-4.0	9.7	14/06/2012 15:30	18.2	-18.2	-8.0	12.5	5.3	-1.3	-201.1	-0.155	9.96	8.1	1.696	27.2	0.87	2.5	-0.003	0.070	0.000	0.170	-0.368	-0.162	0.018	-0.692
contract design	RUN_043	-8.0	-10.2	14/06/2012 16:01	18.2	-23.7	-122.0	16.9	14.9	-1.7	-108.6	-0.153	9.96	9.2	1.696	26.1	0.86	2.8	-0.010	0.139	0.000	-0.178	-0.479	-2.464	0.051	-0.374
contract design	RUN_043	-8.0	-0.4	14/06/2012 16:01	18.2	-20.7	-89.7	19.4	14.6	-1.5	-220.8	-0.154	9.96	9.6	1.696	26.6	0.86	2.5	-0.010	0.139	0.000	-0.007	-0.418	-1.811	0.050	-0.759
contract design	RUN_043	-8.0	9.7	14/06/2012 16:01	18.2	-20.6	-57.3	17.3	13.7	-1.5	-311.6	-0.162	9.96	9.8	1.696	27.7	0.89	2.4	-0.010	0.139	0.000	0.169	-0.416	-1.158	0.047	-1.071
contract design	RUN_047	-12.0	-10.2	14/06/2012 16:42	18.2	-34.5	-196.4	3.7	28.0	-2.1	-210.6	-0.182	9.96	14.4	1.696	21.4	0.76	2.9	-0.022	0.208	0.000	-0.178	-0.696	-3.965	0.096	-0.724
contract design	RUN_047	-12.0	-0.2	14/06/2012 16:42	18.2	-28.4	-152.7	13.7	26.4	-2.0	-321.1	-0.184	9.96	14.4	1.696	22.1	0.77	2.5	-0.022	0.208	0.000	-0.004	-0.574	-3.083	0.091	-1.104
contract design	RUN_047	-12.0	9.7	14/06/2012 16:42	18.2	-27.2	-116.6	10.4	25.8	-1.8	-418.1	-0.183	9.96	14.4	1.696	23.3	0.79	2.2	-0.022	0.208	0.000	0.169	-0.549	-2.354	0.089	-1.437
contract design	RUN_050	-16.0	-10.0	14/06/2012 17:12	18.2	-38.9	-289.5	-1.4	45.0	-2.3	-313.8	-0.246	9.96	18.8	1.696	20.4	0.73	2.6	-0.039	0.276	0.000	-0.175	-0.785	-5.844	0.155	-1.079
contract design	RUN_050	-16.0	-0.2	14/06/2012 17:12	18.2	-32.5	-246.7	9.6	44.2	-2.1	-433.4	-0.245	9.96	18.6	1.696	21.2	0.74	2.6	-0.039	0.276	0.000	-0.003	-0.656	-4.980	0.152	-1.490
contract design	RUN_050	-16.0	9.7	14/06/2012 17:12	18.2	-31.2	-209.3	3.9	43.7	-2.0	-535.4	-0.251	9.96	18.6	1.696	22.4	0.76	2.2	-0.039	0.276	0.000	0.170	-0.630	-4.225	0.150	-1.841
contract design	RUN_053	-20.0	-9.9	14/06/2012 18:13	18.2	-42.6	-410.0	6.7	65.1	-2.7	-455.0	-0.283	9.96	24.9	1.696	20.4	0.74	2.7	-0.061	0.342	0.000	-0.174	-0.861	-8.277	0.224	-1.564
contract design	RUN_053	-20.0	-0.3	14/06/2012 18:13	18.2	-36.2	-370.1	10.0	64.3	-2.5	-580.1	-0.335	9.96	24.8	1.697	21.0	0.75	2.7	-0.061	0.342	0.000	-0.006	-0.731	-7.470	0.221	-1.994
contract design	RUN_053	-20.0	9.8	14/06/2012 18:13	18.2	-35.3	-329.4	-1.4	63.6	-2.2	-685.4	-0.339	9.96	24.5	1.696	22.0	0.77	2.2	-0.061	0.342	0.000	0.172	-0.714	-6.650	0.219	-2.357
	Repeats																									
contract design	RUN_101	0.0	-10.2	18/06/2012 14:44	18	-16.2	-28.9	15.8	0.6	-1.3	79.9	-0.157	9.96	6.9	1.697	28.7	0.92	2.7	0.000	0.000	0.000	-0.179	-0.326	-0.583	0.002	0.275
contract design	RUN_103	0.0	-10.0	18/06/2012 15:08	18	-16.2	-27.4	-2.9	0.4	-1.0	84.2	-0.155	9.96	7.2	1.697	28.8	0.91	2.8	0.000	0.000	0.000	-0.179	-0.328	-0.554	0.001	0.290
contract design	RUN_103	0.0	10.0	18/06/2012 15:08	18	-15.5	34.1	1.9	-1.4	-1.0	-90.0	-0.156	9.96	7.1	1.697	28.7	0.91	2.5	0.000	0.000	0.000	0.167	-0.312	0.689	-0.005	-0.310
contract design	RUN_102	12.0	-10.2	18/06/2012 14:56	18	-30.2	130.4	1.5	-29.3	-1.9	418.0	-0.202	9.95	14.3	1.696	23.9	0.82	2.3	-0.022	-0.208	0.000	-0.178	-0.610	2.633	-0.101	1.437
contract design	RUN_102	12.0	-0.5	18/06/2012 14:56	18	-28.6	164.3	-1.5	-29.6	-1.7	319.5	-0.187	9.95	14.4	1.696	23.5	0.82	2.9	-0.022	-0.208	0.000	-0.008	-0.578	3.317	-0.102	1.099
contract design	RUN_102	12.0	9.6	18/06/2012 14:56	18	-32.1	201.8	-3.6	-30.4	-1.7	217.4	-0.186	9.95	14.4	1.696	23.3	0.83	2.1	-0.022	-0.208	0.000	0.167	-0.647	4.075	-0.105	0.748
contract design, repeat	RUN_116	0	-10.0	10/07/2012 13:42	18	-16.8	-27.8	13.5	0.4	-1.2	85.1	5.276	9.95	7.5	1.699	28.7	0.88	3.2	0.001	0.000	0.000	-0.174	-0.339	-0.559	0.001	0.292
contract design, repeat	RUN_116	0	-0.4	10/07/2012 13:42	18	-14.0	3.0	4.3	-0.6	-0.9	2.7	5.275	9.95	7.6	1.699	28.6	0.87	2.7	0.001	0.000	0.000	-0.007	-0.283	0.061	-0.002	0.009
contract design, repeat	RUN_116	0	9.3	10/07/2012 13:42	18	-15.7	33.3	-2.6	-1.5	-0.9	-79.9	5.276	9.95	7.6	1.699	28.5	0.86	2.5	0.001	0.000	0.000	0.163	-0.316	0.671	-0.005	-0.274
contract design, repeat	RUN_117	4	-9.7	10/07/2012 13:54	18	-20.1	12.8	9.2	-5.9	-1.3	188.6	5.277	9.95	8.4	1.696	27.7	0.85	2.7	-0.003	-0.070	0.000	-0.170	-0.405	0.259	-0.020	0.649
contract design, repeat	RUN_117	4	-0.4	10/07/2012 13:54	18	-18.5	43.6	6.7	-7.0	-1.1	105.4	5.276	9.95	8.2	1.696	27.0	0.84	2.8	-0.003	-0.070	0.000	-0.006	-0.374	0.880	-0.024	0.362
contract design, repeat	RUN_117	4	9.5	10/07/2012 13:54	18	-20.6	75.3	3.2	-7.9	-1.1	12.2	5.278	9.95	8.1	1.696	26.8	0.84	2.2	-0.003	-0.070	0.000	0.167	-0.415	1.521	-0.027	0.042
contract design, repeat	RUN_118	8	-9.7	10/07/2012 14:06	18	-22.4	66.2	15.7	-15.4	-1.5	302.7	5.274	9.95	10.5	1.696	27.6	0.86	2.3	-0.010	-0.139	0.000	-0.169	-0.452	1.335	-0.053	1.041
contract design, repeat	RUN_118	8	-0.4	10/07/2012 14:06	18	-21.5	97.2	4.6	-16.1	-1.2	217.0	5.275	9.95	10.9	1.696	27.0	0.85	3.0	-0.010	-0.139	0.000	-0.007	-0.434	1.964	-0.055	0.746
contract design, repeat	RUN_118	8	9.6	10/07/2012 14:06	18	-23.6	132.2	3.4	-17.5	-1.3	123.4	5.277	9.95	10.7	1.696	26.7	0.86	2.3	-0.010	-0.139	0.000	0.167	-0.476	2.670	-0.060	0.424
contract design, repeat	RUN_119	12	-9.7	10/07/2012 14:18	18	-29.7	128.5	-11.9	-28.3	-1.5	413.3	5.241	9.95	15.6	1.696	24.0	0.79	2.5	-0.022	-0.208	0.000	-0.170	-0.600	2.595	-0.097	1.421
contract design, repeat	RUN_119	12	-0.3	10/07/2012 14:18	18	-28.9	163.1	-6.2	-29.1	-1.5	324.7	5.245	9.95	15.5	1.696	23.3	0.78	2.8	-0.022	-0.208	0.000	-0.005	-0.584	3.294	-0.100	1.117
contract design, repeat	RUN_119	12	9.4	10/07/2012 14:18	18	-31.0	196.3	-7.4	-29.5	-1.6	219.6	5.245	9.95	15.2	1.697	23.3	0.78	2.0	-0.022	-0.208	0.000	0.164	-0.626	3.962	-0.101	0.755
contract design, repeat	RUN_120	16	-9.8	10/07/2012 14:30	18	-32.4	222.3	5.9	-45.6	-1.8	527.9	5.181	9.95	19.9	1.697	22.9	0.76	2.3	-0.039	-0.276	0.000	-0.170	-0.654	4.487	-0.157	1.815
contract design, repeat	RUN_120	16	-0.4	10/07/2012 14:30	18	-31.6	258.7	1.2	-46.3	-1.7	436.6	5.180	9.95	20.3	1.697	22.3	0.76	2.9	-0.039	-0.276	0.000	-0.006	-0.639	5.221	-0.159	1.501
contract design, repeat	RUN_120	16	9.6	10/07/2012 14:30	18	-34.4	293.5	-3.1	-46.6	-1.7	323.2	5.180	9.95	20.3	1.697	22.0	0.75	2.1	-0.039	-0.276	0.000	0.167	-0.695	5.924	-0.160	1.111
contract design, repeat	RUN_121	20	-9.8	10/07/2012 14:42	18	-35.9	339.6	8.1	-65.7	-2.1	663.2	5.120	9.95	25.3	1.697	21.9	0.74	2.2	-0.060	-0.342	0.000	-0.171	-0.725	6.855	-0.226	2.280
contract design, repeat	RUN_121	20	-0.4	10/07/2012 14:42	18	-35.7	375.0	-2.5	-66.2	-1.8	567.1	5.125	9.95	25.7	1.696	21.0	0.73	3.0	-0.061	-0.342	0.000	-0.007	-0.720	7.571	-0.228	1.950
contract design, repeat	RUN_121	20	9.5	10/07/2012 14:42	18	-39.2	418.5	-1.2	-67.2	-2.0	458.4	5.148	9.95	25.7	1.696	20.6	0.72	2.1	-0.061	-0.342	0.000	0.166	-0.791	8.451	-0.231	1.577
contract design, repeat	RUN_122	-4	-9.9	10/07/2012 14:54	18	-21.7	-79.1	9.9	8.4	-1.4	-28.8	5.285	9.95	8.4	1.696	26.2	0.83	2.6	-0.003	0.070	0.000	-0.173	-0.439	-1.598	0.029	-0.099
contract design, repeat	RUN_122	-4	-0.2	10/07/2012 14:54	18	-18.4	-41.2	-0.5	6.6	-1.1	-110.0	5.280	9.95	8.4	1.696	26.5	0.83	3.1	-0.003	0.070	0.000	-0.004	-0.371	-0.831	0.023	-0.378
contract design, repeat	RUN_122	-4	9.5	10/07/2012 14:54	18	-18.1	-10.2	0.0	5.5	-1.1	-194.6	5.278	9.95	8.2	1.696	27.4	0.84	2.2	-0.003	0.070	0.000	0.166	-0.366	-0.207	0.019	-0.669
contract design, repeat	RUN_123	-8	-9.8	10/07/2012 15:04	18	-25.2	-128.9	3.2	16.9	-1.5	-127.5	5.279	9.95	11.2	1.696	26.5	0.84	2.8	-0.010	0.139	0.000	-0.171	-0.509	-2.602	0.058	-0.439
contract design, repeat	RUN_123	-8	-0.2	10/07/2012 15:04	18	-20.2	-88.6	-0.8	14.3	-1.2	-210.4	5.278	9.95	10.7	1.696	27.2	0.85	2.3	-0.010	0.139	0.000	-0.004	-0.408	-1.790	0.049	-0.723
contract design, repeat	RUN_123	-8	9.5	10/07/2012 15:04	18	-20.2	-55.6	1.7	12.7	-1.3	-293.0	5.277	9.95	10.0	1.696	28.2	0.87	2.1	-0.010	0.139	0.000	0.167	-0.409	-1.123	0.044	-1.007
contract design, repeat	RUN_124	-12	-9.7	10/07/2012 15:18	18	-32.4	-186.8	8.7	26.5	-2.1	-201.0	5.246	9.95	14.4	1.696	22.2	0.75	3.5	-0.022	0.208	0.000	-0.169	-0.655	-3.771	0.091	-0.691
contract design, repeat	RUN_124	-12	-0.4	10/07/2012 15:18	18	-28.3	-147.7	1.1	25.6	-1.7	-306.1	5.247	9.95	14.7	1.696	22.8	0.76	2.3	-0.022	0.208	0.000	-0.007	-0.571	-2.981	0.088	-1.053
contract design, repeat	RUN_124	-12	9.6	10/07/2012 15:18	18	-27.5	-115.8	4.3	25.4	-1.8	-409.1	5.246	9.95	14.7	1.696	23.7	0.78	1.8	-0.022	0.208	0.000	0.167	-0.556	-2.337	0.087	-1.407
contract design, repeat	RUN_125	-16	-9.8	10/07/2012 15:30	18	-39.7	-285.2	11.3	44.3	-2.5	-307.0	5.185	9.95	19.3	1.697	20.4	0.71	2.5	-0.039	0.276	0.000	-0.171	-0.802	-5.756	0.152	-1.055
contract design, repeat	RUN_125	-16	-0.4	10/07/2012 15:30	18	-33.5	-243.8	11.5	43.6	-2.2	-422.6	5.184	9.95	19.4	1.696	21.2	0.72	3.0	-0.039	0.276	0.000	-0.006	-0.676	-4.921	0.150	-1.453
contract design, repeat	RUN_125	-16	9.6	10/07/2012 15:30	18	-32.5	-209.4	10.7	43.5	-2.1	-526.8	5.185	9.95	19.3	1.697	22.2	0.74	2.2	-0.039	0.276	0.000	0.167	-0.656	-4.226	0.150	-1.811
contract design, repeat	RUN_126	-20	-9.8	10/07/2012 15:43	18	-44.5	-400.9	11.5	63.6	-2.9	-434.9	5.154	9.95	24.8	1.696	20.2	0.71	2.6	-0.061	0.342	0.000	-0.171	-0.899	-8.095	0.219	-1.495
contract design, repeat	RUN_126	-20	-0.1	10/07/2012 15:43	18	-38.2	-365.0	12.6	63.5	-2.6	-563.2	5.139	9.95	24.9	1.696	21.0	0.72	3.1	-0.061	0.342	0.000	-0.002	-0.771	-7.368	0.218	-1.936

Model configuration	Test Name	PMM Yaw	Rudder Angle	Acquisition Time	TEMP	FX	FY	FZ (N)	MX	MY	MZ	PMM Pitch	Shaft Speed	Sinkage	Carriage Speed (Tachogenerator)	Thrust	Torque	Time selection length	Δu'	v'	r'	d'	1000*X'	1000*Y'	1000*K'	1000*N'
		[deg]	[deg]	[date, time]	[Celsius]	[N]	[N]	[N]	[Nm]	[Nm]	[Nm]	[deg]	[rps]	[mm]	[m/s]	[N]	[Nm]	[Model lengths]	[n.d.]	[n.d.]	[n.d.]	[n.d.]	[n.d.]	[n.d.]	[n.d.]	[n.d.]
contract design, repeat	RUN_126	-20	9.6	10/07/2012 15:43	18	-38.3	-331.6	9.0	64.1	-2.6	-678.9	5.106	9.95	25.0	1.696	21.5	0.73	1.9	-0.061	0.342	0.000	0.167	-0.774	-6.694	0.220	-2.334
contract design with Rudder 2	RUN_141	0	-10.8	11/07/2012 11:41	18	-17.1	-37.8	-5.8	1.2	-0.9	107.4	5.311	9.95	7.7	1.697	31.3	0.93	2.7	0.000	0.000	0.000	-0.188	-0.345	-0.763	0.004	0.369
contract design with Rudder 2	RUN_141	0	-0.6	11/07/2012 11:41	18	-12.9	0.7	-0.7	-0.2	-0.8	-3.8	5.311	9.95	7.7	1.697	31.1	0.92	2.7	0.000	0.000	0.000	-0.010	-0.259	0.014	-0.001	-0.013
contract design with Rudder 2	RUN_141	0	8.6	11/07/2012 11:41	18	-14.8	33.9	2.1	-1.4	-0.9	-101.1	5.311	9.95	7.7	1.697	31.0	0.91	2.5	0.000	0.000	0.000	0.150	-0.299	0.684	-0.005	-0.348
contract design with Rudder 2	RUN_142	4	-11.0	11/07/2012 11:53	18	-20.9	3.4	8.8	-5.5	-1.4	221.6	5.311	9.95	8.2	1.696	30.4	0.89	3.0	-0.003	-0.070	0.000	-0.192	-0.422	0.068	-0.019	0.762
contract design with Rudder 2	RUN_142	4	-0.3	11/07/2012 11:53	18	-17.6	47.3	11.6	-7.4	-1.2	105.0	5.312	9.95	8.4	1.696	29.8	0.89	2.3	-0.003	-0.070	0.000	-0.006	-0.355	0.954	-0.026	0.361
contract design with Rudder 2	RUN_142	4	8.6	11/07/2012 11:53	18	-20.9	83.5	10.5	-8.8	-1.3	-1.2	5.312	9.95	8.5	1.696	29.2	0.88	2.3	-0.003	-0.070	0.000	0.150	-0.421	1.686	-0.030	-0.004
contract design with Rudder 2	RUN_143	8	-10.7	11/07/2012 12:05	18	-23.9	57.7	2.8	-15.2	-1.4	328.0	5.278	9.95	10.6	1.696	29.9	0.90	2.7	-0.010	-0.139	0.000	-0.187	-0.483	1.164	-0.052	1.128
contract design with Rudder 2	RUN_143	8	-0.3	11/07/2012 12:05	18	-20.7	102.3	4.2	-16.4	-1.2	207.2	5.277	9.95	10.8	1.696	29.5	0.91	2.9	-0.010	-0.139	0.000	-0.005	-0.418	2.065	-0.056	0.713
contract design with Rudder 2	RUN_143	8	8.6	11/07/2012 12:05	18	-24.0	139.6	4.5	-18.1	-1.3	100.9	5.281	9.95	10.9	1.696	29.0	0.90	2.0	-0.010	-0.139	0.000	0.150	-0.486	2.818	-0.062	0.347
contract design with Rudder 2	RUN_144	12	-10.9	11/07/2012 12:17	18	-30.6	122.6	1.1	-28.2	-1.8	440.1	5.249	9.95	15.0	1.696	26.5	0.84	2.5	-0.022	-0.208	0.000	-0.190	-0.619	2.476	-0.097	1.513
contract design with Rudder 2	RUN_144	12	-0.1	11/07/2012 12:17	18	-27.4	166.9	-3.7	-29.0	-1.5	304.2	5.247	9.95	15.0	1.696	26.4	0.84	2.8	-0.022	-0.208	0.000	-0.003	-0.553	3.371	-0.100	1.046
contract design with Rudder 2	RUN_144	12	8.6	11/07/2012 12:17	18	-31.6	207.3	-5.2	-30.3	-1.6	197.2	5.258	9.95	14.8	1.696	26.2	0.84	1.8	-0.022	-0.208	0.000	0.150	-0.638	4.186	-0.104	0.678
contract design with Rudder 2	RUN_145	16	-11.0	11/07/2012 12:29	18	-33.3	221.5	8.8	-46.5	-2.0	558.6	5.187	9.95	19.9	1.696	25.4	0.82	2.5	-0.039	-0.276	0.000	-0.191	-0.673	4.471	-0.160	1.921
contract design with Rudder 2	RUN_145	16	-0.4	11/07/2012 12:29	18	-31.2	268.1	6.7	-47.4	-1.8	424.6	5.196	9.95	20.1	1.697	24.8	0.81	2.9	-0.039	-0.276	0.000	-0.008	-0.629	5.412	-0.163	1.460
contract design with Rudder 2	RUN_145	16	8.6	11/07/2012 12:29	18	-36.1	311.4	2.8	-48.9	-1.9	301.8	5.226	9.95	20.2	1.697	24.4	0.81	1.9	-0.039	-0.276	0.000	0.150	-0.729	6.284	-0.168	1.037
contract design with Rudder 2	RUN_146	20	-10.9	11/07/2012 12:41	18	-36.9	336.6	1.8	-65.8	-2.3	686.1	5.150	9.95	25.9	1.697	24.2	0.79	2.6	-0.060	-0.342	0.000	-0.190	-0.744	6.794	-0.226	2.358
contract design with Rudder 2	RUN_146	20	-0.5	11/07/2012 12:41	18	-35.2	387.4	6.9	-66.8	-2.3	555.1	5.150	9.95	26.0	1.697	23.4	0.78	2.8	-0.060	-0.342	0.000	-0.008	-0.710	7.820	-0.230	1.908
contract design with Rudder 2	RUN_146	20	8.6	11/07/2012 12:41	18	-39.1	431.3	-3.1	-67.9	-2.2	433.2	5.150	9.95	25.9	1.697	23.2	0.77	1.9	-0.061	-0.342	0.000	0.149	-0.788	8.707	-0.233	1.489
contract design with Rudder 2	RUN_147	-4	-10.8	11/07/2012 12:53	18	-23.9	-86.6	8.5	9.0	-1.6	8.8	5.310	9.95	8.5	1.696	28.5	0.88	2.6	-0.003	0.070	0.000	-0.189	-0.484	-1.748	0.031	0.030
contract design with Rudder 2	RUN_147	-4	-0.4	11/07/2012 12:53	18	-18.1	-41.5	5.8	6.7	-1.2	-115.2	5.310	9.95	8.5	1.696	29.0	0.88	2.8	-0.003	0.070	0.000	-0.006	-0.366	-0.838	0.023	-0.396
contract design with Rudder 2	RUN_147	-4	8.6	11/07/2012 12:53	18	-19.2	-8.3	3.8	5.6	-1.3	-212.5	5.310	9.95	8.4	1.696	29.6	0.88	2.2	-0.003	0.070	0.000	0.151	-0.389	-0.168	0.019	-0.731
contract design with Rudder 2	RUN_148	-8	-10.8	11/07/2012 13:05	18	-26.7	-140.6	10.3	17.4	-1.8	-89.3	5.280	9.95	10.8	1.697	28.4	0.87	3.0	-0.010	0.139	0.000	-0.188	-0.539	-2.838	0.060	-0.307
contract design with Rudder 2	RUN_148	-8	-0.3	11/07/2012 13:05	18	-19.1	-87.7	-0.9	14.5	-1.2	-213.8	5.277	9.95	10.6	1.696	29.8	0.90	3.0	-0.010	0.139	0.000	-0.005	-0.386	-1.770	0.050	-0.735
contract design with Rudder 2	RUN_148	-8	8.7	11/07/2012 13:05	18	-19.4	-54.3	1.5	13.1	-1.3	-309.9	5.279	9.95	10.4	1.696	30.9	0.91	1.9	-0.010	0.139	0.000	0.151	-0.392	-1.096	0.045	-1.065
contract design with Rudder 2	RUN_149	-12	-10.7	11/07/2012 13:17	18	-35.8	-204.3	0.5	28.1	-2.1	-167.6	5.264	9.95	15.0	1.696	23.9	0.78	2.9	-0.022	0.208	0.000	-0.187	-0.722	-4.124	0.097	-0.576
contract design with Rudder 2	RUN_149	-12	-0.3	11/07/2012 13:17	18	-27.3	-151.2	1.2	26.0	-1.8	-311.9	5.246	9.95	14.4	1.697	24.8	0.80	3.0	-0.022	0.208	0.000	-0.005	-0.552	-3.053	0.089	-1.072
contract design with Rudder 2	RUN_149	-12	8.6	11/07/2012 13:17	18	-27.8	-116.8	-2.5	25.7	-1.7	-421.5	5.245	9.95	14.2	1.696	25.6	0.81	2.0	-0.022	0.208	0.000	0.150	-0.562	-2.357	0.088	-1.449
contract design with Rudder 2	RUN_150	-16	-10.8	11/07/2012 13:29	18	-41.3	-297.9	1.2	45.2	-2.4	-264.2	5.246	9.95	20.0	1.696	23.1	0.76	2.5	-0.039	0.276	0.000	-0.188	-0.834	-6.014	0.155	-0.909
contract design with Rudder 2	RUN_150	-16	0.2	11/07/2012 13:29	18	-32.5	-245.2	-0.8	44.2	-1.9	-427.0	5.204	9.95	19.8	1.696	23.7	0.77	2.9	-0.039	0.276	0.000	0.003	-0.656	-4.950	0.152	-1.468
contract design with Rudder 2	RUN_150	-16	8.6	11/07/2012 13:29	18	-32.3	-207.6	-2.7	43.1	-1.9	-536.6	5.187	9.95	19.4	1.696	24.3	0.78	1.6	-0.039	0.276	0.000	0.150	-0.651	-4.193	0.148	-1.846
contract design with Rudder 2	RUN_151	-20	-10.7	11/07/2012 13:41	18	-45.1	-417.1	6.2	65.0	-2.8	-393.6	5.173	9.95	25.0	1.697	22.9	0.76	2.7	-0.061	0.342	0.000	-0.187	-0.911	-8.420	0.223	-1.353
contract design with Rudder 2	RUN_151	-20	0.1	11/07/2012 13:41	18	-37.0	-370.1	8.6	64.6	-2.5	-565.3	5.151	9.95	25.6	1.696	23.6	0.77	3.0	-0.061	0.342	0.000	0.001	-0.746	-7.471	0.222	-1.943
contract design with Rudder 2	RUN_151	-20	8.9	11/07/2012 13:41	18	-37.7	-331.7	6.9	64.5	-2.5	-681.4	5.151	9.95	25.7	1.696	23.9	0.78	2.1	-0.061	0.342	0.000	0.155	-0.761	-6.699	0.222	-2.344
contract design with Rudder 3	RUN_165	0	-10.5	11/07/2012 17:21	18	-16.8	-32.8	12.0	1.1	-1.2	93.4	5.307	9.95	7.3	1.697	29.8	0.90	2.6	0.000	0.000	0.000	-0.184	-0.338	-0.661	0.004	0.321
contract design with Rudder 3	RUN_165	0	-0.7	11/07/2012 17:21	18	-12.9	0.5	14.5	-0.6	-1.1	10.0	5.302	9.95	7.4	1.697	29.7	0.89	2.8	0.000	0.000	0.000	-0.012	-0.260	0.011	-0.002	0.034
contract design with Rudder 3	RUN_165	0	9.4	11/07/2012 17:21	18	-14.3	33.1	10.8	-2.0	-1.1	-80.6	5.308	9.95	7.4	1.697	30.0	0.89	2.5	0.000	0.000	0.000	0.164	-0.289	0.668	-0.007	-0.277
contract design with Rudder 3	RUN_166	4	-10.4	11/07/2012 17:33	18	-20.0	7.6	14.1	-5.3	-1.4	201.0	5.298	9.95	8.4	1.697	29.0	0.87	2.9	-0.003	-0.070	0.000	-0.181	-0.403	0.154	-0.018	0.691
contract design with Rudder 3	RUN_166	4	-0.5	11/07/2012 17:33	18	-17.7	43.3	14.2	-7.1	-1.4	112.0	5.307	9.95	8.6	1.696	28.2	0.86	2.5	-0.003	-0.070	0.000	-0.009	-0.358	0.873	-0.025	0.385
contract design with Rudder 3	RUN_166	4	9.2	11/07/2012 17:33	18	-20.0	76.0	6.6	-8.6	-1.3	13.3	5.311	9.95	8.6	1.697	28.1	0.87	2.1	-0.003	-0.070	0.000	0.160	-0.403	1.533	-0.029	0.046
contract design with Rudder 3	RUN_167	8	-10.4	11/07/2012 17:46	18	-23.3	62.1	7.3	-15.1	-1.5	320.2	5.277	9.95	10.9	1.697	28.5	0.87	2.6	-0.010	-0.139	0.000	-0.182	-0.470	1.254	-0.052	1.101
contract design with Rudder 3	RUN_167	8	-0.6	11/07/2012 17:46	18	-21.1	99.3	13.4	-16.8	-1.5	229.3	5.277	9.95	11.3	1.697	27.8	0.87	2.5	-0.010	-0.139	0.000	-0.011	-0.426	2.004	-0.058	0.788
contract design with Rudder 3	RUN_167	8	9.2	11/07/2012 17:46	18	-23.5	134.1	11.8	-18.1	-1.6	120.3	5.279	9.95	11.2	1.697	27.6	0.87	2.4	-0.010	-0.139	0.000	0.161	-0.475	2.707	-0.062	0.414
contract design with Rudder 3	RUN_168	12	-10.3	11/07/2012 17:58	18	-30.9	125.8	12.1	-28.1	-2.0	427.8	5.245	9.95	14.5	1.697	24.9	0.80	2.4	-0.022	-0.208	0.000	-0.180	-0.624	2.538	-0.097	1.471
contract design with Rudder 3	RUN_168	12	-0.5	11/07/2012 17:58	18	-28.9	167.0	12.6	-30.0	-1.8	326.7	5.246	9.95	15.1	1.697	24.6	0.80	2.7	-0.022	-0.208	0.000	-0.009	-0.583	3.370	-0.103	1.123
contract design with Rudder 3	RUN_168	12	9.3	11/07/2012 17:58	18	-31.5	199.8	10.1	-30.2	-1.9	215.3	5.246	9.95	15.0	1.697	24.5	0.81	1.9	-0.022	-0.208	0.000	0.163	-0.635	4.033	-0.104	0.740
contract design with Rudder 3	RUN_169	16	-10.3	11/07/2012 18:10	18	-33.1	223.2	0.6	-46.1	-1.9	546.8	5.185	9.95	19.6	1.697	23.9	0.79	2.4	-0.039	-0.276	0.000	-0.180	-0.668	4.503	-0.158	1.879
contract design with Rudder 3	RUN_169	16	-0.5	11/07/2012 18:10	18	-31.5	265.5	7.3	-47.8	-2.0	439.9	5.185	9.95	19.8	1.697	23.1	0.77	2.7	-0.039	-0.276	0.000	-0.008	-0.635	5.358	-0.164	1.512
contract design with Rudder 3	RUN_169	16	9.1	11/07/2012 18:10	18	-34.4	299.1	1.7	-47.8	-2.1	328.9	5.187	9.95	19.6	1.697	22.9	0.77	1.8	-0.039	-0.276	0.000	0.159	-0.695	6.035	-0.164	1.130
contract design with Rudder 3	RUN_170	-4	-10.4	11/07/2012 18:22	18	-22.4	-75.6	-1.4	7.9	-1.3	-2.5	5.306	9.95	8.2	1.697	27.2	0.86	2.7	-0.002	0.070	0.000	-0.181	-0.453	-1.526	0.027	-0.009
contract design with Rudder 3	RUN_170	-4	-0.6	11/07/2012 18:22	18	-18.1	-42.2	3.3	6.2	-1.1	-98.3	5.305	9.95	8.2	1.697	27.6	0.85	2.6	-0.002	0.070	0.000	-0.010	-0.364	-0.851	0.021	-0.338
contract design with Rudder 3	RUN_170	-4	9.2	11/07/2012 18:22	18	-19.0	-10.2	4.5	5.2	-1.2	-192.0	5.304	9.95	8.2	1.697	28.1	0.86	2.0	-0.003	0.070	0.000	0.161	-0.384	-0.206	0.018	-0.660
contract design with Rudder 3	RUN_171	-8	-10.4	11/07/2012 18:34	18	-25.6	-132.7	1.5	16.9	-1.6	-109.5	5.278	9.95	11.0	1.697	27.1	0.84	3.0	-0.010	0.139	0.000	-0.181	-0.517	-2.677	0.058	-0.376
contract design with Rudder 3	RUN_171	-8	-0.4	11/07/2012 18:34	18	-19.8	-95.5	5.9	15.4	-1.4	-218.4	5.278	9.95	10.9	1.697	28.3	0.87	3.0	-0.010	0.139	0.000	-0.008	-0.400	-1.927	0.053	-0.751
contract design with Rudder 3	RUN_171	-8	9.4	11/07/2012 18:34	18	-20.8	-61.6	1.9	14.0	-1.4	-310.4	5.278	9.95	10.8	1.697	29.1	0.88	2.5	-0.010	0.139	0.000	0.164	-0.420	-1.244	0.048	-1.067
contract design with Rudder 3	RUN_172	-12	-10.3	11/07/2012 18:46	18	-34.2	-199.0	13.3	28.7	-2.2	-198.0	5.249	9.95	14.3	1.697	22.7	0.76	3.1	-0.022	0.208	0.000	-0.180	-0.690	-4.016	0.099	-0.680
contract design with Rudder 3	RUN_172	-12	-0.5	11/07/2012 18:46	18	-29.0	-160.0	16.1	27.2	-2.0	-312.5	5.246	9.95	14.5	1.697	23.0	0.76	3.2	-0.022	0.208	0.000	-0.009	-0.586	-3.229	0.094	-1.074
contract design with Rudder 3	RUN_172	-12	9.4	11/07/2012 18:46	18	-28.6	-120.0	8.4	25.6	-1.9	-415.3	5.246	9.95	14.4	1.697	24.2	0.78	2.6	-0.022	0.208	0.000	0.164	-0.577	-2.422	0.088	-1.428
contract design with Rudder 3	RUN_173	-16	-10.3	11/07/2012 18:58	18	-40.4	-296.9	10.3	46.8	-2.6	-300.5	5.184	9.95	19.3	1.697	21.4	0.73	3.0	-0.039	0.276	0.000	-0.180	-0.816	-5.994	0.161	-1.033
contract design with Rudder 3	RUN_173	-16	-0.6	11/07/2012 18:58	18	-34.2	-255.6	10.6	45.2	-2.3	-425.3	5.181	9.95	19.3	1.697	21.8	0.74	3.4	-0.039	0.276	0.000	-0.011	-0.689	-5.160	0.155	-1.462
contract design with Rudder 3	RUN_173	-16	9.3	11/07/2012 18:58	18	-33.3	-214.2	1.7	43.7	-2.1	-529.1	5.181	9.95	19.1	1.697	22.6	0.75	2.4	-0.039	0.276	0.000	0.162	-0.671	-4.321	0.150	-1.818
contract design with Rudder 3	RUN_174	20	-10.6	11/07/2012 19:10	18	-37.1	360.8	-1.0	-70.0	-2.2	706.8	5.115	9.95	26.7	1.697	22.4	0.75	2.8	-0.060	-0.342	0.000	-0.185	-0.749	7.281	-0.241	2.429
contract design with Rudder 3	RUN_174	20	-0.5	11/07/2012 19:10	18	-35.6	405.0	6.0	-71.3	-2.1	600.9	5.116	9.95	26.9	1.697	21.7	0.74	3.3	-0.060	-0.342	0.000	-0.009	-0.718	8.175	-0.245	2.066
contract design with Rudder 3	RUN_174	20	9.2	11/07/2012 19:10	18	-39.0	448.4	3.6	-72.5	-2.1	484.2	5.147	9.95	26.9	1.697	21.5	0.74	2.5	-0.061	-0.342	0.000	0.161	-0.787	9.051	-0.249	1.664
contract design with Rudder 3	RUN_175	-20	-10.3	11/07/2012 19:21	18	-45.6	-440.4	6.9	69.7	-2.8	-463.8	5.154	9.95	26.7	1.697	21.3	0.73	3.0	-0.060	0.342	0.000	-0.181	-0.920	-8.886	0.239	-1.594
contract design with Rudder 3	RUN_175	-20	-0.7	11/07/2012 19:21	18	-38.6	-393.7	5.0	68.0	-2.4	-588.9	5.146	9.95	26.6	1.697	21.8	0.74	3.2	-0.060	0.342	0.000	-0.012	-0.779	-7.942	0.234	-2.024
contract design with Rudder 3	RUN_175	-20	9.4	11/07/2012 19:21	18	-36.6	-348.0	-2.5	65.9	-2.2	-691.1	5.106	9.95	26.2	1.697	22.7	0.75	2.4	-0.060	0.342	0.000	0.165	-0.738	-7.023	0.226	-2.376

APPENDIX F
Mathematical Model Equations in Harmonic Form

The model and equations for N are of the same form as those for Y, therefore the equations are written here for Y only.

Pure harmonic sway:

Mathematical model:

$$Y = Y_0 + Y_v v + Y_{vvv} v^3 + Y_{\dot{v}} \dot{v} \tag{F-1}$$

(If the model is perfectly symmetrical, Y_0 should be zero)

Motion:

$$\begin{aligned} u &= U_c = \text{constant } u_0 \\ v &= v_a \cos \omega t \\ r &= 0 \end{aligned} \tag{F-2}$$

Forces and moments:

$$Y = \frac{a_{0Y}}{2} + a_{1Y} \cos(\omega t) + a_{3Y} \cos(3\omega t) + b_{1Y} \sin(\omega t) \tag{F-3}$$

(a_{0Y} should be zero for reasons of symmetry, but is kept here to account for imperfections in the symmetry of the model)

Polynomial equations for Y (and N):

$$\begin{aligned} \frac{a_{0Y}}{2} &= Y_0 \\ a_{1Y} &= Y_v v_a + \frac{3}{4} Y_{vvv} v_a^3 \\ a_{3Y} &= \frac{1}{4} Y_{vvv} v_a^3 \\ b_{1Y} &= -Y_{\dot{v}} \omega v_a \end{aligned} \tag{F-4}$$

Pure harmonic yaw:

The equations are the same as for pure sway, replacing all v terms by r.

Mathematical model:

$$Y = Y_0 + Y_r r + Y_{rrr} r^3 + Y_{\dot{r}} \dot{r} \tag{F-5}$$

(If the model is perfectly symmetrical, Y_0 should be zero)

Motion:

$$\begin{aligned} u &= \text{constant } u_0 \\ r &= r_a \cos \omega t \\ v &= 0 \end{aligned} \tag{F-6}$$

Forces and moments:

$$Y = \frac{a_{0Y}}{2} + a_{1Y} \cos(\omega t) + a_{3Y} \cos(3\omega t) + b_{1Y} \sin(\omega t) \tag{F-7}$$

(a_{0Y} should be zero for reasons of symmetry, but is kept here to account for imperfections in the symmetry of the model)

Polynomial equations for Y (and N):

$$\begin{aligned} \frac{a_{0Y}}{2} &= Y_0 \\ a_{1Y} &= Y_r r_a + \frac{3}{4} Y_{rrr} r_a^3 \\ a_{3Y} &= \frac{1}{4} Y_{rrr} r_a^3 \\ b_{1Y} &= -Y_{\dot{r}} \omega r_a \end{aligned} \tag{F-8}$$

APPENDIX G
Non-Dimensional Equations Written in Harmonic Form

Non-dimensional equations written in harmonic form

When working with non-dimensional motions and forces, the kinematic equations incur additional terms in their Fourier series form, due to the fact that the characteristic scale for velocities, U(t), is a function of time.
Equations are written here for the general case encompassing both types of harmonic tests carried out in the JSS test program (pure harmonic sway and yaw motions).

Kinematic equations, dimensional:

$$\begin{aligned} u &= u_0 \\ \dot{u} &= 0 \\ v &= v_a \cos\omega t \\ \dot{v} &= -v_a \omega \sin\omega t \\ r &= r_a \cos\omega t \\ \dot{r} &= -r_a \omega \sin\omega t \end{aligned} \qquad \text{(G-1)}$$

Kinematic equations, non-dimensional:

$$\begin{aligned} U(t) &= \sqrt{u_0^2 + v_a^2 \cos^2 \omega t} \\ \Delta u' &= \frac{(u_0 - U_{ref})}{U(t)} \\ \dot{u}' &= 0 \\ v' &= \frac{v_a}{U(t)} \cos\omega t \\ \dot{v}' &= \frac{-v_a \omega L \sin\omega t}{U^2(t)} \\ r' &= \frac{r_a L}{U(t)} \cos\omega t \\ \dot{r}' &= \frac{-r_a \omega L^2 \sin\omega t}{U^2(t)} \end{aligned} \qquad \text{(G-2)}$$

Decomposed in Fourier series up to the third order, the non-dimensional kinematic equations take the form:

$$\begin{aligned} v' &= v'_1 \cos\omega t + v'_3 \cos 3\omega t \\ r' &= r'_1 \cos\omega t + r'_3 \cos 3\omega t \\ \Delta u' &= u'_0 + u'_2 \cos 2\omega t \\ \dot{u}' &= 0 \\ \dot{v}' &= \dot{v}'_1 \sin\omega t + \dot{v}'_3 \sin 3\omega t \\ \dot{r}' &= \dot{r}'_1 \sin\omega t + \dot{r}'_3 \sin 3\omega t \end{aligned} \qquad \text{(G-3)}$$

$v'_3 << v'_1$; $\dot{v}'_3 << \dot{v}'_1$; $r'_3 << r'_1$; $\dot{r}'_3 << \dot{r}'_1$; $u'_2 << u'_0$.
In first approximation, only the terms up to first order harmonic are retained:

$$\begin{aligned} v' &\approx v'_1 \cos \omega t \\ r' &\approx r'_1 \cos \omega t \\ \Delta u' &\approx u'_0 \\ \dot{u}' &= 0 \\ \dot{v}' &\approx \dot{v}'_1 \sin \omega t \\ \dot{r}' &\approx \dot{r}'_1 \sin \omega t \end{aligned} \qquad \text{(G-4)}$$

Non-dimensional amplitudes of the motion:

$$\begin{aligned} v'_1 &= \frac{2}{3}\frac{v_a}{u_0}\left(\frac{1}{\sqrt{4+(v_a/u_0)^2}} + \frac{1}{\sqrt{1+(v_a/u_0)^2}}\right) \\ u'_0 &= \frac{1}{2}\left(\frac{u_0 - U_{ref}}{\sqrt{u_0^2 + v_a^2}} + \frac{u_0 - U_{ref}}{u_0}\right) \\ \dot{v}'_1 &= \frac{-2}{3}\frac{v_a \omega L}{u_0^2}\left(1 + \frac{1}{2\left(1+\frac{3}{4}\left(\frac{v_a}{u_0}\right)^2\right)}\right) \\ r'_1 &= \frac{2}{3}\frac{r_a L}{u_0}\left(\frac{1}{\sqrt{4+(v_a/u_0)^2}} + \frac{1}{\sqrt{1+(v_a/u_0)^2}}\right) \\ \dot{r}'_1 &= \frac{-2}{3}\frac{r_a \omega L^2}{u_0^2}\left(1 + \frac{1}{2\left(1+\frac{3}{4}\left(\frac{v_a}{u_0}\right)^2\right)}\right) \end{aligned} \qquad \text{(G-5)}$$

We note that if the amplitude of the sway motion is small, $\frac{v_a}{u_0} << 1$, then:

$$
\begin{aligned}
v'_1 &\approx \frac{v_a}{u_0} \\
u'_0 &\approx \frac{u_0 - U_{ref}}{u_0} \\
\dot{v}'_1 &\approx \frac{-v_a \omega L}{u_0^2} \\
r'_1 &\approx \frac{r_a L}{u_0} \\
\dot{r}'_1 &\approx \frac{-r_a \omega L^2}{u_0^2}
\end{aligned}
\tag{G-6}
$$

Mathematical model:

The model and equations for N are of the same form as those for Y, and the equations are written here for Y only.

Pure harmonic sway:

$$Y' = Y'_0 + Y'_v\, v' + Y'_{vvv}\, v'^3 + Y'_{\dot{v}}\, \dot{v}' \tag{G-7}$$

Pure harmonic yaw:

$$Y' = Y'_0 + Y'_r\, r' + Y'_{rrr}\, r'^3 + Y'_{\dot{r}}\, \dot{r}' \tag{G-8}$$

with the rudder angle held constant along the centerline or at neutral angle.

Forces and moments are decomposed in Fourier series:

$$Y' = \frac{a_{0Y}}{2} + a_{1Y}\cos(\omega t) + a_{2Y}\cos(2\omega t) + a_{3Y}\cos(3\omega t) + b_{1Y}\sin(\omega t) \tag{G-9}$$

Polynomial equations for Y' (and N'):

Pure harmonic sway:

$$\begin{aligned} \frac{a_{0Y}}{2} - a_{2Y} &= Y'_0 \\ a_{1Y} - 3a_{3Y} &= Y'_v \, v'_1 \\ a_{2Y} &= 0 \\ a_{3Y} &= \frac{1}{4} Y'_{vvv} \, v'^3_1 \\ b_{1Y} &= Y'_{\dot{v}} \, \dot{v}_1 \end{aligned} \qquad \text{(G-10)}$$

Pure harmonic yaw:

$$\begin{aligned} \frac{a_{0Y}}{2} - a_{2Y} &= Y'_0 \\ a_{1Y} - 3a_{3Y} &= Y'_r \, r'_1 \\ a_{2Y} &= 0 \\ a_{3Y} &= \frac{1}{4} Y'_{rrr} \, r'^3_1 \\ b_{1Y} &= Y'_{\dot{r}} \, \dot{r}'_1 \end{aligned} \qquad \text{(G-11)}$$

APPENDIX H
Harmonic Runs: Data Summary

hlpp2 5.8715
Uref2 1.6969
Scale2 29.77901
JSS contract design

RUN Name / VORG file		RUN_008 VORG0039	RUN_009 VORG0014	RUN_010 VORG0015	RUN_011 VORG0016	RUN_012 VORG0017	RUN_013 VORG0018	RUN_014 VORG0019	RUN_001 VORG0021	RUN_002 VORG0022	RUN_003 VORG0022	RUN_004 VORG0024	RUN_005 VORG0025	RUN_006 VORG0026	RUN_007 VORG0027
u_0	[m/s]	1.696	1.693	1.685	1.673	1.659	1.64	1.659	1.697	1.697	1.697	1.697	1.697	1.697	1.697
v_a	[m/s]	0.085	0.17	0.29	0.4	0.51	0.62	0.51	0	0	0	0	0	0	0
ra	[deg/s]	0	0	0	0	0	0	0	1.7	3.3	5	6.7	8.3	10	6.7
T	[sec]	16	16	16	16	16	16	20	14	14	14	14	14	14	17
ω'_1	[-]	1.36	1.36	1.36	1.36	1.36	1.36	1.09	1.55	1.55	1.55	1.55	1.55	1.55	1.28
u'_0	[-]	-0.001	-0.002	-0.007	-0.014	-0.022	-0.034	-0.022	0	0	0	0	0	0	0
v'_1	[-]	0.050	0.100	0.170	0.234	0.297	0.360	0.297	0	0	0	0	0	0	0
r'_1	[-]	0	0	0	0	0	0	0	0.103	0.199	0.302	0.405	0.501	0.604	0.405
$v'dot_1$	[-]	-0.068	-0.136	-0.234	-0.325	-0.418	-0.514	-0.334	0	0	0	0	0	0	0
$r'dot_1$	[-]	0	0	0	0	0	0	0	-0.159	-0.309	-0.469	-0.628	-0.778	-0.938	-0.517
a_{0Y}	[-]	0.04	0.07	0.09	0.06	0.11	0.15	0.09	0.18	0.10	0.07	0.03	0.02	0.05	0.00
a_{1Y}	[-]	-0.49	-1.18	-2.24	-3.54	-5.32	-7.51	-5.33	0.29	0.56	0.78	1.07	1.45	1.89	1.17
a_{2Y}	[-]	0.01	0.01	0.03	0.03	0.03	0.02	0.00	0.00	-0.01	0.01	-0.01	0.00	-0.01	-0.03
a_{3Y}	[-]	-0.02	-0.05	-0.12	-0.34	-0.56	-0.82	-0.53	0.01	-0.02	-0.05	-0.08	-0.12	-0.20	-0.14
a_{0N}	[-]	0.03	0.02	0.04	0.04	0.06	0.05	0.04	0.11	0.08	0.07	0.04	0.06	0.06	0.04
a_{1N}	[-]	-0.24	-0.51	-0.94	-1.27	-1.65	-2.06	-1.63	-0.21	-0.42	-0.71	-0.98	-1.30	-1.71	-0.99
a_{2N}	[-]	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.02	0.01	0.02	0.01
a_{3N}	[-]	0.00	-0.01	-0.05	-0.03	-0.07	-0.14	-0.03	0.00	-0.01	-0.03	-0.07	-0.12	-0.17	-0.07
b_{1Y}	[-]	0.66	1.29	2.27	3.33	4.49	5.65	0.04	0.06	0.13	0.24	0.29	0.44	0.60	0.30
b_{1N}	[-]	0.01	0.00	-0.02	-0.01	0.00	-0.02	0.00	0.08	0.17	0.27	0.34	0.46	0.57	0.31
a_{1Y}-$3a_{3Y}$	[-]	-0.44	-1.04	-1.88	-2.51	-3.65	-5.06	-3.75	0.27	0.60	0.92	1.31	1.80	2.49	1.58
a_{1N}-$3a_{3N}$	[-]	-0.24	-0.49	-0.80	-1.18	-1.44	-1.64	-1.55	-0.22	-0.40	-0.62	-0.77	-0.96	-1.19	-0.78
Single run analysis															
Y'v	*1000	-8.9	-10.4	-11.0	-10.7	-12.3	-14.1	-12.6							
Y'vdot	*1000	-9.7	-9.5	-9.7	-10.2	-10.7	-11.0	-0.1							
Y'r	*1000								2.6	3.0	3.0	3.2	3.6	4.1	3.9
N'v	*1000	-4.8	-4.9	-4.7	-5.1	-4.9	-4.6	-5.2							
N'r	*1000								-2.1	-2.0	-2.0	-1.9	-1.9	-2.0	-1.9
N'rdot	*1000								-0.5	-0.5	-0.6	-0.5	-0.6	-0.6	-0.6

hlpp2 5.8715
Uref2 1.6969
Scale2 29.77901
JSS contract design repeat

RUN Name / VORG file		RUN_110 VORG0039	RUN_111 VORG0014	RUN_112 VORG0015	RUN_113 VORG0016	RUN_114 VORG0017	RUN_115 VORG0018	RUN_104 VORG0021	RUN_105 VORG0022	RUN_106 VORG0023	RUN_107 VORG0024	RUN_108 VORG0025	RUN_109 VORG0026
u_0	[m/s]	1.696	1.693	1.685	1.673	1.659	1.64	1.697	1.697	1.697	1.697	1.697	1.697
v_a	[m/s]	0.085	0.17	0.29	0.4	0.51	0.62	0	0	0	0	0	0
ra	[deg/s]	0	0	0	0	0	0	1.7	3.3	5	6.7	8.3	10
T	[sec]	16	16	16	16	16	16	14	14	14	14	14	14
ω'_1	[-]	1.36	1.36	1.36	1.36	1.36	1.36	1.55	1.55	1.55	1.55	1.55	1.55
u'_0	[-]	-0.001	-0.002	-0.007	-0.014	-0.022	-0.034	0	0	0	0	0	0
v'_1	[-]	0.050	0.100	0.170	0.234	0.297	0.360	0	0	0	0	0	0
r'_1	[-]	0	0	0	0	0	0	0.103	0.199	0.302	0.405	0.501	0.604
$v'dot_1$	[-]	-0.068	-0.136	-0.234	-0.325	-0.418	-0.514	0	0	0	0	0	0
$r'dot_1$	[-]	0	0	0	0	0	0	-0.159	-0.309	-0.469	-0.628	-0.778	-0.938
a_{0Y}	[-]	0.01	0.01	-0.01	0.08	0.13	0.09	0.06	0.03	0.04	0.06	0.09	0.13
a_{1Y}	[-]	-0.53	-1.18	-2.30	-3.63	-5.46	-7.76	0.29	0.56	0.84	1.14	1.52	1.94
a_{2Y}	[-]	0.01	-0.01	0.01	0.03	0.03	0.03	0.00	-0.02	-0.01	-0.03	-0.02	-0.01
a_{3Y}	[-]	-0.02	-0.05	-0.11	-0.33	-0.59	-0.84	0.01	-0.02	-0.04	-0.10	-0.13	-0.21
a_{0N}	[-]	0.05	0.04	0.05	0.07	0.09	0.07	-0.05	0.00	-0.01	0.00	0.02	0.04
a_{1N}	[-]	-0.24	-0.49	-0.92	-1.25	-1.63	-2.06	-0.22	-0.43	-0.69	-0.97	-1.29	-1.68
a_{2N}	[-]	0.00	0.00	0.00	0.01	0.01	0.02	0.00	0.00	0.01	0.01	0.01	0.01
a_{3N}	[-]	0.00	-0.01	-0.04	-0.02	-0.07	-0.13	0.00	-0.01	-0.03	-0.07	-0.12	-0.17
b_{1Y}	[-]	0.62	1.27	2.22	3.25	4.31	5.50	0.06	0.14	0.24	0.33	0.41	0.63
b_{1N}	[-]	-0.01	-0.01	-0.04	-0.04	-0.05	-0.06	0.09	0.17	0.27	0.36	0.44	0.59
$a_{1Y}-3a_{3Y}$	[-]	-0.48	-1.03	-1.98	-2.63	-3.70	-5.24	0.26	0.61	0.97	1.43	1.90	2.56
$a_{1N}-3a_{3N}$	[-]	-0.24	-0.47	-0.80	-1.19	-1.43	-1.66	-0.22	-0.40	-0.60	-0.76	-0.94	-1.16
Single run analysis													
Y'v	*1000	-9.6	-10.3	-11.6	-11.2	-12.4	-14.6						
Y'vdot	*1000	-9.0	-9.3	-9.5	-10.0	-10.3	-10.7						
Y'r	*1000							2.6	3.1	3.2	3.5	3.8	4.2
N'v	*1000	-4.8	-4.7	-4.7	-5.1	-4.8	-4.6						
N'r	*1000							-2.1	-2.0	-2.0	-1.9	-1.9	-1.9
N'rdot	*1000							-0.5	-0.6	-0.6	-0.6	-0.6	-0.6

hlpp2	5.8715
Uref2	1.6969
Scale2	29.77901

JSS contract design Rudder 3

RUN Name / VORG file		RUN_159 VORG0039	RUN_160 VORG0014	RUN_161 VORG0015	RUN_162 VORG0016	RUN_163 VORG0017	RUN_164 VORG0018	RUN_153 VORG0021	RUN_154 VORG0022	RUN_155 VORG0023	RUN_156 VORG0024	RUN_157 VORG0025	RUN_158 VORG0026
u_0	[m/s]	1.696	1.693	1.685	1.673	1.659	1.64	1.697	1.697	1.697	1.697	1.697	1.697
v_a	[m/s]	0.085	0.17	0.29	0.4	0.51	0.62	0	0	0	0	0	0
ra	[deg/s]	0	0	0	0	0	0	1.7	3.3	5	6.7	8.3	10
T	[sec]	16	16	16	16	16	16	14	14	14	14	14	14
ω'_1	[-]	1.36	1.36	1.36	1.36	1.36	1.36	1.55	1.55	1.55	1.55	1.55	1.55
u'_0	[-]	-0.001	-0.002	-0.007	-0.014	-0.022	-0.034	0	0	0	0	0	0
v'_1	[-]	0.050	0.100	0.170	0.234	0.297	0.360	0	0	0	0	0	0
r'_1	[-]	0	0	0	0	0	0	0.103	0.199	0.302	0.405	0.501	0.604
$v'dot_1$	[-]	-0.068	-0.136	-0.234	-0.325	-0.418	-0.514	0	0	0	0	0	0
$r'dot_1$	[-]	0	0	0	0	0	0	-0.159	-0.309	-0.469	-0.628	-0.778	-0.938
a_{0Y}	[-]	0.05	0.02	-0.09	-0.06	-0.03	0.07	-0.20	-0.05	0.12	0.11	0.15	0.19
a_{1Y}	[-]	-0.51	-1.21	-2.31	-3.58	-5.36	-7.57	0.32	0.59	0.86	1.16	1.51	1.98
a_{2Y}	[-]	0.00	0.01	0.01	-0.02	-0.02	0.02	0.00	-0.01	0.02	0.01	0.04	0.04
a_{3Y}	[-]	-0.02	-0.06	-0.12	-0.33	-0.56	-0.81	0.01	-0.01	-0.05	-0.09	-0.14	-0.21
a_{0N}	[-]	0.09	0.04	0.01	0.01	0.03	0.03	-0.01	0.05	0.13	0.11	0.12	0.13
a_{1N}	[-]	-0.23	-0.49	-0.91	-1.23	-1.58	-1.99	-0.23	-0.45	-0.72	-1.00	-1.32	-1.73
a_{2N}	[-]	0.00	0.00	-0.01	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01
a_{3N}	[-]	0.00	-0.01	-0.04	-0.02	-0.07	-0.14	0.00	-0.01	-0.03	-0.06	-0.11	-0.17
b_{1Y}	[-]	0.62	1.26	2.24	3.26	4.37	5.61	0.07	0.13	0.19	0.30	0.45	0.55
b_{1N}	[-]	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	-0.01	-0.01	-0.01	-0.01
a_{1Y}-3a_{3Y}	[-]	-0.46	-1.03	-1.96	-2.61	-3.69	-5.15	0.28	0.62	1.01	1.44	1.94	2.61
a_{1N}-3a_{3N}	[-]	-0.23	-0.47	-0.79	-1.17	-1.38	-1.57	-0.23	-0.43	-0.63	-0.81	-0.99	-1.23
Single run analysis													
Y'v	*1000	-9.2	-10.3	-11.5	-11.1	-12.4	-14.3						
Y'vdot	*1000	-9.1	-9.2	-9.6	-10.0	-10.5	-10.9						
Y'r	*1000							2.7	3.1	3.3	3.6	3.9	4.3
N'v	*1000	-4.5	-4.7	-4.6	-5.0	-4.6	-4.4						
N'r	*1000							-2.2	-2.1	-2.1	-2.0	-2.0	-2.0
N'rdot	*1000							0.0	0.0	0.0	0.0	0.0	0.0

hlpp2	5.8715
Uref2	1.6969
Scale2	29.77901

JSS contract design Rudder 2

RUN Name VORG file		RUN_135 VORG0039	RUN_136 VORG0014	RUN_137 VORG0015	RUN_138 VORG0016	RUN_139 VORG0017	RUN_140 VORG0018	RUN_129 VORG0021	RUN_130 VORG0022	RUN_131 VORG0023	RUN_132 VORG0024	RUN_133 VORG0025	RUN_134 VORG0026
u_0	[m/s]	1.696	1.693	1.685	1.673	1.659	1.64	1.697	1.697	1.697	1.697	1.697	1.697
v_a	[m/s]	0.085	0.17	0.29	0.4	0.51	0.62	0	0	0	0	0	0
ra	[deg/s]	0	0	0	0	0	0	1.7	3.3	5	6.7	8.3	10
T	[sec]	16	16	16	16	16	16	14	14	14	14	14	14
ω'_1	[-]	1.36	1.36	1.36	1.36	1.36	1.36	1.55	1.55	1.55	1.55	1.55	1.55
u'_0	[-]	-0.001	-0.002	-0.007	-0.014	-0.022	-0.034	0	0	0	0	0	0
v'_1	[-]	0.050	0.100	0.170	0.234	0.297	0.360	0	0	0	0	0	0
r'_1	[-]	0	0	0	0	0	0	0.103	0.199	0.302	0.405	0.501	0.604
$v'dot_1$	[-]	-0.068	-0.136	-0.234	-0.325	-0.418	-0.514	0	0	0	0	0	0
$r'dot_1$	[-]	0	0	0	0	0	0	-0.159	-0.309	-0.469	-0.628	-0.778	-0.938
a_{0Y}	[-]	0.13	0.29	0.33	0.32	0.17	0.14	0.15	0.04	0.11	-0.01	0.03	0.12
a_{1Y}	[-]	-0.55	-1.23	-2.30	-3.70	-5.46	-7.64	0.31	0.63	0.92	1.23	1.58	2.05
a_{2Y}	[-]	0.01	0.01	0.02	0.04	0.01	0.00	0.00	0.00	-0.03	-0.04	-0.04	-0.01
a_{3Y}	[-]	-0.03	-0.05	-0.11	-0.32	-0.55	-0.80	0.01	-0.02	-0.04	-0.08	-0.13	-0.20
a_{0N}	[-]	-0.01	0.02	0.00	-0.01	-0.02	-0.07	-0.02	-0.02	-0.09	-0.09	-0.07	-0.02
a_{1N}	[-]	-0.25	-0.50	-0.90	-1.22	-1.56	-1.96	-0.24	-0.46	-0.73	-1.04	-1.38	-1.79
a_{2N}	[-]	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.01
a_{3N}	[-]	0.00	-0.01	-0.04	-0.02	-0.06	-0.14	0.00	-0.01	-0.03	-0.06	-0.11	-0.18
b_{1Y}	[-]	0.66	1.32	2.29	3.29	4.37	5.65	0.05	0.09	0.16	0.28	0.41	0.53
b_{1N}	[-]	0.00	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
a_{1Y}-3a_{3Y}	[-]	-0.47	-1.08	-1.96	-2.72	-3.80	-5.23	0.27	0.68	1.05	1.47	1.98	2.64
a_{1N}-3a_{3N}	[-]	-0.25	-0.47	-0.77	-1.15	-1.37	-1.55	-0.24	-0.44	-0.65	-0.84	-1.04	-1.27
Single run analysis													
Y'v	*1000	-9.3	-10.8	-11.5	-11.6	-12.8	-14.6						
Y'vdot	*1000	-9.7	-9.6	-9.8	-10.1	-10.5	-11.0						
Y'r	*1000							2.7	3.4	3.5	3.6	4.0	4.4
N'v	*1000	-4.9	-4.7	-4.5	-4.9	-4.6	-4.3						
N'r	*1000							-2.3	-2.2	-2.1	-2.1	-2.1	-2.1
N'rdot	*1000							0.0	0.0	0.0	0.0	0.0	0.0

hlpp1	5.8271
Uref1	1.6995
Scale1	29.6891

JSS preliminary design (January 2012 test session)

RUN Name VORG file		RUN_037 VORG0039	RUN_038 VORG0014	RUN_039 VORG0015	RUN_040 VORG0016	RUN_041 VORG0017	RUN_042 VORG0018	RUN_031 VORG0021	RUN_032 VORG0022	RUN_033 VORG0023	RUN_034 VORG0024	RUN_035 VORG0025	RUN_036 VORG0026
u_0	[m/s]	1.698	1.695	1.687	1.675	1.66	1.641	1.6995	1.6995	1.6995	1.6995	1.6995	1.6995
v_a	[m/s]	0.085	0.17	0.29	0.41	0.52	0.63	0	0	0	0	0	0
$_{ra}$	[deg/s]	0	0	0	0	0	0	1.7	3.3	5	6.7	8.4	10
T	[sec]	15	15	15	15	15	15	14	14	14	14	14	14
ω'_1	[-]	1.44	1.44	1.44	1.44	1.44	1.44	1.54	1.54	1.54	1.54	1.54	1.54
u'_0	[-]	-0.001	-0.003	-0.007	-0.014	-0.023	-0.034	0	0	0	0	0	0
v'_1	[-]	0.050	0.100	0.170	0.239	0.302	0.365	0	0	0	0	0	0
r'_1	[-]	0	0	0	0	0	0	0.102	0.197	0.299	0.401	0.503	0.598
$v'dot_1$	[-]	-0.072	-0.144	-0.247	-0.352	-0.450	-0.552	0	0	0	0	0	0
$r'dot_1$	[-]	0	0	0	0	0	0	-0.157	-0.304	-0.460	-0.617	-0.774	-0.921
a_{0Y}	[-]	0.08	0.15	0.16	0.21	0.25	0.29	0.08	0.08	0.12	0.13	0.15	0.14
a_{1Y}	[-]	-0.48	-1.11	-2.22	-3.48	-5.14	-7.10	0.25	0.49	0.78	1.14	1.56	2.01
a_{2Y}	[-]	0.01	0.00	0.01	0.03	0.05	0.06	0.00	0.00	-0.01	-0.01	0.00	0.00
a_{3Y}	[-]	-0.02	-0.06	-0.13	-0.33	-0.59	-0.79	0.01	0.01	-0.02	-0.04	-0.07	-0.15
a_{0N}	[-]	-0.03	0.04	-0.01	-0.01	0.00	0.00	0.00	0.00	0.04	0.02	0.00	0.02
a_{1N}	[-]	-0.26	-0.49	-0.82	-1.14	-1.45	-1.78	-0.20	-0.41	-0.66	-0.92	-1.23	-1.55
a_{2N}	[-]	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.00
a_{3N}	[-]	0.00	0.00	-0.01	0.00	-0.03	-0.08	0.00	0.00	-0.03	-0.06	-0.09	-0.14
b_{1Y}	[-]	0.62	1.26	2.21	3.39	4.53	5.80	0.06	0.13	0.19	0.31	0.42	0.58
b_{1N}	[-]	-0.01	0.00	-0.02	-0.01	-0.03	-0.03	0.09	0.17	0.22	0.33	0.42	0.52
a_{1Y}-$3a_{3Y}$	[-]	-0.43	-0.94	-1.82	-2.50	-3.38	-4.75	0.22	0.47	0.85	1.26	1.79	2.47
a_{1N}-$3a_{3N}$	[-]	-0.27	-0.49	-0.79	-1.13	-1.36	-1.55	-0.20	-0.39	-0.57	-0.75	-0.95	-1.12
Single run analysis													
Y'v	*1000	-8.7	-9.4	-10.7	-10.5	-11.2	-13.0						
Y'vdot	*1000	-8.6	-8.8	-8.9	-9.7	-10.1	-10.5						
Y'r	*1000							2.2	2.4	2.8	3.1	3.6	4.1
N'v	*1000	-5.4	-4.9	-4.6	-4.7	-4.5	-4.2						
N'r	*1000							-2.0	-2.0	-1.9	-1.9	-1.9	-1.9
N'rdot	*1000							-0.6	-0.6	-0.5	-0.5	-0.5	-0.6

APPENDIX I
"Single-Run" Method of Harmonic Analysis

"Single-run" harmonic analysis suffers the same limitations as "multiple-run" harmonic analysis, and more: like "multiple-run" harmonic analysis it assumes pure harmonic nature of the motions; and runs of different motion amplitude yield slightly different hydrodynamic coefficients. This method was used to assess the January 2012 phase of testing, on the JSS Preliminary Design, before the analysis method was refined. It is presented here as it permits relative comparison of the stability of all vessel configurations: those tested with the JSS Preliminary Design in January 2012 together with those tested with the JSS Contract Design in this phase.

Method:

In Section 5.5, under the assumption that the motions were purely harmonic, the following equations were developed linking the Fourier coefficients of forces and moments to the hydrodynamic coefficients.

For pure harmonic sway tests:

$$\frac{a_{0Y}}{2} - a_{2Y} = Y'_0$$
$$a_{1Y} - 3a_{3Y} = Y'_v v'_1$$
$$a_{3Y} = \frac{1}{4} Y'_{vvv} v'^3_1$$
$$b_{1Y} = Y'_{\dot{v}} \dot{v}_1$$

And for pure harmonic yaw tests:

$$\frac{a_{0Y}}{2} - a_{2Y} = Y'_0$$
$$a_{1Y} - 3a_{3Y} = Y'_r r'_1$$
$$a_{3Y} = \frac{1}{4} Y'_{rrr} r'^3_1$$
$$b_{1Y} = Y'_{\dot{r}} \dot{r}'_1$$

(and equivalent sets of equations for non-dimensional yaw moment N').

Using the second (a_1-$3a_3$) and fourth (b_1) equations in the first equation set, coefficients in v and in $\dot{v}$ can be obtained from any single pure harmonic sway run. Using the second (a_1-$3a_3$) and fourth (b_1) equations in the second equation set, coefficients in r and in $\dot{r}$ can be obtained from any single pure harmonic yaw run.

The analysis software "pmmana" is designed to perform the "single-run" method of analysis, where hydrodynamic coefficients in v are assessed on the basis of one single pure sway harmonic run, and hydrodynamic coefficients in r are assessed on the basis of one single pure yaw harmonic run. After analysis of a pure motion run the software computes the hydrodynamic coefficients from the harmonic coefficients and outputs a table of hydrodynamic coefficients, where the newly calculated coefficients have been updated.

The hydrodynamic coefficients calculated using the "single run" analysis, vary somewhat with the amplitude of motion of the harmonic run being analyzed. The "single run" analysis is akin to determining the slope of a linear fit based on a single data point. Results from small amplitude runs could be carrying a large measurement uncertainty and be less significant, while at the largest amplitudes the mathematical model might be less valid as the physics could call for higher order terms.

Results:

Appendix H: Harmonic Runs – Data Summary shows the data and Fourier coefficients from all harmonic runs, as well as coefficients extracted for each run using the "single-run" harmonic method.

The following Figures I-1 and I-2 show that the hydrodynamic coefficients extracted with the "single-run" analysis method vary with the amplitude of the motion for that run. Yet, trends are clearly noticeable between different vessel configurations (different rudders, or compared to the JSS preliminary design).

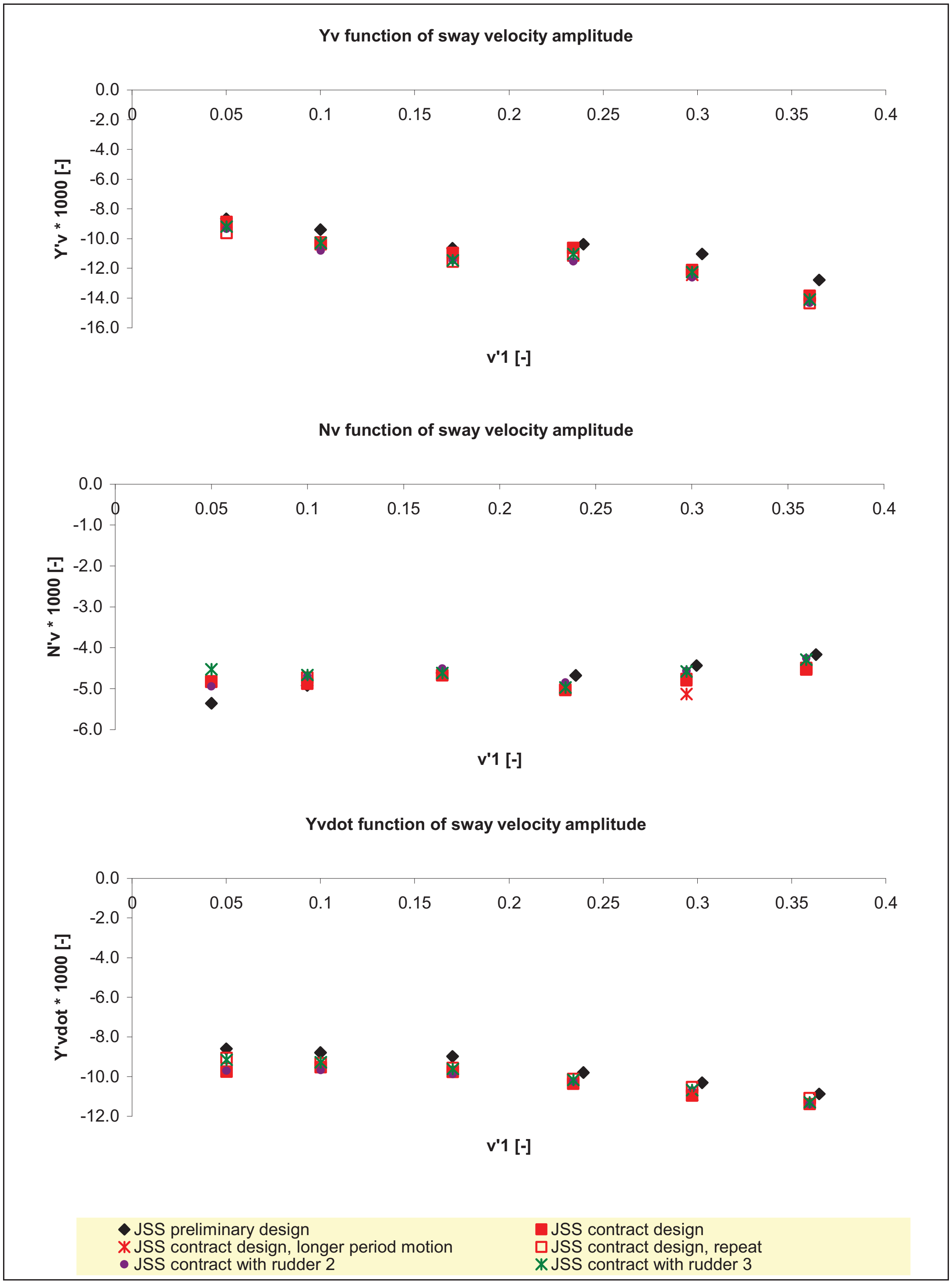

Figure I-1. Single Run Analysis: Variation with Sway Amplitude of Hydrodynamic Coefficients in v

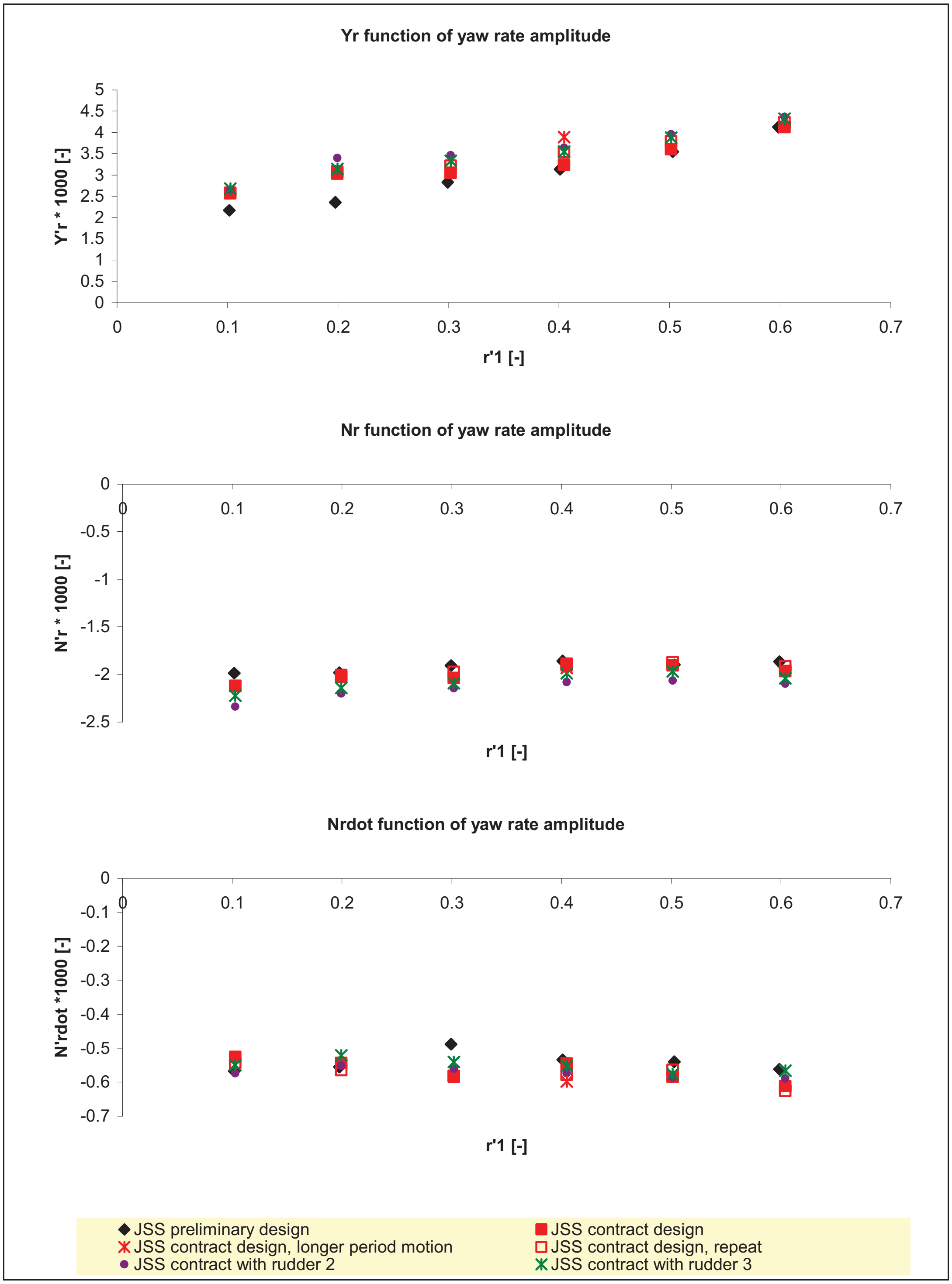

Figure I-2. Single Run Analysis: Variation with Yaw Amplitude of Hydrodynamic Coefficients in r

The hydrodynamic coefficients from the "single-run" analysis, and the resulting stability indices and criteria for all vessel configurations, are presented in Table I-1 below: for each vessel configuration, an average hydrodynamic coefficient was calculated from a selection of runs. The runs retained for calculation of each hydrodynamic coefficient, indicated to the right of the table, were chosen during the January 2012 test session, based on information available then (the choice was guided by the results of static drift tests in that session and by the observations during the pond trials done with the JSS preliminary design). Importantly, for comparing vessel configurations in a consistent manner, the same selection of runs is retained here for analysis of the contract design from the present session measurements. The corresponding results from the January session on the preliminary design (Reference [17]) are reproduced below in Table I-2 for reference.

Configuration	JSS contract design	JSS contract design, repeat	JSS contract design, with Rudder 3	JSS contract design, with Rudder 2	(Runs used)
Rudder	design rudder	design rudder	Rudder 3	Rudder 2	(runs are numbered in ascending order of amplitude)
Skeg	none	none	none	none	
shaft speed	ship self-propulsion	ship self-propulsion	ship self-propulsion	ship self-propulsion	
Y'v *1000	-12.99	-13.32	-13.18	-13.48	(5,6)
N'r *1000	-1.93	-1.89	-2.00	-2.08	(4,5,6)
Y'r *1000	3.42	3.67	3.72	3.80	(4,5)
N'v *1000	-4.85	-4.86	-4.79	-4.68	(3,4)
Y'vdot *1000	-10.07	-9.85	-9.89	-10.06	(3,4)
N'rdot *1000	-0.56	-0.58	-0.55	-0.57	(3,4)
A' *10^6	19.75	19.80	19.22	19.78	
B' *10^6	50.15	49.59	51.13	53.60	
C' *10^6	-1.8	-0.5	1.3	3.9	
sigma1	0.03	0.01	-0.02	-0.08	

A' is (I'z-N'rdot)*(m'-Y'vdot)
B' is -(I'z-N'rdot)*Y'v-(m'-Y'vdot)*N'r
C' is Y'v*N'r-N'v*(Y'r-m')

Non-dimensionalization uses the following quantities:
distance: Lpp
speed: instantaneous speed along track

Table I-1. Stability of JSS Contract Design, using "Single-run" analysis (and January 2011 selection of runs)

Configuration	Preliminary design	Preliminary design, with Rudder 3	Preliminary design, with Rudder 2	Preliminary design, with skeg	Preliminary design, with skeg	Preliminary design, with skeg	Preliminary design, with skeg	Preliminary design, model as tested on the pond	(Runs used)
Rudder Skeg shaft speed	design rudder none ship self-propulsion	Rudder 3 none ship self-propulsion	Rudder 2 none ship self-propulsion	design rudder -2 deg ship self-propulsion	design rudder 0 deg ship self-propulsion	design rudder 2 deg ship self-propulsion	design rudder 4 deg ship self-propulsion	design rudder none model self-propulsion	(runs are numbered in ascending order of amplitude)
Y'v *1000	-11.92	-11.93	-12.43	-12.82	-12.85	-12.96	-13.06	-12.02	(5,6)
N'r *1000	-1.88	-2.00	-2.13	-2.18	-2.20	-2.22	-2.28	-1.96	(4,5,6)
Y'r *1000	3.34	4.16	4.43	3.97	4.03	4.11	4.21	3.44	(4,5)
N'v *1000	-4.65	-4.57	-4.48	-4.26	-4.24	-4.19	-4.14	-4.53	(3,4)
Y'vdot *1000	-9.40	-9.60	-9.72	-10.30	-10.35	-10.29	-10.26	-9.61	(3,4)
N'rdot *1000	-0.51	-0.56	-0.58	-0.58	-0.58	-0.59	-0.59	-0.54	(3,4)
A' *10^6	18.23	19.42	19.75	20.51	20.60	20.59	20.60	18.98	
B' *10^6	46.24	49.55	52.83	55.61	56.22	56.66	57.77	48.61	
C' *10^6	-3.7	2.0	6.3	6.7	7.5	8.6	10.2	-1.4	
sigma1	0.08	-0.04	-0.12	-0.13	-0.14	-0.16	-0.19	0.03	

Information from analysis of earlier tests

A' is (I'z-N'rdot)*(m'-Y'vdot)
B' is -(I'z-N'rdot)*Y'v-(m'-Y'vdot)*N'r
C' is Y'v*N'r-N'v*(Y'r-m')

Non-dimensionalization uses the following quantities:
distance: Lpp
speed: instantaneous speed along track

Table I-2. Stability of JSS Preliminary Design (January 2011 tests) , using “Single-run” analysis

In the above results, the determination of Y_v coefficients appears too high, when compared with the drift test measurements from this session (see Table 10 of the report). In the following table, the stability criteria was recalculated using for all hydrodynamic coefficient an average of the results of the four lowest amplitude motion runs. The design configurations rank the same way, albeit now all configurations show as unstable.

Configuration	JSS2 Ship	JSS2_2	JSS2_R3	JSS2_R2	Ship (Baseline)	(Runs used)
Rudder	design rudder	design rudder	Rudder 3	Rudder 2	design rudder	(runs are numbered in ascending order of amplitude)
Skeg	none			none	none	
shaft speed	ship self-propulsion	ship self-propulsion	ship self-propulsion	ship self-propulsion	ship self-propulsion	
Y'v *1000	-10.23	-10.66	-10.50	-10.80	-9.78	(1-4)
N'r *1000	-2.02	-2.00	-2.11	-2.19	-1.93	(1-4)
Y'r *1000	2.98	3.10	3.18	3.29	2.62	(1-4)
N'v *1000	-4.85	-4.82	-4.69	-4.75	-4.89	(1-4)
Y'vdot *1000	-9.86	-9.53	-9.56	-9.88	-9.05	(1-4)
N'rdot *1000	-0.55	-0.57	-0.54	-0.56	-0.54	(1-4)
A' *10^6=	19.25	19.23	18.78	19.55	18.33	
B' *10^6=	48.46	48.10	49.77	52.49	44.76	
C' *10^6=	-8.3	-6.9	-4.9	-3.2	-12.0	
sigma1 =	0.16	0.14	0.10	0.06	0.24	

A' is (I'z-N'rdot)*(m'-Y'vdot)
B' is -(I'z-N'rdot)*Y'v-(m'-Y'vdot)*N'r
C' is Y'v*N'r-N'v*(Y'r-m')

Non-dimensionalization uses the following quantities:
distance: Lpp
speed: instantaneous speed along track

Table I-3. Stability of JSS Contract Design (and Preliminary Design), using "Single-run" analysis and harmonic runs 1 to 4.

As can be expected, these results are close to those obtained with the "Multiple-Run" harmonic analysis using the four lower amplitude motion runs (Table 11 of the report, bottom part).

APPENDIX J
Comparison of Repeat Runs

Test Name	Carriage Speed	PMM Yaw	Rudder Angle	TEMP	FX	FY	MX	MZ	FX stdev	FY stdev	MX stdev	MZ stdev	1000*X'	1000*Y'	1000*K'	1000*N'	1000*X' stdev	1000*Y' stdev	1000*K' stdev	1000*N' stdev
	[m/s]	[deg]	[deg]	[Celsius]	[N]	[N]	[Nm]	[Nm]	[N]	[N]	[Nm]	[Nm]	[n.d.]	[n.d.]	[n.d.]	[n.d.]	[n.d.]	[n.d.]	[n.d.]	[n.d.]
RUN_016	1.697	0.0	-10.6	18.2	-15.6	-25.7	0.0	90.6	0.3	1.6	0.3	5.4	-0.315	-0.519	0.000	0.311	0.007	0.032	0.001	0.018
RUN_101	1.697	0.0	-10.2	18	-16.2	-28.9	0.6	79.9					-0.326	-0.583	0.002	0.275				
RUN_103	1.697	0.0	-10.0	18	-16.2	-27.4	0.4	84.2					-0.328	-0.554	0.001	0.290				
RUN_018	1.697	0.0	9.2	18.2	-14.5	34.8	-1.6	-86.4	0.7	0.5	0.1	2.6	-0.293	0.703	-0.006	-0.297	0.014	0.010	0.000	0.009
RUN_103	1.697	0.0	10.0	18	-15.5	34.1	-1.4	-90.0					-0.312	0.689	-0.005	-0.310				
RUN_028	1.696	12.0	-10.2	18.2	-30.0	127.6	-28.3	420.3	0.1	2.0	0.7	1.6	-0.606	2.577	-0.097	1.445	0.003	0.040	0.002	0.006
RUN_102	1.696	12.0	-10.2	18	-30.2	130.4	-29.3	418.0					-0.610	2.633	-0.101	1.437				
RUN_028	1.696	12.0	-0.5	18.2	-28.2	161.2	-28.9	319.2	0.3	2.2	0.5	0.2	-0.569	3.254	-0.099	1.098	0.006	0.045	0.002	0.001
RUN_102	1.696	12.0	-0.5	18	-28.6	164.3	-29.6	319.5					-0.578	3.317	-0.102	1.099				
RUN_028	1.696	12.0	9.5	18.2	-31.1	198.9	-30.1	216.7	0.7	2.1	0.2	0.5	-0.628	4.016	-0.103	0.745	0.014	0.042	0.001	0.002
RUN_102	1.696	12.0	9.6	18	-32.1	201.8	-30.4	217.4					-0.647	4.075	-0.105	0.748				

Table J1 Comparison of Repeat Static Runs

Uref= 1.6969 m/s

		RUN_011 VORG0016	RUN_096 VORG0016	STDEV	RUN_004 VORG0024	RUN_095 VORG0024	STDEV
u_0	[m/s]	1.673	1.673		1.697	1.697	
v_a	[m/s]	0.4	0.4		0	0	
r_a	[deg/]	0	0		6.7	6.7	
T	[s]	16	16		14	14	
u'0	[-]	-0.014	-0.014		0	0	
v'0	[-]	0	0		0	0	
v'1	[-]	0.234	0.234		0	0	
r'1	[-]	0	0		0.405	0.405	
v'dot1	[-]	-0.325	-0.325		0	0	
r'dot1	[-]	0	0		-0.628	-0.628	
a0Y	[-]	0.06	-0.02	0.053	0.03	0.01	0.013
a1Y	[-]	-3.54	-3.51	0.020	1.07	1.12	0.032
a2Y	[-]	0.03	-0.01	0.026	-0.01	-0.02	0.013
a3Y	[-]	-0.34	-0.33	0.012	-0.08	-0.07	0.005
a0N	[-]	0.04	-0.01	0.034	0.04	0.03	0.011
a1N	[-]	-1.27	-1.25	0.012	-0.98	-0.97	0.010
a2N	[-]	0.01	0.00	0.006	0.02	0.01	0.003
a3N	[-]	-0.03	-0.02	0.006	-0.07	-0.06	0.004
b1Y	[-]	3.33	3.33	0.007	0.29	0.34	0.040
b1N	[-]	-0.01	-0.01	0.001	0.34	0.37	0.016
a1Y-3a3Y	[-]	-2.51	-2.54	0.018	1.31	1.34	0.018
a1N-3a3N	[-]	-1.18	-1.19	0.005	-0.77	-0.78	0.002

Single run analysis

Y'v	*1000	-10.7	-10.8	0.08			
Y'vdot	*1000	-10.2	-10.3	0.02			
Y'r	*1000				3.2	3.3	0.04
N'v	*1000	-5.1	-5.1	0.02			
N'r	*1000				-1.9	-1.9	0.01
N'rdot	*1000				0.0	0.0	0.00

Table J2 Comparison of Repeat Harmonic Runs