Preliminary report on the results of tests to assess the effect of various model construction techniques on resistance

Pallard, Rob

Publisher's version / Version de l'éditeur:
https://doi.org/10.4224/21277545
Laboratory Memorandum, 2015-07

Laboratory Memorandum
OCRE-LM-2015-001

NRC·CNRC Ocean, Coastal and River Engineering

PRELIMINARY REPORT ON THE RESULTS OF TESTS TO ASSESS THE EFFECT OF VARIOUS MODEL CONSTRUCTION TECHNIQUES ON RESISTANCE

Laboratory Memorandum - Unclassified
OCRE-LM-2015-001

V1.0

Rob Pallard

Location

July 2015

National Research Council Canada | Conseil national de recherches Canada

Canada

National Research Council Canada
Conseil national de recherches Canada

Ocean, Coastal and River Engineering
Génie océanique, côtier et fluvial

PRELIMINARY REPORT ON THE RESULTS OF TESTS TO ASSESS THE EFFECT OF VARIOUS MODEL CONSTRUCTION TECHNIQUES ON RESISTANCE

Laboratory Memorandum
UNCLASSIFIED

LM-2015-001

V1.0

Rob Pallard

July 2015

Abstract or Executive Summary

The preliminary report describes the bare hull resistance experiments carried out on 5 m models of a PANAMAX bulk carrier in January 2015 to assess the effects of proposed changes in model construction techniques on experimental results. Two model options were assessed during this session.
The test results for these two options are compared to the large model originally tested in April 2013. Repeatability tests were done at multiple speeds to estimate the typical uncertainty of a resistance test done in this laboratory.

Table of Contents

Table of Figures

Table of Tables

1 INTRODUCTION

This report describes experiments carried out on two 1:45 scale models of a PANAMAX bulk carrier, designated OCRE930 and OCRE931 in the National Research Council St. John's (NRCSJS) Towing Tank in January 2015. Tests with this bulk carrier were originally done at a scale of 1:31.45 using model OCRE916. The results obtained with model 916, reported in TR-2013-024, form the basis for the comparison of the test results.

This document includes background information on the project, a description of the instrumentation, facility used, test program, data analysis procedure and discussion of the results. It describes the bare hull resistance and repeatability experiments conducted in the Towing Tank between January 8 and January 16, 2015.

2 BACKGROUND

Over the years, a recurring comment from clients is that our model prices seem high, particularly when they are compared with the prices charged at other facilities. For example, during discussions with Garry Cooke and CSL over the cost of the test program for the revisions to the CSL Metis, it was clear that the major stumbling block was the cost of the model. We were informed that NRC was competitive with other facilities with respect to experimental testing, analysis and reporting costs but our model cost was approximately double that of a European tank.

This prompted NRC-DFS to look at options for model construction that might reduce model cost. New procedures could potentially make it easier to do some of the typical modifications to ship models that arise based on the results of model tests. Examples of these modifications include bilge keel alignment, stabilizer fins and cutaways in way of thruster openings. The present model construction technique requires that potential locations for these appendages be locally strengthened prior to final determination of the best location and has a fairly high up-front design cost. Details of the planned construction procedures and estimates of their relative costs can be found in Reference 1

Originally, it was proposed that the optional model construction techniques would be applied to models of the same scale as OCRE916. The cost of these relatively large models prompted the idea of using smaller models to assess the construction techniques. Four meter long models were proposed but the estimated resistance of these models at the median speed of the test program was about 13 N and a compromise was reached that would have 5 m long geosims built with an estimated resistance of about 24 N.

Another concern for this test was the performance of the "frictionless" table based towing gimbals in use at OCRE. Tests done by Muselet, prior to a series of experiments with rowing shells and kayaks, revealed that the performance of the medium towing gimbals in terms of linearity, repeatability and hysteresis was not as good as thought or needed. This prompted the idea of using the R35-I Kempf and Remmers single-component balance normally used with the opens boat to measure duct thrust as an option. These initial tests looked very promising and are described in Reference 2.

3 DESCRIPTION OF THE NRCSJS TOWING TANK

NRCSJS Towing Tank has dimensions of 200 m by 12 m by 7 m. Flexible side absorbers can be deployed along the entire length of the tank to minimize the time between runs. The 85 t tow carriage, capable of speeds up to 10 m/s, is used to accommodate models for a wide range of test types carried out in calm water and waves. A 4,000 kg lift capacity moveable overhead crane is available over half of the tank length.
At the west end of the tank is a dual flap hydraulic wave board capable of generating regular waves up to 1 m. in height and irregular waves with a signification wave height of 0.5 m. Waves are absorbed by a parabolic corrugated surface beach with transverse slats at the east end of the tank.

Additional information on the Towing Tank is provided in Appendix A.

4 DESCRIPTION OF PHYSICAL MODELS

The models are 1:45 scale, nominally 5 m long, representations of a PANAMAX bulk carrier. They were fitted with a lateral bow thruster opening but no provision was made for rudder, or shafting, nor were there any bilge keels fitted to the model. A photo OCRE931 as installed in the towing tank is given in Figure 1.

Model OCRE930 represents the standard OCRE model construction method (option 1) as described in Reference 3. It uses a plywood box construction at its core. High density polystyrene foam is laminated to the box to approximate the shape of the ship. High density epoxy foam, Renshape^{TM}, is used locally for areas requiring reinforcement, like the shafting or bilge keel, or to permit better definition of the shape of the hull in way of a tunnel thruster. The model surface is milled undersize by about 1-1.5 mm depending on the thickness of the fibreglass laminate. It was coated with Duratek high build primer left unsanded for this phase of the test.

Model OCRE931 represents option 3 of the DFS model construction plan [1]. The plug was laminated using a locally produced expanded polystyrene foam, Trufoam^{TM}, without a box structure. The structure of the model consisted simply of two plywood decks. A sprayed on product was intended to produce the finish surface but proved unsuitable for use with the curved and vertical surfaces of a ship model. Two layer of 10 oz fibreglass boat cloth were applied to the plug instead of the “coating” and the model was primed and painted without using the Duratek product.

Turbulence stimulation of the hull was placed in a vertical line 16 cm aft of the forward perpendicular. Turbulence stimulation of the bulb was in a vertical line 5.4 cm forward of the forward perpendicular. Turbulence stimulation consisted of right cylindrical studs, nominally 3 mm in height and diameter spaced at 25 mm intervals along the girth as shown in Figure 2. An eye screw was fitted on centerline at deck level at the transom to permit verification of the resistance measurement system.

The models were tested at the following full scale displacement condition: 83548 m^3 volume displacement, level trim at a draft of 13.5 m full scale. Hydrostatics for the ship and model and details of the Floatation Quality Assurance are given in Appendix B.

5 DESCRIPTION OF INSTRUMENTATION AND DATA ACQUISITION SYSTEM

This section describes the instrumentation and calibration methodology used for each parameter measured on the models. The standard NRCSJS sign convention described in Reference 4 was followed where:

Trim Angle – positive bow up
Sinkage – positive down
Roll Angle – positive starboard down
Tow Force – positive forward

5.1 Standard Resistance Test Instrumentation

Tow force was measured using the K&R R35-I single component balance. Model sinkage and trim was measured using a pair of Celesco PT100 Series cable extension transducers attached to the model nominally at the fore and aft perpendiculars. Static trim was measured using a Shaevitz LSOC gravity-referenced inclinometer. Water temperature was periodically measured manually using a hand-held digital thermometer submerged at the nominal mean draft depth.

The load cells (resistance and verification pull) were calibrated by applying a series of static weights over the desired measuring range. All NRCSJS calibration weights are verified on precision digital scales. At the beginning of the resistance test, a series of in-line loads were applied to the model stern pull point and the output from the resistance load cell compared to a 50 lb S-type load cell attached to the stern pull point to verify that the acceleration stops in the gimbal were not attenuating the measured resistance.

The sinkage (heave) displacement sensors were calibrated using a dedicated apparatus whereby the yoyo potentiometer cable was attached to a flat plate such that the cable could be adjusted in discrete increments a known distance from the sensor.

The Shaevitz inclinometer used to measure pitch (trim) angle was calibrated using a digital inclinometer.

Carriage Speed: Carriage speed is calibrated periodically by setting up two proximity switches on the ice tank rails at a measured distance apart with companion switches on the tow carriage linked by cable to the carriage data acquisition system. The towing carriage is operated at a constant speed between the two switches and the time between activating the switches recorded on the carriage data acquisition system - thus providing an accurate measure of tow carriage speed. The carriage speed is calibrated over a range of -0.5 to 2.5 m/s.

The list of signals is presented in Table 1 and the instrumentation calibration information is given in Appendix C.

Data Acquisition System: All acquired analog DC signals were low pass filtered at 10 Hz, amplified as required and digitized at 50 Hz using NRCSJS's standard data acquisition system and software described in Appendix D.

6 DESCRIPTION OF THE EXPERIMENTAL SET UP

The towing tank was configured as follows for these experiments:

Water Depth: The water depth is fixed at nominally 7 m.

Model Towing Arrangement: The model was towed using the medium tow post and gimbal modified to accept the Kempf and Remmers R35-I single component dynamometer. The model was towed towards the west end of the Towing Tank. A yaw restraint is fitted forward of the tow post.

Pull Point: The pull point apparatus used to carry out daily verification of resistance was installed on the outboard edge at the west end of the tow carriage to enable a standard series of weights could be applied to the gimbal load cell at the beginning and end of every test day during the resistance tests. The applied load was verified using a waterproof in-line load cell.

Wake Suppression Strategy:
Side Beaches described in Reference 5 were deployed along the length of both the north and south side of the tank to suppress the model wake generated wave.

7 DESCRIPTION OF THE TEST PROGRAM

7.1 Bare Hull Resistance

Bare hull resistance experiments were carried out as per the NRCSJS standard resistance procedure (Reference 6) from 9 to 17 knots full scale (0.692 to 1.304 m/s model scale) with repeat runs included for data verification. One of the speed sets was repeated ten times to determine the variability inherent in the measurement system and to develop a better understanding of the uncertainty of the measurement. As all speeds were low, more than one speed could be acquired for each run down the tank. Data was acquired for the displacement condition described in Section 4.0.

Each model was tested on at least three different days. At the conclusion of most test days, the model was removed from the tank. Exceptions are noted in the test log. The resistance and repeatability test plan is given Table 2 and the Run Log for all tests in the Towing Tank can be found in Appendix E.

8 ONLINE DATA ANALYSIS PROCEDURE

An analysis of the preliminary data was carried out on the Tow Tank carriage workstation throughout the test program to verify the integrity of the acquired data. The carriage operator was responsible for viewing the time series data for all acquired data using the SWEET software described in Reference 7. In addition, the following data analysis was carried out during the experiments:

8.1 Bare Hull Resistance

The data were acquired in GDAC format (*.DAQ files) described in References 8 and 9 and preliminary online analysis done using the SWEET software described in Reference 7 during the test to verify the integrity of the acquired data. Because of the Cyber Intrusion, it is not possible to use the OCRE RSP

software for online analysis. The resistance online data analysis was implemented using SWEET and described as follows:

- The basic resistance channels (forward speed, tow force, sinkage AP, sinkage FP and pitch) were plotted on screen in the time domain. Start and end times (T1, T2) were interactively selected for the initial tare segment as well as for each steady state segment. There was more than one steady state segment if more than one forward speed was acquired during a single run up the tank – a common situation for low forward speeds.
- The following three plots are displayed on the same screen:
  - Trim (degrees) vs. Froude Number
  - Sinkage (mm) vs. Froude Number
  - Resistance (N) vs. Froude Number
- Run Designation, Acquire Time, Start and End Times (T1,T2) and mean values of Carriage Speed (m/s), Resistance (N), Sinkage LCB (mm) and Trim (degrees) computed over each steady state time segment were output in tabular form for all runs completed for the given model configuration up to the given run.

The raw test results for the resistance curve and the repeatability tests are given in Tables 3-9.

9 OFFLINE DATA ANALYSIS

The following data analysis was carried out after completion of the experimental program to generate the final data products. Because of the Cyber Intrusion, it was not possible to use the VMS based RSP software to perform the offline analysis. Part of this analysis suite generates the blockage correction that must be applied to the data. Scott's blockage correction method (Reference 10), as implemented in the RSP software, corrects the value of CTM and maintains speed but does not lend itself to easy implementation within a spreadsheet. Since speeds were low, the Scott delta V corrector recommended in ITTC procedure 7.5-02-02-01 (Reference 11) was used to compute blockage correction. All test results were corrected to 15 deg. C in fresh water.

The original model 916 dataset was re-analyzed using the same blockage corrector to provide direct comparison. All comparisons are done on the basis of CTM and Resistance corrected to 15 deg C in fresh water. The resistance of the large model was predicted from the small model results using the ITTC57 method (Reference 12). No form factor was applied.
The tabulated results of this re-analysis are given in Table 10.

The Model Resistance Coefficients corrected to 15 deg. C in fresh water are tabulated for each runs as follows: Froude number (Fr), Reynold's Number (10^6 Re_M), Total Resistance Coefficient (10^{-3} CT_M), and Frictional Resistance Coefficient (10^{-3} CF_M). In addition, the Resistance corrected to 15 deg. C and the ratio of CTM(15) measured with the large model versus CTM(15) predicted using the small model (916/93x) are tabulated and given in Tables 11-17. Statistics for the ten repeat runs are included at the bottom of each table.

Sinkage and Trim are tabulated for each runs as follows: Froude number (Fr), non-dimensional Sinkage at LCB (10^2 Zv/LM), trim (deg) as measured using the inclinometer and derived from the heave

potentiometers (θ_V) and given in Tables 18-24. Statistics for the ten repeat runs are included at the bottom of each table.

10 QUALITY ASSURANCE

The following measures were taken to ensure the integrity of the acquired resistance data:

ONLINE DATA ANALYSIS: The data were analyzed during the test as described in Section 8.1. Any anomalies in the primary resistance channels were identified. Using the technique of plotting the acquired data against a comparison curve, it was possible to detect and address even minor problems immediately. If the data from a given run was found to vary from what was expected by an unacceptable amount, then the run was repeated. If the variance persisted, the test was halted and an investigation carried out to determine the source of the problem.

DAILY PULLS TO CHECK RESISTANCE LOAD CELL: Every effort was made to verify the integrity of the load cell used to measure the resistance load as it was acknowledged that this was the single most critical acquired parameter. The resistance load cell was calibrated prior to the test by suspending a series of known static weights from it. It was then installed in the model tow gimbal balance such that it remains horizontal with respect to the still waterline independent of model attitude. Mechanical stops were adjusted to prevent inertial carriage acceleration/deceleration induced forces from damaging the load cell. A series of in-situ longitudinal loads was applied to the stern of the model using a dedicated drag verification apparatus fitted on the west end of the ice tank for this purpose. An S-type load cell with a waterproof coating was calibrated in a similar manner to the model resistance load cell and attached to the pull point on the model at deck level. A steel wire was connected to the opposite end of this load cell and extended to the drag verification apparatus, which was aligned with the longitudinal centerline of the model. This wire passed over three low friction sheaves vertically up and over the west end of the carriage deck such that weights could be applied using a weight pan on the carriage deck. The height of the post was vertically adjustable to ensure that the applied load was horizontal. The use of an inline load cell at the model stern, while it adds an extra instrument to the process, mitigates the unknown effects of friction in the sheaves. In-situ checks were carried out at the start and end of each test day. The results of these checks are presented in Table 25.

The residual standard deviation was calculated on the basis of correcting the tow force using the slope and offset to the inline pull load cell. The Standard Uncertainty of Calibration (SEE) (Reference 12) was calculated using the uncorrected measured tow force and the measured inline load. This calculation does not account for the uncertainty in the calibration of the inline load cell. Table 26 summarizes the Standard Uncertainty of Calibration calculation for Tow Force and the Inline load cell.

11 DISCUSSION

11.1 Bare Hull Resistance Comparison to Large Model

Resistance Curve

The results for the two resistance curves with OCRE930 and four curves with OCRE 931 were extrapolated to the size of model OCRE916 and presented as Resistance at 15 deg C in fresh water in

Table 27 and shown in Figure 3. These results show that the rough finish on Model OCRE930 for these tests increased the resistance by about 3% and that this increase was consistent across the speed range of the test. The tests with model OCRE931 show more variability particularly during the first day of running with this model. During the resistance curve on the first day, repeatability was poor and prompted a stop during the test to assess the model condition. Turbulence stimulation was still attached to the model and a freeboard check showed that the model had not distorted. The x-pulls done at the start and end of the session compared well. The repeatability set done after the resistance curve did not show the variability observed during the resistance curve. Had this test been done after a period when the tank was idle, tank stratification might have been the cause but this particular test was done on Tuesday and the Monday test with OCRE930 did not show this sort of non-repeatability nor was there more than 0.2 degree difference in water temperature from top to bottom of the towing tank.
The three subsequent curves with OCRE931 were consistent but showed a trend towards decreased resistance with each test.

This trend was also evident in the repeatability series done each day after the resistance curve. This trend is illustrated in Figures 4-6 which show the distribution of the measured resistance at three speeds during the repeatability sets for both models tested in this session. The repeatability plots show that the standard model unfinished performed better than the lightweight Trufoam model but that the difference is quite small.

12 ACKNOWLEDGEMENTS

The author thanks all NRC technical staff that assisted with this project.

13 REFERENCES

1) Randell, T. (2014), "*DFS Ship Model Design and Fabrication Optimization Project",* DRAFT

2) Muselet, C. (2014) "*Assessment of Performance of OCRE Resistance Gimbals*", DRAFT

3) "*Construction of Models of Ships, Offshore Structures, and Propellers*", IOT Standard Test Method GM-1, V10.0, October 18, 2007.

4) "*Model Test Co-ordinate System & Units of Measure*", IOT Standard Test Method GM-5, V6.0, November 29, 2004.

5) Harris, C. J. (1989), "*Use of Side Beaches in the 200m Towing Tank at the Institute for Marine Dynamics*", Proceedings of the 22nd American Towing Tank Conference (ATTC), St. John's, NL.

6) "*Resistance in Open Water*", IOT Standard Test Method TM-1, V7.0, December 12, 2006.

7) Web Site: https://segweb.iot.nrc.ca/trac/sweet

8) Miles, M.D. (1996), "*Test Data File for New GDAC Software*", NRC Institute for Marine Dynamics Software Design Specification, Version 3.0.

9) Miles, M.D. (1996), "*DACON Configuration File for New GDAC Software*", NRC Institute for Marine Dynamics Software Design Specification, Version 3.2.

10) Scott, J.R. (1976), "*Blockage Correction at Sub-Critical Speeds*", Trans. RINA 1976, p. 169

11) Proceedings of 8th ITTC, Madrid, Spain, 1957.

12) "Best Practice Guideline for Uncertainty Analysis in Routine Resistance Tests" ITTC – Recommended Procedures, Procedure 7.5-02-02-02.2, Copenhagen, Denmark, 2014.

TABLES

Table 1: List of Signals

List of Signals

Ch. #	Channel Name	Data Units	Cal Date/Time	Sensor	Calibrated Range		Max Absolute Error	Standard Uncertainty of Calibration (SEE)
					min	max		
2	Carriage Speed	m/s	1/7/2015 17:37	Towing Tank Control System	-0.501	2.502	0.00121	0.00087
3	Carriage Position	m	12/9/2014 14:20	Towing Tank Control System	22.155	149.95	0.01961	0.01517
9	Gimbal Pitch	deg	1/7/2015 14:56	200165 waters WPM pot	-4.77	2.21	0.0556	0.0378
11	Inline load	N	1/7/2015 14:14	9363-D3-50-20P1 50lb S type	0	137.31	0.0695	0.0483
15	Sinkage FP	mm	1/7/2015 17:05	Celesco displacement potentiometer	0	150	0.1575	0.1146
16	Sinkage AP	mm	1/7/2015 17:17	Celesco displacement potentiometer	0	150	0.1721	0.1333
16	Sinkage AP	mm	1/9/2015 18:02	Celesco displacement potentiometer	0	150	0.1369	0.0962
17	Tow Force	N	1/6/2015 17:55	Kempf and Remmers R35-I	0	176.54	0.0697	0.0376
28	Pitch	deg	1/7/2015 15:18	Shaevitz LSOC-14.5 inclinometer	-4.92	6.08	0.0194	0.0125

Table 2: Test Plan

Resistance and Repeatability Test Plan

Ship Length		222.71	m		
Scale		45			
Run	VS [knots]	VS [m/s]	Vm [m/s]	Fr [-]	Comment
1	13	6.688	0.9970	0.143	Roughup - full length
2	13	6.688	0.9970	0.143	Roughup - full length
	9	4.630	0.6902	0.099	Accel. rate =0.1 m/s^2
3	12	6.173	0.9203	0.132	
	15.5	7.974	1.1887	0.171	
	10	5.144	0.7669	0.110	
4	13	6.688	0.9970	0.143	
	14.5	7.459	1.1120	0.160	
5	12.5	6.431	0.9586	0.138	
	17	8.746	1.3037	0.187	
6	14	7.202	1.0736	0.154	
	16.5	8.488	1.2654	0.182	
7	11	5.659	0.8436	0.121	
	16	8.231	1.2270	0.176	
8	13.5	6.945	1.0353	0.149	
	15	7.717	1.1503	0.165	
9	14	7.202	1.0736	0.154	Sched Repeat 1
	16.5	8.488	1.2654	0.182	
10	11	5.659	0.8436	0.121	Sched Repeat 2
	16	8.231	1.2270	0.176	
11-20	9	4.630	0.6902	0.099	
	12	6.173	0.9203	0.132	Repeatability Test 1-10
	15.5	7.974	1.1887	0.171	

Table 3: Resistance Results - Standard - Unpainted - January 8

Results of Resistance Experiments

Model:	OCRE930	Test Date:	8-Jan-2015
Description:	Standard Model	Project:	A1-006518
Condition:	Unpainted		
Tank:	Towing Tank		
Avg. Test Temperature:	15.4 ℃		

Run Designation	Time of Day	T1 (s)	T2 (s)	Carriage Speed (m/s)	Resistance (N)	Sinkage (mm)	Trim (deg)
M1A1_001	17:39:41	47.70	146.68	0.9993	12.518	4.35	-0.0818
M1A1_002	17:54:28	53.49	152.73	0.9993	12.555	4.87	-0.0809
M1A1_003	18:05:12	43.01	76.23	0.6917	6.260	2.00	-0.0374
M1A1_003	18:05:12	88.24	119.93	0.9214	10.798	3.63	-0.0684
M1A1_003	18:05:12	132.46	164.91	1.1906	18.075	6.27	-0.1243
M1A1_004	18:15:34	44.46	75.98	0.6917	6.286	1.82	-0.0373
M1A1_004	18:15:34	87.39	119.93	0.9213	10.849	3.45	-0.0683
M1A1_004	18:15:34	131.69	163.72	1.1906	18.016	6.22	-0.1239
M1A1_005	18:24:53	114.22	147.96	0.6918	6.260	1.62	-0.0375
M1A1_005	18:24:53	158.18	192.93	0.9213	10.816	3.42	-0.0682
M1A1_005	18:24:53	203.67	236.38	1.1906	18.006	6.36	-0.1238
M1A1_006	18:36:56	72.14	106.39	0.6917	6.232	2.06	-0.0373
M1A1_006	18:36:56	115.84	150.34	0.9213	10.779	3.98	-0.0679
M1A1_006	18:36:56	160.82	195.83	1.1906	18.055	6.94	-0.1233
M1A1_007	18:46:38	69.84	104.34	0.6917	6.224	2.08	-0.0377
M1A1_007	18:46:38	117.12	149.83	0.9214	10.772	4.02	-0.0681
M1A1_007	18:46:38	160.82	195.32	1.1907	17.987	6.97	-0.1236
M1A1_008	18:56:40	72.40	105.62	0.6917	6.248	2.19	-0.0377
M1A1_008	18:56:40	117.89	150.09	0.9214	10.835	4.13	-0.0680
M1A1_008	18:56:40	161.33	195.58	1.1907	17.999	6.85	-0.1234
M1A1_009	19:07:09	69.59	104.34	0.6917	6.199	2.16	-0.0376
M1A1_009	19:07:09	118.66	149.07	0.9214	10.854	4.08	-0.0680
M1A1_009	19:07:09	162.36	194.81	1.1907	18.047	6.56	-0.1231
M1A1_010	19:17:38	70.87	105.37	0.6917	6.237	1.96	-0.0375
M1A1_010	19:17:38	117.12	149.58	0.9214	10.822	3.76	-0.0678
M1A1_010	19:17:38	160.06	195.07	1.1907	18.008	6.30	-0.1229
M1A1_011	19:27:24	71.38	105.37	0.6918	6.260	1.76	-0.0377
M1A1_011	19:27:24	117.12	148.30	0.9214	10.769	3.59	-0.0684
M1A1_011	19:27:24	161.59	194.30	1.1907	17.957	6.37	-0.1231
M1A1_012	19:37:34	70.61	104.34	0.6917	6.254	1.91	-0.0374
M1A1_012	19:37:34	116.87	150.09	0.9214	10.825	3.51	-0.0679
M1A1_012	19:37:34	160.82	195.58	1.1907	18.051	6.19	-0.1228

Table 4: Resistance Results - Standard - Unpainted - January 9

Results of Resistance Experiments

Model:	OCRE930	Test Date:	9-Jan-2015
Description:	Standard Model	Project:	A1-006518
Condition:	Unpainted		
Tank:	Towing Tank		
Avg Test Temperature:	15.4 ℃		

Run Designation	Time of Day	T1 (s)	T2 (s)	Carriage Speed (m/s)	Resistance (N)	Sinkage (mm)	Trim (deg)
M1A1_R_001	12:09:02	81.60	183.82	0.9994	12.455	4.12	-0.0819
M1A1_R_002	12:19:30	79.04	185.36	0.9993	12.489	4.21	-0.0817
M1A1_R_003	12:29:02	75.21	104.09	0.6917	6.247	1.55	-0.0380
M1A1_R_003	12:29:02	115.33	148.30	0.9214	10.756	3.47	-0.0688
M1A1_R_003	12:29:02	163.89	194.30	1.1906	17.817	6.37	-0.1232
M1A1_R_004	12:39:35	74.19	103.58	0.7685	7.618	2.38	-0.0472
M1A1_R_004	12:39:35	118.40	147.79	0.9992	12.473	4.60	-0.0817
M1A1_R_004	12:39:35	159.29	189.96	1.1136	15.392	5.84	-0.1045
M1A1_R_005	12:49:33	78.15	117.12	0.9596	11.633	4.17	-0.0756
M1A1_R_005	12:49:33	133.94	172.06	1.3045	24.004	8.25	-0.1522
M1A1_R_006	12:59:44	78.36	117.38	1.0747	14.391	5.60	-0.0968
M1A1_R_006	12:59:44	131.69	169.85	1.2672	21.938	7.83	-0.1402
M1A1_R_007	13:09:23	78.02	119.17	0.8440	9.131	3.26	-0.0573
M1A1_R_007	13:09:23	134.76	178.71	1.2275	19.498	7.34	-0.1316
M1A1_R_008	13:19:17	78.02	118.57	1.0366	13.372	5.16	-0.0890
M1A1_R_008	13:19:17	133.05	176.16	1.1523	16.670	6.40	-0.1122
M1A1_R_009	13:32:50	77.93	115.17	1.0748	14.455	5.33	-0.0967
M1A1_R_009	13:32:50	130.62	167.59	1.2672	22.000	7.62	-0.1405
M1A1_R_010	13:43:17	80.58	120.19	0.8439	9.128	3.31	-0.0569
M1A1_R_010	13:43:17	137.82	178.20	1.2275	19.475	7.38	-0.1320
M1A1_R_011	13:55:22	75.21	105.62	0.6917	6.261	1.83	-0.0379
M1A1_R_011	13:55:22	117.12	149.07	0.9213	10.786	3.52	-0.0688
M1A1_R_011	13:55:22	161.33	195.32	1.1906	17.744	6.25	-0.1233
M1A1_R_012	14:06:09	71.89	104.09	0.6917	6.289	1.80	-0.0378
M1A1_R_012	14:06:09	115.84	149.83	0.9213	10.767	3.76	-0.0686
M1A1_R_012	14:06:09	163.12	194.55	1.1906	17.759	6.43	-0.1227
M1A1_R_013	14:16:25	71.89	105.11	0.6917	6.264	2.09	-0.0377
M1A1_R_013	14:16:25	116.87	149.32	0.9214	10.783	4.02	-0.0682
M1A1_R_013	14:16:25	161.84	194.30	1.1907	17.781	6.73	-0.1228

Run Designation	Time of Day	T1 (s)	T2 (s)	Carriage Speed (m/s)	Resistance (N)	Sinkage (mm)	Trim (deg)
M1A1_R_014	14:27:08	117.63	149.58	0.9213	10.786	4.18	-0.0686
M1A1_R_014	14:27:08	161.84	195.07	1.1906	17.805	6.89	-0.1229
M1A1_R_015	14:36:57	72.14	105.11	0.6917	6.267	1.99	-0.0381
M1A1_R_015	14:36:57	115.84	149.32	0.9213	10.726	4.13	-0.0690
M1A1_R_015	14:36:57	160.31	194.55	1.1906	17.750	6.92	-0.1235
M1A1_R_016	14:47:23	74.96	105.88	0.6917	6.273	2.03	-0.0379
M1A1_R_016	14:47:23	116.10	150.34	0.9214	10.788	4.14	-0.0689
M1A1_R_016	14:47:23	162.36	195.58	1.1906	17.806	6.65	-0.1233
M1A1_R_017	14:57:36	70.61	105.37	0.6917	6.287	2.20	-0.0380
M1A1_R_017	14:57:36	118.66	149.32	0.9214	10.813	3.99	-0.0688
M1A1_R_017	14:57:36	162.87	195.83	1.1906	17.806	6.42	-0.1230
M1A1_R_018	15:07:52	74.70	105.88	0.6917	6.322	1.81	-0.0380
M1A1_R_018	15:07:52	120.44	150.09	0.9213	10.758	3.66	-0.0689
M1A1_R_018	15:07:52	162.10	192.77	1.1906	17.734	6.24	-0.1236
M1A1_R_019	15:20:12	72.40	105.11	0.6917	6.279	2.17	-0.0379
M1A1_R_019	15:20:12	118.66	150.34	0.9214	10.749	4.15	-0.0683
M1A1_R_019	15:20:12	163.38	195.58	1.1906	17.760	6.88	-0.1229
M1A1_R_020	15:29:54	71.12	105.62	0.6917	6.270	2.18	-0.0379
M1A1_R_020	15:29:54	117.63	150.09	0.9214	10.769	4.14	-0.0684
M1A1_R_020	15:29:54	162.10	195.58	1.1906	17.781	6.84	-0.1229

Table 5: Resistance Results - Standard - Unpainted - January 12

Results of Resistance Experiments

Model:	OCRE930	Test Date:	12-Jan-2015
Description:	Standard Model	Project:	A1-006518
Condition:	Unpainted		

Tank: Towing Tank
Avg Test Temperature: 15.4 ℃

Run Designation	Time of Day	T1 (s)	T2 (s)	Carriage Speed (m/s)	Resistance (N)	Sinkage (mm)	Trim (deg)
M1A2_001	14:29:37	87.73	181.52	0.9994	12.510	4.23	-0.0831
M1A2_002	14:39:25	86.46	184.33	0.9993	12.513	4.28	-0.0832
M1A2_003	14:49:24	85.43	184.59	0.9993	12.468	4.46	-0.0829
M1A2_004	14:59:25	72.40	105.11	0.6917	6.171	2.15	-0.0376
M1A2_004	14:59:25	119.17	150.09	0.9214	10.728	4.01	-0.0691
M1A2_004	14:59:25	162.36	195.07	1.1907	17.980	6.70	-0.1251
M1A2_005	15:09:45	72.14	105.88	0.7685	7.627	2.76	-0.0473
M1A2_005	15:09:45	115.33	149.32	0.9993	12.413	4.77	-0.0831
M1A2_005	15:09:45	157.76	191.49	1.1137	15.438	5.94	-0.1066
M1A2_006	15:19:28	72.91	118.06	0.9596	11.581	4.32	-0.0763
M1A2_006	15:19:28	127.43	172.75	1.3046	24.243	8.56	-0.1558
M1A2_007	15:29:25	77.00	117.21	1.0748	14.356	5.45	-0.0980
M1A2_007	15:29:25	127.94	169.51	1.2671	22.215	8.01	-0.1431
M1A2_008	15:39:28	78.28	120.44	0.8439	9.157	3.34	-0.0576
M1A2_008	15:39:28	132.71	179.48	1.2276	19.849	7.36	-0.1342
M1A2_009	15:49:29	76.38	120.17	1.0367	13.432	5.10	-0.0902
M1A2_009	15:49:29	131.90	176.38	1.1523	16.746	6.26	-0.1152
M1A2_010	15:59:09	76.06	116.74	1.0748	14.369	5.48	-0.0984
M1A2_010	15:59:09	126.54	168.49	1.2671	22.300	7.97	-0.1434
M1A2_011	16:11:13	73.59	120.10	0.8441	9.142	2.90	-0.0579
M1A2_011	16:11:13	132.71	180.07	1.2276	19.814	6.87	-0.1343
M1A2_012	16:21:57	72.91	106.13	0.6917	6.198	2.06	-0.0377
M1A2_012	16:21:57	116.10	151.11	0.9214	10.800	4.10	-0.0701
M1A2_012	16:21:57	161.59	195.32	1.1907	17.913	6.83	-0.1251
M1A2_013	16:31:45	72.14	105.37	0.6918	6.269	2.12	-0.0382
M1A2_013	16:31:45	115.59	149.83	0.9214	10.765	4.09	-0.0702
M1A2_013	16:31:45	161.33	195.32	1.1907	17.891	6.90	-0.1256
M1A2_014	16:41:41	72.91	104.34	0.6917	6.257	2.32	-0.0383
M1A2_014	16:41:41	117.12	150.34	0.9214	10.824	4.19	-0.0702
M1A2_014	16:41:41	162.36	195.83	1.1907	17.913	6.82	-0.1252
M1A2_015	16:51:24	70.36	106.39	0.6917	6.248	2.29	-0.0385
M1A2_015	16:51:24	115.33	151.11	0.9214	10.795	4.18	-0.0704

Run Designation	Time of Day	T1 (s)	T2 (s)	Carriage Speed (m/s)	Resistance (N)	Sinkage (mm)	Trim (deg)
M1A2_015	16:51:24	159.80	195.83	1.1907	17.946	6.81	-0.1254
M1A2_016	17:01:33	69.84	106.13	0.6917	6.272	2.27	-0.0385
M1A2_016	17:01:33	114.82	151.11	0.9214	10.833	4.20	-0.0702
M1A2_016	17:01:33	160.57	196.34	1.1907	17.937	6.83	-0.1250
M1A2_017	17:11:40	72.66	105.11	0.6917	6.285	2.29	-0.0389
M1A2_017	17:11:40	117.12	149.83	0.9214	10.790	4.22	-0.0703
M1A2_017	17:11:40	162.36	195.58	1.1907	17.912	6.75	-0.1252
M1A2_018	17:21:30	71.38	106.13	0.6917	6.327	2.31	-0.0387
M1A2_018	17:21:30	116.36	149.58	0.9213	10.838	4.18	-0.0700
M1A2_018	17:21:30	161.84	195.32	1.1906	17.885	6.67	-0.1254
M1A2_019	17:32:12	71.12	105.11	0.6917	6.297	2.34	-0.0383
M1A2_019	17:32:12	115.84	149.83	0.9214	10.815	3.87	-0.0701
M1A2_019	17:32:12	160.82	195.83	1.1907	17.930	6.21	-0.1251
M1A2_020	17:42:21	77.00	106.90	0.6917	6.327	2.02	-0.0386
M1A2_020	17:42:21	117.12	150.34	0.9214	10.815	3.64	-0.0701
M1A2_020	17:42:21	164.91	195.58	1.1907	17.937	6.21	-0.1251
M1A2_021	17:52:34	72.40	105.62	0.6917	6.310	1.96	-0.0384
M1A2_021	17:52:34	117.38	150.60	0.9213	10.852	3.57	-0.0700
M1A2_021	17:52:34	162.36	196.34	1.1907	17.910	6.15	-0.1248

Table 6: Resistance Results - TruFoam - January 13

Results of Resistance Experiments

Model:	OCRE931	Test Date:	13-Jan-2015
Description:	TruFoam Model	Project:	A1-006518
Condition:	Load		

Tank: Towing Tank

Avg Test Temperature: 15.5 ℃

Run Designation	Time of Day	T1 (s)	T2 (s)	Carriage Speed (m/s)	Resistance (N)	Sinkage (mm)	Trim (deg)
M2A1_001	14:45:14	82.34	183.87	0.9994	12.214	4.30	-0.0799
M2A1_002	14:55:23	80.07	185.70	0.9994	12.517	4.46	-0.0794
M2A1_003	15:05:25	75.21	104.60	0.6918	6.317	1.88	-0.0354
M2A1_003	15:05:25	117.38	150.34	0.9215	11.040	3.95	-0.0661
M2A1_003	15:05:25	161.59	194.81	1.1908	18.473	6.69	-0.1211
M2A1_004	15:15:50	73.93	105.11	0.7685	7.768	2.64	-0.0444
M2A1_004	15:15:50	116.36	149.58	0.9994	13.089	4.94	-0.0796
M2A1_004	15:15:50	158.52	190.98	1.1138	16.415	6.00	-0.1023
M2A1_005	15:25:59	74.44	116.70	0.9597	12.506	4.44	-0.0727
M2A1_005	15:25:59	132.54	171.90	1.3047	24.599	8.37	-0.1486
M2A1_006	15:36:06	76.06	116.95	1.0748	14.681	5.55	-0.0942
M2A1_006	15:36:06	128.24	170.62	1.2672	22.032	7.74	-0.1378
M2A1_007	15:46:05	75.47	120.44	0.8440	9.079	3.41	-0.0547
M2A1_007	15:46:05	132.88	178.37	1.2276	19.462	7.26	-0.1294
M2A1_008	15:56:16	82.07	120.69	1.0368	13.367	5.16	-0.0866
M2A1_008	15:56:16	133.66	175.87	1.1524	16.556	6.13	-0.1097
M2A1_009	16:06:32	77.34	116.53	1.0749	14.292	5.53	-0.0941
M2A1_009	16:06:32	127.43	167.81	1.2672	21.260	7.53	-0.1376
M2A1_010	16:16:40	77.00	117.89	0.8440	8.780	3.33	-0.0543
M2A1_010	16:16:40	132.71	177.94	1.2277	18.836	6.82	-0.1291
M2A1_011	16:26:35	74.70	103.83	0.6918	6.072	2.23	-0.0352
M2A1_011	16:26:35	117.38	150.34	0.9214	10.409	3.95	-0.0663
M2A1_011	16:26:35	160.82	195.58	1.1907	17.250	6.21	-0.1195
M2A1_012	16:39:06	72.14	106.13	0.6918	6.050	2.25	-0.0356
M2A1_012	16:39:06	117.89	150.09	0.9214	10.403	4.23	-0.0661
M2A1_012	16:39:06	163.63	195.07	1.1907	17.257	6.91	-0.1195
M2A1_013	16:49:25	74.44	105.62	0.6918	6.103	2.34	-0.0359
M2A1_013	16:49:25	117.63	149.58	0.9214	10.396	4.33	-0.0666
M2A1_013	16:49:25	162.36	195.32	1.1907	17.225	6.77	-0.1197
M2A1_014	16:59:11	74.44	104.86	0.6918	6.095	2.23	-0.0359
M2A1_014	16:59:11	117.38	150.60	0.9214	10.418	4.32	-0.0666

Run Designation	Time of Day	T1 (s)	T2 (s)	Carriage Speed (m/s)	Resistance (N)	Sinkage (mm)	Trim (deg)
M2A1_014	16:59:11	162.87	195.32	1.1907	17.183	6.81	-0.1197
M2A1_015	17:09:11	73.42	105.37	0.6918	6.087	2.24	-0.0358
M2A1_015	17:09:11	116.10	149.32	0.9214	10.430	4.23	-0.0667
M2A1_015	17:09:11	162.10	195.07	1.1908	17.189	6.70	-0.1198
M2A1_016	17:24:38	73.42	104.86	0.6918	6.093	2.23	-0.0358
M2A1_016	17:24:38	117.12	150.34	0.9214	10.452	4.21	-0.0668
M2A1_016	17:24:38	161.08	195.07	1.1907	17.250	6.38	-0.1198
M2A1_017	17:34:15	72.40	102.81	0.6918	6.109	2.26	-0.0359
M2A1_017	17:34:15	117.63	150.60	0.9214	10.453	4.32	-0.0667
M2A1_017	17:34:15	161.59	195.07	1.1908	17.226	6.50	-0.1199
M2A1_018	17:44:55	74.70	105.37	0.6918	6.082	2.18	-0.0361
M2A1_018	17:44:55	116.87	150.09	0.9215	10.422	3.89	-0.0671
M2A1_018	17:44:55	161.33	195.07	1.1907	17.231	6.18	-0.1199
M2A1_019	17:54:23	75.21	105.11	0.6918	6.109	2.31	-0.0361
M2A1_019	17:54:23	117.38	150.09	0.9214	10.452	4.07	-0.0670
M2A1_019	17:54:23	163.63	195.58	1.1908	17.246	6.32	-0.1200
M2A1_020	18:04:25	72.66	103.32	0.6918	6.138	2.28	-0.0362
M2A1_020	18:04:25	116.61	150.09	0.9214	10.434	3.91	-0.0670
M2A1_020	18:04:25	161.59	195.58	1.1907	17.257	6.13	-0.1202

Table 7: Resistance Results - TruFoam - January 14

Results of Resistance Experiments

Model:	OCRE931	Test Date:	14-Jan-2015
Description:	TruFoam Model	Project:	A1-006518
Condition:	Load		

Tank: Towing Tank
Avg Test Temperature: 15.5 ℃

Run Designation	Time of Day	T1 (s)	T2 (s)	Carriage Speed (m/s)	Resistance (N)	Sinkage (mm)	Trim (deg)
M2A2_001	13:10:47	81.43	185.87	0.9994	12.137	4.77	-0.0804
M2A2_002	13:20:20	83.47	184.84	0.9993	12.132	4.95	-0.0808
M2A2_003	13:30:40	73.68	104.86	0.6917	6.194	2.40	-0.0362
M2A2_003	13:30:40	117.38	150.09	0.9214	10.448	4.22	-0.0676
M2A2_003	13:30:40	163.12	196.09	1.1907	17.388	6.67	-0.1220
M2A2_004	13:40:24	75.47	104.86	0.7685	7.451	2.83	-0.0458
M2A2_004	13:40:24	117.38	148.30	0.9993	12.055	4.95	-0.0809
M2A2_004	13:40:24	158.78	191.74	1.1137	14.968	5.72	-0.1033
M2A2_005	13:50:26	76.83	117.04	0.9597	11.255	4.47	-0.0738
M2A2_005	13:50:26	132.71	171.73	1.3046	23.571	8.14	-0.1509
M2A2_006	14:00:33	76.28	117.17	1.0748	13.932	5.39	-0.0956
M2A2_006	14:00:33	128.24	168.92	1.2672	21.523	7.43	-0.1394
M2A2_007	14:11:01	75.47	119.59	0.8440	8.862	3.01	-0.0557
M2A2_007	14:11:01	135.44	178.88	1.2276	19.103	6.63	-0.1305
M2A2_008	14:20:26	76.66	119.93	1.0367	12.972	4.93	-0.0878
M2A2_008	14:20:26	130.84	175.81	1.1524	16.101	5.77	-0.1116
M2A2_009	14:30:54	78.02	116.87	1.0748	13.902	5.16	-0.0952
M2A2_009	14:30:54	126.92	167.64	1.2672	21.450	7.30	-0.1389
M2A2_010	14:40:31	78.87	120.61	0.8439	8.847	2.96	-0.0556
M2A2_010	14:40:31	132.71	178.71	1.2276	19.028	6.63	-0.1302
M2A2_011	14:50:23	77.57	105.94	0.6917	6.159	1.96	-0.0363
M2A2_011	14:50:23	117.90	149.89	0.9214	10.353	3.75	-0.0673
M2A2_011	14:50:23	162.92	195.71	1.1907	17.245	6.42	-0.1212
M2A2_012	15:03:37	73.17	103.83	0.6917	6.119	2.38	-0.0366
M2A2_012	15:03:37	115.59	148.30	0.9214	10.369	4.08	-0.0675
M2A2_012	15:03:37	161.59	194.81	1.1907	17.267	6.32	-0.1215
M2A2_013	15:13:36	73.17	105.37	0.6918	6.134	2.22	-0.0366
M2A2_013	15:13:36	116.10	150.34	0.9214	10.375	3.90	-0.0674
M2A2_013	15:13:36	160.57	195.32	1.1908	17.210	6.31	-0.1217
M2A2_014	15:23:53	71.12	104.86	0.6918	6.139	2.02	-0.0363
M2A2_014	15:23:53	116.36	150.60	0.9214	10.412	3.71	-0.0673

Run Designation	Time of Day	T1 (s)	T2 (s)	Carriage Speed (m/s)	Resistance (N)	Sinkage (mm)	Trim (deg)
M2A2_014	15:23:53	160.31	196.09	1.1907	17.262	6.24	-0.1213
M2A2_015	15:33:36	72.53	101.45	0.6917	6.170	2.08	-0.0365
M2A2_015	15:33:36	116.95	148.85	0.9214	10.412	3.72	-0.0675
M2A2_015	15:33:36	162.27	194.47	1.1907	17.255	6.22	-0.1213
M2A2_016	15:43:54	74.61	103.24	0.6917	6.122	1.70	-0.0369
M2A2_016	15:43:54	118.74	149.75	0.9214	10.395	3.69	-0.0675
M2A2_016	15:43:54	163.46	195.96	1.1907	17.275	6.33	-0.1216
M2A2_017	15:54:44	72.40	103.32	0.6917	6.131	2.33	-0.0363
M2A2_017	15:54:44	117.12	148.56	0.9213	10.369	4.24	-0.0673
M2A2_017	15:54:44	161.08	194.81	1.1907	17.236	6.82	-0.1215
M2A2_018	16:05:20	72.91	103.07	0.6918	6.126	2.41	-0.0365
M2A2_018	16:05:20	115.33	149.32	0.9214	10.338	4.40	-0.0673
M2A2_018	16:05:20	159.03	194.81	1.1908	17.227	6.89	-0.1211
M2A2_019	16:15:21	75.47	105.37	0.6917	6.133	2.38	-0.0366
M2A2_019	16:15:21	117.89	150.09	0.9214	10.360	4.36	-0.0674
M2A2_019	16:15:21	159.54	195.83	1.1907	17.214	6.88	-0.1211
M2A2_020	16:25:23	73.93	105.11	0.6917	6.175	2.30	-0.0363
M2A2_020	16:25:23	115.84	150.60	0.9213	10.356	4.28	-0.0672
M2A2_020	16:25:23	162.36	194.81	1.1907	17.214	6.80	-0.1212

Table 8: Resistance Results - TruFoam - January 15

Results of Resistance Experiments

Model: OCRE931 Test Date: 15-Jan-2015
Description: TruFoam Model Project: A1-006518
Condition: Load

Tank: Towing Tank
Avg Test Temperature: 15.5 ℃

Run Designation	Time of Day	T1 (s)	T2 (s)	Carriage Speed (m/s)	Resistance (N)	Sinkage (mm)	Trim (deg)
M2A3_001	14:31:37	81.26	186.21	0.9994	12.046	4.55	-0.0797
M2A3_002	14:41:11	86.71	185.36	0.9994	12.084	4.64	-0.0799
M2A3_003	14:51:08	73.17	105.11	0.6917	6.114	2.33	-0.0364
M2A3_003	14:51:08	115.08	150.09	0.9214	10.323	4.06	-0.0669
M2A3_003	14:51:08	160.82	194.55	1.1907	17.313	6.33	-0.1211
M2A3_004	15:01:09	75.47	103.58	0.7685	7.385	2.59	-0.0450
M2A3_004	15:01:09	116.87	148.04	0.9994	12.050	4.59	-0.0798
M2A3_004	15:01:09	159.29	190.47	1.1137	14.913	5.31	-0.1022
M2A3_005	15:12:22	76.32	117.21	0.9597	11.205	4.00	-0.0731
M2A3_005	15:12:22	133.22	171.73	1.3046	23.454	7.98	-0.1493
M2A3_006	15:22:20	77.77	117.38	1.0749	13.862	5.21	-0.0946
M2A3_006	15:22:20	131.86	169.34	1.2673	21.223	7.53	-0.1377
M2A3_007	15:32:31	75.64	119.42	0.8440	8.790	3.27	-0.0547
M2A3_007	15:32:31	134.07	179.73	1.2276	18.887	7.24	-0.1291
M2A3_008	15:42:37	76.49	120.79	1.0368	12.902	5.16	-0.0865
M2A3_008	15:42:37	130.84	176.84	1.1524	15.966	6.37	-0.1099
M2A3_009	15:52:10	75.85	115.89	1.0749	13.829	5.47	-0.0944
M2A3_009	15:52:10	126.75	166.79	1.2672	21.159	7.80	-0.1371
M2A3_010	16:02:18	75.81	120.27	0.8440	8.758	3.35	-0.0550
M2A3_010	16:02:18	132.54	178.88	1.2276	18.735	7.35	-0.1292
M2A3_011	16:12:22	71.89	105.37	0.6918	6.092	2.40	-0.0359
M2A3_011	16:12:22	116.10	149.83	0.9215	10.297	4.36	-0.0661
M2A3_011	16:12:22	161.59	194.55	1.1907	17.124	6.85	-0.1196
M2A3_012	16:22:45	73.17	105.88	0.6918	6.091	2.40	-0.0364
M2A3_012	16:22:45	116.61	149.32	0.9215	10.316	4.35	-0.0665
M2A3_012	16:22:45	161.84	195.07	1.1908	17.102	6.65	-0.1197
M2A3_013	16:32:37	72.14	104.60	0.6918	6.115	2.42	-0.0361
M2A3_013	16:32:37	117.63	149.83	0.9214	10.332	4.41	-0.0665
M2A3_013	16:32:37	160.82	195.58	1.1908	17.164	6.63	-0.1197
M2A3_014	16:44:49	73.17	105.62	0.6918	6.091	1.89	-0.0360
M2A3_014	16:44:49	115.84	149.83	0.9215	10.297	3.91	-0.0662

Run Designation	Time of Day	T1 (s)	T2 (s)	Carriage Speed (m/s)	Resistance (N)	Sinkage (mm)	Trim (deg)
M2A3_014	16:44:49	162.61	195.58	1.1907	17.131	6.46	-0.1191
M2A3_015	16:54:59	72.40	105.62	0.6918	6.089	2.11	-0.0361
M2A3_015	16:54:59	116.87	149.32	0.9214	10.348	4.07	-0.0662
M2A3_015	16:54:59	161.08	194.81	1.1907	17.123	6.71	-0.1195
M2A3_016	17:04:22	73.42	105.62	0.6918	6.107	1.91	-0.0361
M2A3_016	17:04:22	115.59	150.34	0.9214	10.311	3.94	-0.0667
M2A3_016	17:04:22	162.10	195.83	1.1907	17.129	6.52	-0.1196
M2A3_017	17:14:47	72.91	105.88	0.6918	6.155	2.30	-0.0361
M2A3_017	17:14:47	116.87	148.81	0.9215	10.323	4.31	-0.0664
M2A3_017	17:14:47	161.59	194.81	1.1907	17.092	6.81	-0.1193
M2A3_018	17:24:53	73.93	105.88	0.6918	6.123	2.29	-0.0360
M2A3_018	17:24:53	118.14	150.09	0.9215	10.303	4.34	-0.0665
M2A3_018	17:24:53	161.84	194.81	1.1908	17.074	6.94	-0.1195
M2A3_019	17:34:24	73.42	106.13	0.6918	6.144	2.27	-0.0362
M2A3_019	17:34:24	117.89	149.58	0.9214	10.370	4.28	-0.0662
M2A3_019	17:34:24	162.61	195.32	1.1907	17.124	6.85	-0.1195
M2A3_020	17:44:21	72.91	105.88	0.6918	6.118	2.29	-0.0364
M2A3_020	17:44:21	116.61	150.34	0.9214	10.323	4.30	-0.0669
M2A3_020	17:44:21	161.08	195.07	1.1908	17.105	6.94	-0.1198

Table 9: Resistance Results - TruFoam - January 16

Results of Resistance Experiments

Model: OCRE931 Test Date: 16-Jan-2015
Description: TruFoam Model Project: A1-006518
Condition: Load

Tank: Towing Tank
Avg Test Temperature: 15.6 ℃

Run Designation	Time of Day	T1 (s)	T2 (s)	Carriage Speed (m/s)	Resistance (N)	Sinkage (mm)	Trim (deg)
M2A4_001	12:18:20	81.86	184.33	0.9994	12.009	4.21	-0.0795
M2A4_002	12:29:21	83.26	184.93	0.9994	11.965	4.48	-0.0789
M2A4_003	12:39:40	72.66	104.60	0.6918	6.033	2.27	-0.0361
M2A4_003	12:39:40	116.61	150.09	0.9214	10.276	4.26	-0.0664
M2A4_003	12:39:40	161.33	195.32	1.1908	17.119	6.79	-0.1195
M2A4_004	12:50:52	71.63	104.34	0.7685	7.327	2.93	-0.0449
M2A4_004	12:50:52	115.84	148.04	0.9994	11.947	5.04	-0.0791
M2A4_004	12:50:52	158.78	189.70	1.1137	14.687	5.62	-0.1011
M2A4_005	12:59:50	74.61	116.19	0.9597	11.186	4.42	-0.0730
M2A4_005	12:59:50	130.16	172.41	1.3047	23.099	8.41	-0.1473
M2A4_006	13:09:49	77.34	117.04	1.0748	13.791	5.60	-0.0942
M2A4_006	13:09:49	129.64	169.51	1.2672	20.870	7.88	-0.1363
M2A4_007	13:19:50	76.23	119.17	0.8440	8.743	3.48	-0.0548
M2A4_007	13:19:50	133.99	178.46	1.2277	18.594	7.27	-0.1282
M2A4_008	13:30:52	77.51	121.21	1.0367	12.873	5.06	-0.0865
M2A4_008	13:30:52	131.43	175.39	1.1524	15.847	5.83	-0.1089
M2A4_009	13:40:27	76.32	116.36	1.0749	13.811	5.52	-0.0943
M2A4_009	13:40:27	125.39	166.27	1.2673	20.923	7.47	-0.1365
M2A4_010	13:50:24	75.98	119.93	0.8440	8.726	3.37	-0.0549
M2A4_010	13:50:24	134.50	179.73	1.2277	18.592	6.77	-0.1282
M2A4_011	14:00:49	72.91	104.60	0.6918	6.085	1.98	-0.0357
M2A4_011	14:00:49	118.14	148.81	0.9215	10.261	3.66	-0.0659
M2A4_011	14:00:49	162.36	195.83	1.1908	16.979	6.13	-0.1182
M2A4_012	14:10:39	72.91	104.60	0.6918	6.051	1.91	-0.0360
M2A4_012	14:10:39	117.89	149.83	0.9215	10.286	3.65	-0.0662
M2A4_012	14:10:39	161.33	194.81	1.1908	16.995	6.13	-0.1184
M2A4_013	14:20:40	74.19	104.86	0.6918	6.078	1.83	-0.0362
M2A4_013	14:20:40	116.61	149.83	0.9214	10.257	3.59	-0.0662
M2A4_013	14:20:40	162.36	194.81	1.1908	16.942	6.21	-0.1186
M2A4_014	14:30:21	73.42	105.88	0.6917	6.081	1.84	-0.0361
M2A4_014	14:30:21	117.12	148.81	0.9215	10.224	3.64	-0.0665

Run Designation	Time of Day	T1 (s)	T2 (s)	Carriage Speed (m/s)	Resistance (N)	Sinkage (mm)	Trim (deg)
M2A4_014	14:30:21	162.10	194.81	1.1908	16.964	6.21	-0.1186
M2A4_015	14:40:13	73.42	105.62	0.6917	6.057	1.76	-0.0362
M2A4_015	14:40:13	117.38	150.09	0.9214	10.259	3.64	-0.0663
M2A4_015	14:40:13	160.57	195.32	1.1907	16.974	6.29	-0.1192
M2A4_016	14:50:19	72.66	105.11	0.6918	6.047	1.89	-0.0359
M2A4_016	14:50:19	116.61	149.83	0.9214	10.225	3.87	-0.0662
M2A4_016	14:50:19	162.61	194.81	1.1908	16.994	6.35	-0.1184
M2A4_017	15:01:23	72.14	105.37	0.6918	6.035	2.36	-0.0359
M2A4_017	15:01:23	116.10	149.58	0.9214	10.249	4.31	-0.0663
M2A4_017	15:01:23	161.84	195.58	1.1907	16.970	6.87	-0.1189
M2A4_018	15:11:47	72.91	105.88	0.6918	6.045	2.29	-0.0361
M2A4_018	15:11:47	117.12	149.83	0.9214	10.233	4.33	-0.0663
M2A4_018	15:11:47	160.82	195.07	1.1908	17.029	6.78	-0.1190
M2A4_019	15:21:06	73.93	105.62	0.6918	6.037	2.35	-0.0358
M2A4_019	15:21:06	117.89	150.09	0.9215	10.253	4.31	-0.0663
M2A4_019	15:21:06	162.36	195.07	1.1908	17.006	6.84	-0.1187
M2A4_020	15:31:27	71.63	105.62	0.6918	6.037	2.26	-0.0359
M2A4_020	15:31:27	117.89	149.83	0.9214	10.239	4.24	-0.0660
M2A4_020	15:31:27	162.61	195.83	1.1907	17.060	6.73	-0.1190

Table 10: Re-analysis of OCRE916 dataset using deltaV corrector

OCRE916
Resistance and CTM15
Re-analyzed using Scott's Delta V Blockage Corrector

Fr [-]	CTM15 [-]	RES15 [N]
0.024	0.004628	0.81
0.042	0.004257	2.72
0.060	0.004103	5.75
0.078	0.004037	9.88
0.099	0.004019	16.23
0.110	0.004037	20.11
0.121	0.003975	23.98
0.132	0.003941	28.27
0.143	0.003931	33.08
0.149	0.003874	35.14
0.154	0.003874	37.78
0.160	0.003891	40.73
0.165	0.003938	44.04
0.171	0.003942	47.14
0.176	0.004076	51.93

Table 11: Model Resistance Coefficients - Standard - Unpainted - January 8

Model Resistance Coefficients

Model:	OCRE930	Test Date:	8-Jan-2015
Description:	Standard Model	Project:	A1-006518
Condition:	Unpainted		
Tank:	Towing Tank		
Avg Test Temperature:	15.4 ℃		

using Scott's delta V Blockage Corrector

Fr	10^{-6} Re_M	10^3 C_{TM15}	10^3 C_{FM15}	Res15 (N)
0.144	4.349	4.348	3.486	12.538
0.144	4.349	4.361	3.486	12.576
0.099	3.010	4.538	3.739	6.271
0.132	4.010	4.412	3.540	10.815
0.171	5.181	4.423	3.374	18.102
0.099	3.010	4.557	3.739	6.296
0.132	4.009	4.434	3.540	10.867
0.171	5.181	4.409	3.374	18.043
0.099	3.010	4.538	3.739	6.270
0.132	4.009	4.420	3.540	10.834
0.171	5.181	4.406	3.374	18.033
0.099	3.010	4.519	3.739	6.243
0.132	4.009	4.405	3.540	10.797
0.171	5.181	4.418	3.374	18.082
0.099	3.010	4.513	3.739	6.235
0.132	4.010	4.402	3.540	10.790
0.171	5.181	4.401	3.374	18.015
0.099	3.010	4.530	3.739	6.259
0.132	4.010	4.427	3.540	10.852
0.171	5.181	4.404	3.374	18.027
0.099	3.010	4.494	3.739	6.209
0.132	4.010	4.435	3.540	10.872
0.171	5.181	4.416	3.374	18.074
0.099	3.010	4.523	3.739	6.248
0.132	4.010	4.422	3.540	10.839
0.171	5.181	4.406	3.374	18.035
0.099	3.010	4.538	3.739	6.271
0.132	4.010	4.400	3.540	10.787
0.171	5.181	4.394	3.374	17.985
0.099	3.010	4.534	3.739	6.265

Fr	10^{-6} Re_M	10^3 C_{TM15}	10^3 C_{FM15}	Res15 (N)
0.132	4.010	4.423	3.540	10.843
0.171	5.181	4.417	3.374	18.079

Statistics for Repeat Runs

Fr		10^3 C_{TM15}	Res15 (N)
0.099	Mean	4.5284	6.257
	StDev	0.0173	0.024
	Min	4.4941	6.209
	Max	4.5571	6.296
0.132	Mean	4.4181	10.830
	StDev	0.0127	0.031
	Min	4.4005	10.787
	Max	4.4352	10.872
0.171	Mean	4.4094	18.048
	StDev	0.0090	0.036
	Min	4.3937	17.985
	Max	4.4230	18.102

Table 12: Model Resistance Coefficients - Standard - Unpainted - January 9

Model Resistance Coefficients

Model:	OCRE930	Test Date:	9-Jan-2015
Description:	Standard Model	Project:	A1-006518
Condition:	Unpainted		
Tank:	Towing Tank		
Avg Test Temperature:	15.4 ℃		

using Scott's delta V Blockage Corrector

Fr	10^{-6} Re_M	10^3 C_{TM15}	10^3 C_{FM15}	Res15 (N)
0.144	4.349	4.326	3.486	12.475
0.144	4.349	4.338	3.486	12.509
0.099	3.010	4.529	3.739	6.258
0.132	4.010	4.395	3.540	10.774
0.171	5.181	4.360	3.374	17.845
0.110	3.344	4.475	3.664	7.630
0.144	4.348	4.334	3.486	12.493
0.160	4.846	4.305	3.416	15.416
0.138	4.176	4.383	3.513	11.652
0.188	5.676	4.893	3.318	24.036
0.154	4.677	4.322	3.439	14.414
0.182	5.514	4.739	3.336	21.969
0.121	3.673	4.447	3.599	9.147
0.176	5.341	4.489	3.356	19.527
0.149	4.511	4.316	3.462	13.394
0.166	5.014	4.355	3.395	16.696
0.155	4.677	4.340	3.439	14.478
0.182	5.514	4.753	3.336	22.031
0.121	3.673	4.446	3.599	9.143
0.176	5.341	4.484	3.356	19.504
0.099	3.010	4.540	3.739	6.272
0.132	4.010	4.408	3.540	10.804
0.171	5.181	4.342	3.374	17.772
0.099	3.010	4.560	3.739	6.300
0.132	4.009	4.400	3.540	10.785
0.171	5.181	4.346	3.374	17.787
0.099	3.010	4.542	3.739	6.275
0.132	4.010	4.406	3.540	10.801
0.171	5.181	4.351	3.374	17.808
0.099	3.010	4.547	3.739	6.282
0.132	4.010	4.408	3.540	10.804
0.171	5.181	4.357	3.374	17.833

Fr	10^{-6} Re_M	10^3 C_{TM15}	10^3 C_{FM15}	Res15 (N)
0.099	3.010	4.544	3.739	6.278
0.132	4.010	4.383	3.540	10.744
0.171	5.181	4.344	3.374	17.777
0.099	3.010	4.548	3.739	6.283
0.132	4.010	4.408	3.540	10.805
0.171	5.181	4.357	3.374	17.834
0.099	3.010	4.558	3.739	6.298
0.132	4.010	4.418	3.540	10.830
0.171	5.181	4.357	3.374	17.833
0.099	3.010	4.584	3.739	6.333
0.132	4.009	4.396	3.540	10.775
0.171	5.181	4.340	3.374	17.761
0.099	3.010	4.552	3.739	6.290
0.132	4.010	4.392	3.540	10.766
0.171	5.181	4.346	3.374	17.787
0.099	3.010	4.546	3.739	6.281
0.132	4.010	4.401	3.540	10.787
0.171	5.181	4.351	3.374	17.809

Statistics for Repeat Runs

Fr		10^3 C_{TM15}	Res15 (N)
0.099	Mean	4.5521	6.289
	StDev	0.0130	0.018
	Min	4.5399	6.272
	Max	4.5840	6.333
0.132	Mean	4.4020	10.790
	StDev	0.0099	0.024
	Min	4.3833	10.744
	Max	4.4184	10.830
0.171	Mean	4.3491	17.800
	StDev	0.0066	0.027
	Min	4.3397	17.761
	Max	4.3573	17.834

Table 13: Model Resistance Coefficients - Standard - Unpainted - January 12

Model Resistance Coefficients

Model:	OCRE930	Test Date:	12-Jan-2015
Description:	Standard Model	Project:	A1-006518
Condition:	Unpainted		
Tank:	Towing Tank		
Avg Test Temperature:	15.4 ℃		

using Scott's delta V Blockage Corrector

Fr	10^{-6} Re_M	10^3 C_{TM15}	10^3 C_{FM15}	Res15 (N)
0.144	4.349	4.345	3.486	12.530
0.144	4.349	4.347	3.486	12.534
0.144	4.349	4.331	3.486	12.488
0.099	3.010	4.474	3.739	6.182
0.132	4.010	4.384	3.540	10.746
0.171	5.181	4.399	3.374	18.007
0.110	3.344	4.481	3.664	7.640
0.144	4.349	4.312	3.486	12.434
0.160	4.847	4.317	3.416	15.462
0.138	4.176	4.363	3.513	11.600
0.188	5.677	4.941	3.318	24.275
0.155	4.677	4.311	3.439	14.379
0.182	5.514	4.800	3.336	22.246
0.121	3.672	4.460	3.599	9.172
0.176	5.342	4.569	3.356	19.878
0.149	4.512	4.335	3.462	13.453
0.166	5.015	4.375	3.395	16.772
0.155	4.677	4.315	3.439	14.392
0.182	5.513	4.818	3.336	22.331
0.121	3.673	4.451	3.599	9.157
0.176	5.342	4.561	3.356	19.842
0.099	3.010	4.494	3.739	6.209
0.132	4.010	4.413	3.540	10.817
0.171	5.181	4.383	3.374	17.941
0.099	3.010	4.544	3.739	6.279
0.132	4.010	4.399	3.540	10.782
0.171	5.181	4.378	3.374	17.918
0.099	3.010	4.536	3.739	6.268
0.132	4.010	4.423	3.540	10.842
0.171	5.181	4.383	3.374	17.940
0.099	3.010	4.530	3.739	6.258
0.132	4.010	4.411	3.540	10.812
0.171	5.181	4.391	3.374	17.973

Fr	10^{-6} Re_M	10^3 C_{TM15}	10^3 C_{FM15}	Res15 (N)
0.099	3.010	4.547	3.739	6.283
0.132	4.010	4.426	3.540	10.851
0.171	5.181	4.389	3.374	17.964
0.099	3.010	4.556	3.739	6.295
0.132	4.010	4.408	3.540	10.807
0.171	5.181	4.383	3.374	17.940
0.099	3.010	4.587	3.739	6.337
0.132	4.009	4.429	3.540	10.855
0.171	5.181	4.377	3.374	17.913
0.099	3.010	4.566	3.739	6.308
0.132	4.010	4.419	3.540	10.832
0.171	5.181	4.387	3.374	17.957
0.099	3.010	4.587	3.739	6.338
0.132	4.010	4.419	3.540	10.832
0.171	5.181	4.389	3.374	17.965
0.099	3.010	4.575	3.739	6.321
0.132	4.009	4.434	3.540	10.869
0.171	5.181	4.382	3.374	17.937

Statistics for Repeat Runs

Fr		10^3 C_{TM15}	Res15 (N)
0.099	Mean	4.5522	6.290
	StDev	0.0287	0.040
	Min	4.4938	6.209
	Max	4.5873	6.338
0.132	Mean	4.4181	10.830
	StDev	0.0107	0.026
	Min	4.3987	10.782
	Max	4.4344	10.869
0.171	Mean	4.3842	17.945
	StDev	0.0048	0.020
	Min	4.3769	17.913
	Max	4.3910	17.973

Table 14: Model Resistance Coefficients - TruFoam - January 13

Model Resistance Coefficients

Model:	OCRE931	Test Date:	13-Jan-2015
Description:	TruFoam Model	Project:	A1-006518
Condition:	Load		
Tank:	Towing Tank		
Avg Test Temperature:	15.5 ℃		

using Scott's delta V Blockage Corrector

Fr	10^{-6} Re_M	10^3 C_{TM15}	10^3 C_{FM15}	Res15 (N)
0.144	4.349	4.2418	3.486	12.234
0.144	4.349	4.3470	3.486	12.537
0.099	3.011	4.5789	3.739	6.328
0.132	4.010	4.5098	3.540	11.058
0.171	5.182	4.5190	3.374	18.501
0.110	3.344	4.5627	3.664	7.781
0.144	4.349	4.5457	3.486	13.110
0.160	4.847	4.5898	3.416	16.439
0.138	4.176	4.7096	3.513	12.525
0.188	5.677	5.0125	3.318	24.631
0.155	4.677	4.4080	3.439	14.704
0.182	5.514	4.7596	3.336	22.063
0.121	3.673	4.4215	3.599	9.094
0.176	5.342	4.4796	3.356	19.491
0.149	4.512	4.3136	3.462	13.388
0.166	5.015	4.3246	3.395	16.582
0.155	4.678	4.2910	3.439	14.315
0.182	5.514	4.5926	3.336	21.290
0.121	3.673	4.2757	3.599	8.795
0.176	5.342	4.3357	3.356	18.865
0.099	3.010	4.4025	3.739	6.083
0.132	4.010	4.2537	3.540	10.427
0.171	5.181	4.2209	3.374	17.278
0.099	3.011	4.3861	3.739	6.061
0.132	4.010	4.2508	3.540	10.421
0.171	5.182	4.2224	3.374	17.285
0.099	3.010	4.4244	3.739	6.113
0.132	4.010	4.2480	3.540	10.414
0.171	5.181	4.2147	3.374	17.253
0.099	3.010	4.4184	3.739	6.105
0.132	4.010	4.2565	3.540	10.435
0.171	5.182	4.2044	3.374	17.211

Fr	10^{-6} Re_M	10^3 C_{TM15}	10^3 C_{FM15}	Res15 (N)
0.099	3.010	4.4125	3.739	6.097
0.132	4.010	4.2614	3.540	10.447
0.171	5.182	4.2052	3.374	17.216
0.099	3.010	4.4167	3.739	6.103
0.132	4.010	4.2708	3.540	10.469
0.171	5.181	4.2210	3.374	17.278
0.099	3.010	4.4295	3.739	6.120
0.132	4.010	4.2709	3.540	10.471
0.171	5.182	4.2145	3.374	17.253
0.099	3.011	4.4093	3.739	6.093
0.132	4.010	4.2578	3.540	10.440
0.171	5.181	4.2160	3.374	17.258
0.099	3.011	4.4287	3.739	6.120
0.132	4.010	4.2703	3.540	10.469
0.171	5.182	4.2195	3.374	17.273
0.099	3.010	4.4496	3.739	6.149
0.132	4.010	4.2633	3.540	10.452
0.171	5.182	4.2223	3.374	17.284

Statistics for Repeat Runs

Fr	10^{-6} Re_M	10^3 C_{TM15}	10^3 C_{FM15}	Res15 (N)
0.099	Mean	4.4178		6.105
	StDev	0.0172		0.024
	Min	4.3861		6.061
	Max	4.4496		6.149
0.132	Mean	4.2604		10.444
	StDev	0.0084		0.021
	Min	4.2480		10.414
	Max	4.2709		10.471
0.171	Mean	4.2161		17.259
	StDev	0.0066		0.027
	Min	4.2044		17.211
	Max	4.2224		17.285

Table 15: Model Resistance Coefficients - TruFoam - January 14

Model Resistance Coefficients

Model:	OCRE931	Test Date:	14-Jan-2015
Description:	TruFoam Model	Project:	A1-006518
Condition:	Load		
Tank:	Towing Tank		
Avg Test Temperature:	15.5 ℃		

using Scott's delta V Blockage Corrector

Fr	10^{-6} Re_M	10^3 C_{TM15}	10^3 C_{FM15}	Res15 (N)
0.144	4.349	4.2154	3.486	12.157
0.144	4.349	4.2143	3.486	12.153
0.099	3.010	4.4909	3.739	6.205
0.132	4.010	4.2693	3.540	10.466
0.171	5.181	4.2546	3.374	17.415
0.110	3.344	4.3771	3.664	7.464
0.144	4.349	4.1875	3.486	12.075
0.160	4.846	4.1864	3.416	14.993
0.138	4.176	4.2392	3.513	11.274
0.188	5.677	4.8039	3.318	23.603
0.155	4.677	4.1832	3.439	13.955
0.182	5.514	4.6496	3.336	21.554
0.121	3.673	4.3162	3.599	8.877
0.176	5.342	4.3976	3.356	19.132
0.149	4.512	4.1866	3.462	12.993
0.166	5.015	4.2062	3.395	16.126
0.155	4.677	4.1749	3.439	13.925
0.182	5.514	4.6342	3.336	21.481
0.121	3.673	4.3092	3.599	8.862
0.176	5.342	4.3803	3.356	19.057
0.099	3.010	4.4657	3.739	6.170
0.132	4.010	4.2306	3.540	10.371
0.171	5.181	4.2197	3.374	17.272
0.099	3.010	4.4366	3.739	6.130
0.132	4.010	4.2372	3.540	10.386
0.171	5.181	4.2251	3.374	17.294
0.099	3.010	4.4469	3.739	6.145
0.132	4.010	4.2394	3.540	10.393
0.171	5.182	4.2107	3.374	17.237

Fr	10^{-6} Re_M	10^3 C_{TM15}	10^3 C_{FM15}	Res15 (N)
0.099	3.010	4.4503	3.739	6.150
0.132	4.010	4.2546	3.540	10.430
0.171	5.181	4.2237	3.374	17.289
0.099	3.010	4.4733	3.739	6.180
0.132	4.010	4.2547	3.540	10.429
0.171	5.181	4.2222	3.374	17.282
0.099	3.010	4.4386	3.739	6.133
0.132	4.010	4.2479	3.540	10.413
0.171	5.181	4.2268	3.374	17.302
0.099	3.010	4.4455	3.739	6.142
0.132	4.009	4.2374	3.540	10.386
0.171	5.181	4.2177	3.374	17.264
0.099	3.011	4.4413	3.739	6.137
0.132	4.010	4.2242	3.540	10.355
0.171	5.182	4.2149	3.374	17.254
0.099	3.010	4.4467	3.739	6.144
0.132	4.010	4.2339	3.540	10.378
0.171	5.181	4.2121	3.374	17.241
0.099	3.010	4.4766	3.739	6.185
0.132	4.009	4.2322	3.540	10.374
0.171	5.181	4.2123	3.374	17.241

Statistics for Repeat Runs

Fr	10^{-6} Re_M	10^3 C_{TM15}	10^3 C_{FM15}	Res15 (N)
0.099	Mean	4.4522		6.152
	StDev	0.0145		0.020
	Min	4.4366		6.130
	Max	4.4766		6.185
0.132	Mean	4.2392		10.391
	StDev	0.0102		0.025
	Min	4.2242		10.355
	Max	4.2547		10.430
0.171	Mean	4.2185		17.268
	StDev	0.0058		0.024
	Min	4.2107		17.237
	Max	4.2268		17.302

Table 16: Model Resistance Coefficients - TruFoam - January 15

Model Resistance Coefficients

Model:	OCRE931	Test Date:	15-Jan-2015
Description:	TruFoam Model	Project:	A1-006518
Condition:	Load		
Tank:	Towing Tank		
Avg Test Temperature:	15.5 ℃		

using Scott's delta V Blockage Corrector

Fr	10^{-6} Re_M	10^3 C_{TM15}	10^3 C_{FM15}	Res15 (N)
0.144	4.349	4.1834	3.486	12.066
0.144	4.349	4.1968	3.486	12.104
0.099	3.010	4.4331	3.739	6.125
0.132	4.010	4.2180	3.540	10.341
0.171	5.181	4.2362	3.374	17.341
0.110	3.344	4.3382	3.664	7.398
0.144	4.349	4.1852	3.486	12.070
0.160	4.847	4.1708	3.416	14.937
0.138	4.176	4.2205	3.513	11.224
0.188	5.677	4.7802	3.318	23.486
0.155	4.678	4.1620	3.439	13.885
0.182	5.514	4.5841	3.336	21.253
0.121	3.673	4.2808	3.599	8.805
0.176	5.342	4.3480	3.356	18.916
0.149	4.512	4.1640	3.462	12.924
0.166	5.015	4.1709	3.395	15.992
0.155	4.678	4.1523	3.439	13.852
0.182	5.514	4.5707	3.336	21.190
0.121	3.673	4.2651	3.599	8.773
0.176	5.342	4.3128	3.356	18.763
0.099	3.010	4.4167	3.739	6.103
0.132	4.010	4.2067	3.540	10.314
0.171	5.182	4.1900	3.374	17.152
0.099	3.010	4.4159	3.739	6.102
0.132	4.010	4.2147	3.540	10.333
0.171	5.182	4.1844	3.374	17.129
0.099	3.010	4.4329	3.739	6.125
0.132	4.010	4.2220	3.540	10.350
0.171	5.182	4.1996	3.374	17.192

Fr	10^{-6} Re_M	10^3 C_{TM15}	10^3 C_{FM15}	Res15 (N)
0.099	3.010	4.4160	3.739	6.102
0.132	4.010	4.2066	3.540	10.314
0.171	5.182	4.1914	3.374	17.158
0.099	3.010	4.4149	3.739	6.100
0.132	4.010	4.2284	3.540	10.366
0.171	5.182	4.1897	3.374	17.151
0.099	3.010	4.4271	3.739	6.118
0.132	4.010	4.2128	3.540	10.328
0.171	5.182	4.1911	3.374	17.156
0.099	3.011	4.4619	3.739	6.166
0.132	4.010	4.2178	3.540	10.341
0.171	5.182	4.1819	3.374	17.119
0.099	3.011	4.4388	3.739	6.134
0.132	4.010	4.2093	3.540	10.321
0.171	5.182	4.1777	3.374	17.102
0.099	3.010	4.4541	3.739	6.155
0.132	4.010	4.2371	3.540	10.387
0.171	5.181	4.1899	3.374	17.151
0.099	3.011	4.4353	3.739	6.129
0.132	4.010	4.2183	3.540	10.341
0.171	5.182	4.1850	3.374	17.133

Statistics for Repeat Runs

Fr	10^{-6} Re_M	10^3 C_{TM15}	10^3 C_{FM15}	Res15 (N)
0.099	Mean	4.4314		6.123
	StDev	0.0167		0.023
	Min	4.4149		6.100
	Max	4.4619		6.166
0.132	Mean	4.2174		10.340
	StDev	0.0098		0.023
	Min	4.2066		10.314
	Max	4.2371		10.387
0.171	Mean	4.1881		17.144
	StDev	0.0061		0.025
	Min	4.1777		17.102
	Max	4.1996		17.192

Table 17: Model Resistance Coefficients - TruFoam - January 16

Model Resistance Coefficients

Model:	OCRE931	Test Date:	16-Jan-2015
Description:	TruFoam Model	Project:	A1-006518
Condition:	Load		
Tank:	Towing Tank		
Avg Test Temperature:	15.6 ℃		

using Scott's delta V Blockage Corrector

Fr	10^{-6} Re_M	10^3 C_{TM15}	10^3 C_{FM15}	Res15 (N)
0.144	4.349	4.1709	3.486	12.030
0.144	4.349	4.1556	3.486	11.985
0.099	3.010	4.3739	3.739	6.044
0.132	4.010	4.1987	3.540	10.293
0.171	5.182	4.1885	3.374	17.147
0.110	3.344	4.3041	3.664	7.340
0.144	4.349	4.1497	3.486	11.968
0.160	4.847	4.1075	3.416	14.712
0.138	4.176	4.2134	3.513	11.205
0.188	5.677	4.7073	3.318	23.131
0.155	4.677	4.1410	3.439	13.814
0.182	5.514	4.5089	3.336	20.900
0.121	3.673	4.2576	3.599	8.758
0.176	5.342	4.2801	3.356	18.623
0.149	4.512	4.1546	3.462	12.894
0.166	5.015	4.1401	3.395	15.873
0.155	4.678	4.1468	3.439	13.834
0.182	5.514	4.5197	3.336	20.953
0.121	3.673	4.2496	3.599	8.742
0.176	5.342	4.2797	3.356	18.621
0.099	3.011	4.4113	3.739	6.096
0.132	4.010	4.1920	3.540	10.278
0.171	5.182	4.1544	3.374	17.007
0.099	3.011	4.3864	3.739	6.062
0.132	4.010	4.2024	3.540	10.304
0.171	5.182	4.1581	3.374	17.023
0.099	3.011	4.4059	3.739	6.089
0.132	4.010	4.1914	3.540	10.275
0.171	5.182	4.1454	3.374	16.970

Fr	10^{-6} Re_M	10^3 C_{TM15}	10^3 C_{FM15}	Res15 (N)
0.099	3.010	4.4090	3.739	6.092
0.132	4.010	4.1771	3.540	10.241
0.171	5.182	4.1507	3.374	16.992
0.099	3.010	4.3911	3.739	6.067
0.132	4.010	4.1917	3.540	10.276
0.171	5.181	4.1534	3.374	17.001
0.099	3.010	4.3840	3.739	6.058
0.132	4.010	4.1780	3.540	10.243
0.171	5.182	4.1581	3.374	17.022
0.099	3.010	4.3751	3.739	6.046
0.132	4.010	4.1877	3.540	10.267
0.171	5.182	4.1523	3.374	16.998
0.099	3.011	4.3819	3.739	6.055
0.132	4.010	4.1815	3.540	10.251
0.171	5.182	4.1664	3.374	17.056
0.099	3.010	4.3768	3.739	6.048
0.132	4.010	4.1886	3.540	10.270
0.171	5.182	4.1605	3.374	17.034
0.099	3.010	4.3770	3.739	6.048
0.132	4.010	4.1841	3.540	10.257
0.171	5.181	4.1744	3.374	17.088

Statistics for Repeat Runs

Fr	10^{-6} Re_M	10^3 C_{TM15}	10^3 C_{FM15}	Res15 (N)
0.099	Mean	4.3899		6.066
	StDev	0.0139		0.019
	Min	4.3751		6.046
	Max	4.4113		6.096
0.132	Mean	4.1874		10.266
	StDev	0.0076		0.019
	Min	4.1771		10.241
	Max	4.2024		10.304
0.171	Mean	4.1574		17.019
	StDev	0.0083		0.034
	Min	4.1454		16.970
	Max	4.1744		17.088

Table 18: Sinkage and Trim - Standard - Unpainted - January 8

Sinkage and Trim

Model:	OCRE930	Test Date:	8-Jan-2015
Description:	Standard Model	Project:	A1-006518
Condition:	Unpainted	Length WL:	4.949 m
		Model Scale:	45
Tank:	Towing Tank		
Avg Test Temperature:	15.4 ℃		

Fr	10^2 Zv/L_M	Inclinometer θ_V (Degrees)	Trim Pots θ_V (Degrees)
0.144	0.088	-0.0819	-0.0818
0.144	0.098	-0.0810	-0.0809
0.099	0.040	-0.0375	-0.0374
0.132	0.073	-0.0684	-0.0684
0.171	0.127	-0.1244	-0.1243
0.099	0.037	-0.0373	-0.0373
0.132	0.070	-0.0684	-0.0683
0.171	0.126	-0.1240	-0.1239
0.099	0.033	-0.0375	-0.0375
0.132	0.069	-0.0683	-0.0682
0.171	0.129	-0.1239	-0.1238
0.099	0.042	-0.0373	-0.0373
0.132	0.080	-0.0680	-0.0679
0.171	0.140	-0.1234	-0.1233
0.099	0.042	-0.0377	-0.0377
0.132	0.081	-0.0682	-0.0681
0.171	0.141	-0.1237	-0.1236
0.099	0.044	-0.0377	-0.0377
0.132	0.083	-0.0681	-0.0680
0.171	0.138	-0.1235	-0.1234
0.099	0.044	-0.0376	-0.0376
0.132	0.082	-0.0681	-0.0680
0.171	0.132	-0.1233	-0.1231
0.099	0.040	-0.0376	-0.0375
0.132	0.076	-0.0678	-0.0678
0.171	0.127	-0.1230	-0.1229
0.099	0.036	-0.0378	-0.0377
0.132	0.072	-0.0684	-0.0684
0.171	0.129	-0.1232	-0.1231
0.099	0.039	-0.0375	-0.0374
0.132	0.071	-0.0679	-0.0679
0.171	0.125	-0.1229	-0.1228

Statistics for Repeat Runs

Fr		10^2 Zv/L_M	θ_V (Degrees)	θ_V (Degrees)
0.099	Mean	0.0395	-0.0376	-0.0375
	StDev	0.0037	0.0002	0.0002
	Min	0.0328	-0.0378	-0.0377
	Max	0.0442	-0.0373	-0.0373
0.132	Mean	0.0759	-0.0682	-0.0681
	StDev	0.0055	0.0002	0.0002
	Min	0.0691	-0.0684	-0.0684
	Max	0.0835	-0.0678	-0.0678
0.171	Mean	0.1314	-0.1235	-0.1234
	StDev	0.0062	0.0005	0.0005
	Min	0.1250	-0.1244	-0.1243
	Max	0.1409	-0.1229	-0.1228

Table 19: Sinkage and Trim - Standard - Unpainted - January 9

Sinkage and Trim

Model:	OCRE930	Test Date:	9-Jan-2015
Description:	Standard Model	Project:	A1-006518
Condition:	Unpainted	Length WL:	4.949 m
		Model Scale:	45
Tank:	Towing Tank		
Avg Test Temperature:	15.4 ℃		

		Inclinometer	Trim Pots
Fr	10^2 Zv/L_M	θ_V (Degrees)	θ_V (Degrees)
0.144	0.083	-0.0820	-0.0819
0.144	0.085	-0.0818	-0.0817
0.099	0.031	-0.0381	-0.0380
0.132	0.070	-0.0689	-0.0688
0.171	0.129	-0.1233	-0.1232
0.110	0.048	-0.0472	-0.0472
0.144	0.093	-0.0817	-0.0817
0.160	0.118	-0.1046	-0.1045
0.138	0.084	-0.0756	-0.0756
0.188	0.167	-0.1523	-0.1522
0.154	0.113	-0.0969	-0.0968
0.182	0.158	-0.1403	-0.1402
0.121	0.066	-0.0574	-0.0573
0.176	0.148	-0.1317	-0.1316
0.149	0.104	-0.0891	-0.0890
0.166	0.129	-0.1123	-0.1122
0.155	0.108	-0.0968	-0.0967
0.182	0.154	-0.1406	-0.1405
0.121	0.067	-0.0570	-0.0569
0.176	0.149	-0.1321	-0.1320
0.099	0.037	-0.0379	-0.0379
0.132	0.071	-0.0688	-0.0688
0.171	0.126	-0.1234	-0.1233
0.099	0.036	-0.0378	-0.0378
0.132	0.076	-0.0686	-0.0686
0.171	0.130	-0.1228	-0.1227
0.099	0.042	-0.0377	-0.0377
0.132	0.081	-0.0682	-0.0682
0.171	0.136	-0.1229	-0.1228

Fr	10^2 Zv/L_M	θ_V (Degrees)	θ_V (Degrees)
0.099	0.041	-0.0381	-0.0381
0.132	0.084	-0.0687	-0.0686
0.171	0.139	-0.1230	-0.1229
0.099	0.040	-0.0381	-0.0381
0.132	0.084	-0.0690	-0.0690
0.171	0.140	-0.1236	-0.1235
0.099	0.041	-0.0379	-0.0379
0.132	0.084	-0.0689	-0.0689
0.171	0.134	-0.1234	-0.1233
0.099	0.044	-0.0380	-0.0380
0.132	0.081	-0.0689	-0.0688
0.171	0.130	-0.1231	-0.1230
0.099	0.037	-0.0381	-0.0380
0.132	0.074	-0.0690	-0.0689
0.171	0.126	-0.1237	-0.1236
0.099	0.044	-0.0379	-0.0379
0.132	0.084	-0.0684	-0.0683
0.171	0.139	-0.1230	-0.1229
0.099	0.044	-0.0379	-0.0379
0.132	0.084	-0.0684	-0.0684
0.171	0.138	-0.1230	-0.1229

Statistics for Repeat Runs

Fr		10^2 Zv/L_M	θ_V (Degrees)	θ_V (Degrees)
0.099	Mean	0.0408	-0.0379	-0.0379
	StDev	0.0031	0.0001	0.0001
	Min	0.0365	-0.0381	-0.0381
	Max	0.0445	-0.0377	-0.0377
0.132	Mean	0.0802	-0.0687	-0.0686
	StDev	0.0048	0.0003	0.0003
	Min	0.0712	-0.0690	-0.0690
	Max	0.0844	-0.0682	-0.0682
0.171	Mean	0.1339	-0.1232	-0.1231
	StDev	0.0054	0.0003	0.0003
	Min	0.1262	-0.1237	-0.1236
	Max	0.1398	-0.1228	-0.1227

Table 20: Sinkage and Trim - Standard - Unpainted - January 12

Sinkage and Trim

Model:	OCRE930	Test Date:	12-Jan-2015
Description:	Standard Model	Project:	A1-006518
Condition:	Unpainted	Length WL:	4.949 m
		Model Scale:	45
Tank:	Towing Tank		
Avg Test Temperature:	15.4 ℃		

		Inclinometer	TrimPots
Fr	10^2 Zv/L_M	θ_V (Degrees)	θ_V (Degrees)
0.144	0.085	-0.0832	-0.0831
0.144	0.086	-0.0833	-0.0832
0.144	0.090	-0.0829	-0.0829
0.099	0.043	-0.0376	-0.0376
0.132	0.081	-0.0692	-0.0691
0.171	0.135	-0.1252	-0.1251
0.110	0.056	-0.0473	-0.0473
0.144	0.096	-0.0831	-0.0831
0.160	0.120	-0.1067	-0.1066
0.138	0.087	-0.0763	-0.0763
0.188	0.173	-0.1559	-0.1558
0.155	0.110	-0.0981	-0.0980
0.182	0.162	-0.1432	-0.1431
0.121	0.068	-0.0576	-0.0576
0.176	0.149	-0.1344	-0.1342
0.149	0.103	-0.0903	-0.0902
0.166	0.126	-0.1153	-0.1152
0.155	0.111	-0.0984	-0.0984
0.182	0.161	-0.1435	-0.1434
0.121	0.059	-0.0580	-0.0579
0.176	0.139	-0.1344	-0.1343
0.099	0.042	-0.0377	-0.0377
0.132	0.083	-0.0701	-0.0701
0.171	0.138	-0.1252	-0.1251
0.099	0.043	-0.0382	-0.0382
0.132	0.083	-0.0703	-0.0702
0.171	0.139	-0.1257	-0.1256
0.099	0.047	-0.0383	-0.0383
0.132	0.085	-0.0703	-0.0702
0.171	0.138	-0.1253	-0.1252

Fr	10^2 Zv/L_M	θ_V (Degrees)	θ_V (Degrees)
0.099	0.046	-0.0386	-0.0385
0.132	0.085	-0.0705	-0.0704
0.171	0.138	-0.1255	-0.1254
0.099	0.046	-0.0385	-0.0385
0.132	0.085	-0.0703	-0.0702
0.171	0.138	-0.1251	-0.1250
0.099	0.046	-0.0389	-0.0389
0.132	0.085	-0.0703	-0.0703
0.171	0.136	-0.1253	-0.1252
0.099	0.047	-0.0387	-0.0387
0.132	0.084	-0.0701	-0.0700
0.171	0.135	-0.1255	-0.1254
0.099	0.047	-0.0383	-0.0383
0.132	0.078	-0.0702	-0.0701
0.171	0.126	-0.1252	-0.1251
0.099	0.041	-0.0386	-0.0386
0.132	0.074	-0.0702	-0.0701
0.171	0.126	-0.1252	-0.1251
0.099	0.040	-0.0384	-0.0384
0.132	0.072	-0.0700	-0.0700
0.171	0.124	-0.1249	-0.1248

Statistics for Repeat Runs

Fr		10^2 Zv/L_M	θ_V (Degrees)	θ_V (Degrees)
0.099	Mean	0.0444	-0.0384	-0.0384
	StDev	0.0029	0.0003	0.0003
	Min	0.0397	-0.0389	-0.0389
	Max	0.0472	-0.0377	-0.0377
0.132	Mean	0.0813	-0.0702	-0.0702
	StDev	0.0049	0.0001	0.0001
	Min	0.0722	-0.0705	-0.0704
	Max	0.0853	-0.0700	-0.0700
0.171	Mean	0.1337	-0.1253	-0.1252
	StDev	0.0061	0.0002	0.0002
	Min	0.1243	-0.1257	-0.1256
	Max	0.1394	-0.1249	-0.1248

Table 21: Sinkage and Trim - TruFoam - January 13

Sinkage and Trim

Model:	OCRE931	Test Date:	13-Jan-2015
Description:	TruFoam Model	Project:	A1-006518
Condition:	Load	Length WL:	4.949 m
		Model Scale:	45
Tank:	Towing Tank		
Avg Test Temperature:	15.5 ℃		

Fr	10^2 Zv/L_M	Inclinometer θ_V (Degrees)	TrimPots θ_V (Degrees)
0.144	0.087	-0.0799	-0.0799
0.144	0.090	-0.0794	-0.0794
0.099	0.038	-0.0354	-0.0354
0.132	0.080	-0.0661	-0.0661
0.171	0.135	-0.1210	-0.1211
0.110	0.053	-0.0444	-0.0444
0.144	0.100	-0.0796	-0.0796
0.160	0.121	-0.1023	-0.1023
0.138	0.090	-0.0727	-0.0727
0.188	0.169	-0.1486	-0.1486
0.155	0.112	-0.0941	-0.0942
0.182	0.156	-0.1378	-0.1378
0.121	0.069	-0.0547	-0.0547
0.176	0.147	-0.1294	-0.1294
0.149	0.104	-0.0865	-0.0866
0.166	0.124	-0.1097	-0.1097
0.155	0.112	-0.0941	-0.0941
0.182	0.152	-0.1376	-0.1376
0.121	0.067	-0.0543	-0.0543
0.176	0.138	-0.1291	-0.1291
0.099	0.045	-0.0351	-0.0352
0.132	0.080	-0.0663	-0.0663
0.171	0.126	-0.1195	-0.1195
0.099	0.045	-0.0356	-0.0356
0.132	0.086	-0.0661	-0.0661
0.171	0.140	-0.1195	-0.1195
0.099	0.047	-0.0359	-0.0359
0.132	0.088	-0.0666	-0.0666
0.171	0.137	-0.1197	-0.1197
0.099	0.045	-0.0359	-0.0359
0.132	0.087	-0.0666	-0.0666
0.171	0.138	-0.1197	-0.1197

Fr	10^2 Zv/L_M	θ_V (Degrees)	θ_V (Degrees)
0.099	0.045	-0.0358	-0.0358
0.132	0.086	-0.0666	-0.0667
0.171	0.135	-0.1198	-0.1198
0.099	0.045	-0.0358	-0.0358
0.132	0.085	-0.0668	-0.0668
0.171	0.129	-0.1198	-0.1198
0.099	0.046	-0.0358	-0.0359
0.132	0.087	-0.0667	-0.0667
0.171	0.131	-0.1199	-0.1199
0.099	0.044	-0.0361	-0.0361
0.132	0.079	-0.0671	-0.0671
0.171	0.125	-0.1199	-0.1199
0.099	0.047	-0.0360	-0.0361
0.132	0.082	-0.0670	-0.0670
0.171	0.128	-0.1200	-0.1200
0.099	0.046	-0.0362	-0.0362
0.132	0.079	-0.0669	-0.0670
0.171	0.124	-0.1202	-0.1202

Statistics for Repeat Runs

Fr		10^2 Zv/L_M	θ_V (Degrees)	θ_V (Degrees)
0.099	Mean	0.0456	-0.0358	-0.0358
	StDev	0.0009	0.0003	0.0003
	Min	0.0441	-0.0362	-0.0362
	Max	0.0473	-0.0351	-0.0352
0.132	Mean	0.0838	-0.0667	-0.0667
	StDev	0.0035	0.0003	0.0003
	Min	0.0786	-0.0671	-0.0671
	Max	0.0876	-0.0661	-0.0661
0.171	Mean	0.1312	-0.1198	-0.1198
	StDev	0.0058	0.0002	0.0002
	Min	0.1239	-0.1202	-0.1202
	Max	0.1396	-0.1195	-0.1195

Table 22: Sinkage and Trim - TruFoam - January 14

Sinkage and Trim

Model:	OCRE931	Test Date:	14-Jan-2015
Description:	TruFoam Model	Project:	A1-006518
Condition:	Load	Length WL:	4.949 m
		Model Scale:	45
Tank:	Towing Tank		
Avg Test Temperature:	15.5 ℃		

		Inclinometer	TrimPots
Fr	10^2 Zv/L_M	θ_V (Degrees)	θ_V (Degrees)
0.144	0.096	-0.0804	-0.0804
0.144	0.100	-0.0808	-0.0808
0.099	0.048	-0.0362	-0.0362
0.132	0.085	-0.0676	-0.0676
0.171	0.135	-0.1220	-0.1220
0.110	0.057	-0.0458	-0.0458
0.144	0.100	-0.0808	-0.0809
0.160	0.116	-0.1033	-0.1033
0.138	0.090	-0.0738	-0.0738
0.188	0.164	-0.1508	-0.1509
0.155	0.109	-0.0956	-0.0956
0.182	0.150	-0.1394	-0.1394
0.121	0.061	-0.0557	-0.0557
0.176	0.134	-0.1305	-0.1305
0.149	0.100	-0.0878	-0.0878
0.166	0.117	-0.1116	-0.1116
0.155	0.104	-0.0952	-0.0952
0.182	0.148	-0.1389	-0.1389
0.121	0.060	-0.0555	-0.0556
0.176	0.134	-0.1302	-0.1302
0.099	0.040	-0.0363	-0.0363
0.132	0.076	-0.0673	-0.0673
0.171	0.130	-0.1212	-0.1212
0.099	0.048	-0.0366	-0.0366
0.132	0.082	-0.0675	-0.0675
0.171	0.128	-0.1215	-0.1215
0.099	0.045	-0.0366	-0.0366
0.132	0.079	-0.0674	-0.0674
0.171	0.127	-0.1217	-0.1217

Fr	10^2 Zv/L_M	θ_V (Degrees)	θ_V (Degrees)
0.099	0.041	-0.0363	-0.0363
0.132	0.075	-0.0673	-0.0673
0.171	0.126	-0.1213	-0.1213
0.099	0.042	-0.0364	-0.0365
0.132	0.075	-0.0674	-0.0675
0.171	0.126	-0.1213	-0.1213
0.099	0.034	-0.0369	-0.0369
0.132	0.074	-0.0675	-0.0675
0.171	0.128	-0.1216	-0.1216
0.099	0.047	-0.0363	-0.0363
0.132	0.086	-0.0673	-0.0673
0.171	0.138	-0.1215	-0.1215
0.099	0.049	-0.0365	-0.0365
0.132	0.089	-0.0673	-0.0673
0.171	0.139	-0.1211	-0.1211
0.099	0.048	-0.0365	-0.0366
0.132	0.088	-0.0673	-0.0674
0.171	0.139	-0.1211	-0.1211
0.099	0.047	-0.0363	-0.0363
0.132	0.087	-0.0672	-0.0672
0.171	0.137	-0.1212	-0.1212

Statistics for Repeat Runs

Fr		10^2 Zv/L_M	θ_V (Degrees)	θ_V (Degrees)
0.099	Mean	0.0440	-0.0365	-0.0365
	StDev	0.0047	0.0002	0.0002
	Min	0.0343	-0.0369	-0.0369
	Max	0.0487	-0.0363	-0.0363
0.132	Mean	0.0811	-0.0674	-0.0674
	StDev	0.0059	0.0001	0.0001
	Min	0.0745	-0.0675	-0.0675
	Max	0.0890	-0.0672	-0.0672
0.171	Mean	0.1318	-0.1213	-0.1214
	StDev	0.0058	0.0002	0.0002
	Min	0.1257	-0.1217	-0.1217
	Max	0.1392	-0.1211	-0.1211

Table 23: Sinkage and Trim - TruFoam - January 15

Sinkage and Trim

Model:	OCRE931	Test Date:	15-Jan-2015
Description:	TruFoam Model	Project:	A1-006518
Condition:	Load	Length WL:	4.949 m
		Model Scale:	45
Tank:	Towing Tank		
Avg Test Temperature:	15.5 ℃		

		Inclinometer	TrimPots
Fr	10^2 Zv/L_M	θ_V (Degrees)	θ_V (Degrees)
0.144	0.092	-0.0797	-0.0797
0.144	0.094	-0.0799	-0.0799
0.099	0.047	-0.0364	-0.0364
0.132	0.082	-0.0669	-0.0669
0.171	0.128	-0.1211	-0.1211
0.110	0.052	-0.0449	-0.0450
0.144	0.093	-0.0798	-0.0798
0.160	0.107	-0.1022	-0.1022
0.138	0.081	-0.0731	-0.0731
0.188	0.161	-0.1493	-0.1493
0.155	0.105	-0.0946	-0.0946
0.182	0.152	-0.1377	-0.1377
0.121	0.066	-0.0547	-0.0547
0.176	0.146	-0.1291	-0.1291
0.149	0.104	-0.0864	-0.0865
0.166	0.129	-0.1099	-0.1099
0.155	0.111	-0.0944	-0.0944
0.182	0.158	-0.1370	-0.1371
0.121	0.068	-0.0550	-0.0550
0.176	0.149	-0.1292	-0.1292
0.099	0.048	-0.0359	-0.0359
0.132	0.088	-0.0661	-0.0661
0.171	0.138	-0.1196	-0.1196
0.099	0.048	-0.0364	-0.0364
0.132	0.088	-0.0665	-0.0665
0.171	0.134	-0.1197	-0.1197
0.099	0.049	-0.0361	-0.0361
0.132	0.089	-0.0665	-0.0665
0.171	0.134	-0.1197	-0.1197
0.099	0.038	-0.0360	-0.0360
0.132	0.079	-0.0662	-0.0662
0.171	0.131	-0.1191	-0.1191
Fr	10^2 Zv/L_M	θ_V (Degrees)	θ_V (Degrees)

0.099	0.043	-0.0361	-0.0361
0.132	0.082	-0.0662	-0.0662
0.171	0.136	-0.1195	-0.1195
0.099	0.039	-0.0361	-0.0361
0.132	0.080	-0.0667	-0.0667
0.171	0.132	-0.1196	-0.1196
0.099	0.046	-0.0361	-0.0361
0.132	0.087	-0.0664	-0.0664
0.171	0.138	-0.1192	-0.1193
0.099	0.046	-0.0360	-0.0360
0.132	0.088	-0.0665	-0.0665
0.171	0.140	-0.1195	-0.1195
0.099	0.046	-0.0362	-0.0362
0.132	0.087	-0.0661	-0.0662
0.171	0.138	-0.1195	-0.1195
0.099	0.046	-0.0364	-0.0364
0.132	0.087	-0.0669	-0.0669
0.171	0.140	-0.1198	-0.1198

Statistics for Repeat Runs

Fr		10^2 Zv/L_M	θ_V (Degrees)	θ_V (Degrees)
0.099	Mean	0.0450	-0.0361	-0.0361
	StDev	0.0039	0.0002	0.0002
	Min	0.0381	-0.0364	-0.0364
	Max	0.0489	-0.0359	-0.0359
0.132	Mean	0.0854	-0.0664	-0.0664
	StDev	0.0037	0.0002	0.0002
	Min	0.0790	-0.0669	-0.0669
	Max	0.0891	-0.0661	-0.0661
0.171	Mean	0.1361	-0.1195	-0.1195
	StDev	0.0034	0.0002	0.0002
	Min	0.1306	-0.1198	-0.1198
	Max	0.1402	-0.1191	-0.1191

Table 24: Sinkage and Trim - TruFoam - January 16

Sinkage and Trim

Model:	OCRE931	Test Date:	16-Jan-2015
Description:	TruFoam Model	Project:	A1-006518
Condition:	Load	Length WL:	4.949 m
		Model Scale:	45
Tank:	Towing Tank		
Avg Test Temperature:	15.6 ℃		

		Inclinometer	TrimPots
Fr	10^2 Zv/L_M	θ_V (Degrees)	θ_V (Degrees)
0.144	0.085	-0.0795	-0.0795
0.144	0.091	-0.0789	-0.0789
0.099	0.046	-0.0361	-0.0361
0.132	0.086	-0.0663	-0.0664
0.171	0.137	-0.1194	-0.1195
0.110	0.059	-0.0448	-0.0449
0.144	0.102	-0.0791	-0.0791
0.160	0.114	-0.1010	-0.1011
0.138	0.089	-0.0730	-0.0730
0.188	0.170	-0.1473	-0.1473
0.155	0.113	-0.0942	-0.0942
0.182	0.159	-0.1363	-0.1363
0.121	0.070	-0.0548	-0.0548
0.176	0.147	-0.1282	-0.1282
0.149	0.102	-0.0865	-0.0865
0.166	0.118	-0.1089	-0.1089
0.155	0.112	-0.0943	-0.0943
0.182	0.151	-0.1365	-0.1365
0.121	0.068	-0.0549	-0.0549
0.176	0.137	-0.1282	-0.1282
0.099	0.040	-0.0357	-0.0357
0.132	0.074	-0.0658	-0.0659
0.171	0.124	-0.1182	-0.1182
0.099	0.039	-0.0360	-0.0360
0.132	0.074	-0.0662	-0.0662
0.171	0.124	-0.1183	-0.1184
0.099	0.037	-0.0362	-0.0362
0.132	0.073	-0.0662	-0.0662
0.171	0.125	-0.1186	-0.1186

Fr	10^2 Zv/L_M	θ_V (Degrees)	θ_V (Degrees)
0.099	0.037	-0.0361	-0.0361
0.132	0.074	-0.0664	-0.0665
0.171	0.126	-0.1186	-0.1186
0.099	0.036	-0.0362	-0.0362
0.132	0.074	-0.0663	-0.0663
0.171	0.127	-0.1192	-0.1192
0.099	0.038	-0.0359	-0.0359
0.132	0.078	-0.0661	-0.0662
0.171	0.128	-0.1184	-0.1184
0.099	0.048	-0.0359	-0.0359
0.132	0.087	-0.0663	-0.0663
0.171	0.139	-0.1189	-0.1189
0.099	0.046	-0.0361	-0.0361
0.132	0.087	-0.0663	-0.0663
0.171	0.137	-0.1190	-0.1190
0.099	0.048	-0.0358	-0.0358
0.132	0.087	-0.0663	-0.0663
0.171	0.138	-0.1187	-0.1187
0.099	0.046	-0.0359	-0.0359
0.132	0.086	-0.0660	-0.0660
0.171	0.136	-0.1190	-0.1190

Statistics for Repeat Runs

Fr		10^2 Zv/L_M	θ_V (Degrees)	θ_V (Degrees)
0.099	Mean	0.0414	-0.0360	-0.0360
	StDev	0.0048	0.0002	0.0002
	Min	0.0356	-0.0362	-0.0362
	Max	0.0477	-0.0357	-0.0357
0.132	Mean	0.0793	-0.0662	-0.0662
	StDev	0.0067	0.0002	0.0002
	Min	0.0725	-0.0664	-0.0665
	Max	0.0875	-0.0658	-0.0659
0.171	Mean	0.1304	-0.1187	-0.1187
	StDev	0.0063	0.0003	0.0003
	Min	0.1238	-0.1192	-0.1192
	Max	0.1388	-0.1182	-0.1182

Table 25: Summary of Balance Verification Tests

Summary of X-pull Checks

Test	Acquire Date/Time	Slope	Intercept	R^2	Residual SD [N]	SEE [N]	n	Chauvenet
XPULL_001	1/8/2015 17:10	1.00120	-0.0604	1.000	0.0122	0.0588	11	0.20
XPULL_002	1/8/2015 19:49	1.00191	-0.0694	1.000	0.0239	0.0406	11	1.05
XPULL_003	1/9/2015 11:37	1.00232	-0.0291	1.000	0.0154	0.0325	11	1.43
XPULL_004	1/9/2015 15:44	1.00220	-0.0132	1.000	0.0085	0.0457	8	0.81
XPULL_005	1/9/2015 15:57	1.00267	-0.0276	1.000	0.0137	0.0488	11	0.67
XPULL_006	1/12/2015 14:02	0.99984	-0.0499	1.000	0.0135	0.0569	11	0.29
X_PULL_007	1/12/2015 18:06	1.00013	-0.0924	1.000	0.0162	0.0907	11	1.30
X_PULL_008	1/13/2015 14:11	0.99830	-0.0195	1.000	0.0195	0.0628	10	0.01
XPULL_009	1/13/2015 18:21	0.99867	-0.0194	1.000	0.0250	0.0566	10	0.30
XPULL_010	1/14/2015 12:44	0.99894	-0.0001	1.000	0.0174	0.0310	10	1.50
XPULL_011	1/14/2015 16:41	1.00246	0.0300	1.000	0.0209	0.0902	10	1.28
XPULL_012	1/15/2015 14:00	0.99826	-0.0337	1.000	0.0200	0.0774	10	0.68
XPULL_013	1/15/2015 18:00	0.99840	-0.0373	1.000	0.0208	0.0780	10	0.71
XPULL_014	1/16/2015 11:52	0.99821	-0.0337	1.000	0.0174	0.0781	10	0.71
XPULL_015	1/16/2015 15:47	0.99782	-0.0424	1.000	0.0262	0.0963	12	1.57
	mean	1.00009	-0.03321			0.0630		
	stdev	0.00185	0.02910			0.0213		
	min	0.99782	-0.09239			0.0310		
	max	1.00267	0.02997			0.0963		

Table 26: Standard Uncertainty of Calibration

Standard Uncertainty of Calibration (SEE)

Inline Load Cell	SEE	TowForce	SEE	
	0.0483	N	**0.0363**	N
Residual		Residual		
0.0539	0.0029	0.0545	0.0030	
0.0061	0.0000	0.0105	0.0001	
-0.0525	0.0028	-0.0390	0.0015	
-0.0695	0.0048	-0.0697	0.0049	
0.0566	0.0032	-0.0090	0.0001	
0.0137	0.0002	0.0465	0.0022	
-0.0084	0.0001	0.0113	0.0001	
		0.0055	0.0000	
		0.0013	0.0000	
		-0.0019	0.0000	
SEE for system $u_2(R_T)$	**0.0604**	**N**		

Table 27: Summary of Prediction of Large Model Resistance

								Mean	2.8%	2.9%	3.4%	-0.7%	-1.6%	-2.8%
								StDev	0.5%	0.7%	3.0%	0.8%	0.7%	0.8%
		Test Date	9-jan	12-jan	13-jan	14-jan	15-jan	16-jan						
		916	930-1	930-2	931-1	931-2	931-3	931-4	930-1	930-2	931-1	931-2	931-3	931-4
VS	Fr	Actual	Pred	Pred	Pred	Pred	Pred	Pred	Pred	Pred	Pred	Pred	Pred	Pred
9	0.099	**16.14**	16.77	16.56	16.43	16.50	16.26	16.06	3.9%	2.6%	1.8%	2.3%	0.8%	-0.5%
9.25	0.102	**17.11**	17.65	17.51	17.63	17.30	17.09	16.86	3.1%	2.3%	3.0%	1.1%	-0.2%	-1.5%
9.5	0.105	**18.09**	18.55	18.48	18.76	18.13	17.93	17.69	2.6%	2.2%	3.8%	0.2%	-0.8%	-2.2%
9.75	0.107	**19.06**	19.49	19.47	19.82	18.99	18.80	18.55	2.3%	2.2%	4.0%	-0.3%	-1.3%	-2.7%
10	0.110	**20.02**	20.46	20.48	20.81	19.89	19.69	19.43	2.2%	2.3%	3.9%	-0.7%	-1.7%	-3.0%
10.25	0.113	**20.98**	21.46	21.51	21.68	20.82	20.61	20.35	2.3%	2.5%	3.3%	-0.8%	-1.8%	-3.0%
10.5	0.116	**21.92**	22.50	22.56	22.40	21.78	21.55	21.29	2.6%	2.9%	2.2%	-0.6%	-1.7%	-2.9%
10.75	0.118	**22.88**	23.56	23.62	23.11	22.78	22.51	22.27	3.0%	3.3%	1.0%	-0.4%	-1.6%	-2.7%
11	0.121	**23.86**	24.64	24.69	23.95	23.78	23.49	23.26	3.2%	3.5%	0.3%	-0.4%	-1.6%	-2.5%
11.25	0.124	**24.89**	25.72	25.77	24.89	24.78	24.47	24.24	3.3%	3.5%	0.0%	-0.5%	-1.7%	-2.6%
11.5	0.127	**25.94**	26.81	26.85	25.82	25.77	25.45	25.21	3.3%	3.5%	-0.5%	-0.7%	-1.9%	-2.8%
11.75	0.129	**27.03**	27.92	27.94	26.96	26.79	26.47	26.22	3.3%	3.4%	-0.2%	-0.9%	-2.1%	-3.0%
12	0.132	**28.15**	29.06	29.04	28.55	27.87	27.56	27.29	3.2%	3.2%	1.5%	-1.0%	-2.1%	-3.0%
12.25	0.135	**29.32**	30.24	30.16	30.96	29.04	28.75	28.50	3.1%	2.8%	5.6%	-1.0%	-1.9%	-2.8%
12.5	0.138	**30.56**	31.42	31.27	33.62	30.23	30.00	29.79	2.8%	2.3%	10.0%	-1.1%	-1.8%	-2.5%
12.75	0.140	**31.80**	32.52	32.32	34.98	31.26	31.14	30.88	2.3%	1.7%	10.0%	-1.7%	-2.1%	-2.9%
13	0.143	**32.96**	33.61	33.41	35.49	32.24	32.22	31.80	2.0%	1.4%	7.7%	-2.2%	-2.3%	-3.5%
13.25	0.146	**33.99**	34.81	34.78	35.83	33.46	33.36	32.94	2.4%	2.3%	5.4%	-1.6%	-1.8%	-3.1%
13.5	0.149	**35.03**	36.09	36.26	36.07	34.82	34.56	34.26	3.0%	3.5%	3.0%	-0.6%	-1.4%	-2.2%
13.75	0.151	**36.28**	37.52	37.56	37.10	36.13	35.80	35.56	3.4%	3.5%	2.3%	-0.4%	-1.3%	-2.0%
14	0.154	**37.65**	38.99	38.82	38.78	37.42	37.10	36.83	3.6%	3.1%	3.0%	-0.6%	-1.4%	-2.2%
14.25	0.157	**39.06**	40.28	40.20	41.30	38.75	38.50	38.02	3.1%	2.9%	5.7%	-0.8%	-1.4%	-2.6%
14.5	0.160	**40.55**	41.58	41.69	44.22	40.12	39.96	39.16	2.5%	2.8%	9.0%	-1.1%	-1.5%	-3.4%
14.75	0.162	**42.22**	43.25	43.42	45.17	41.64	41.37	40.53	2.4%	2.8%	7.0%	-1.4%	-2.0%	-4.0%
15	0.165	**43.93**	45.06	45.27	44.88	43.27	42.78	42.15	2.6%	3.0%	2.2%	-1.5%	-2.6%	-4.1%
15.25	0.168	**45.37**	46.56	46.85	45.96	44.82	44.36	43.75	2.6%	3.3%	1.3%	-1.2%	-2.2%	-3.6%
15.5	0.171	**46.92**	48.07	48.51	47.97	46.44	46.09	45.35	2.5%	3.4%	2.2%	-1.0%	-1.8%	-3.3%
15.75	0.173	**49.04**	50.23	50.94	49.74	48.67	48.13	47.24	2.4%	3.9%	1.4%	-0.7%	-1.9%	-3.7%
16	0.176	**51.61**	52.89	53.87	51.55	51.40	50.48	49.45	2.5%	4.4%	-0.1%	-0.4%	-2.2%	-4.2%

Table 28: Summary of Repeatability Tests

Model Construction Technique Evaluation

Standard Model - Unpainted/unsanded Duratek Finish

M1A Summary

		8-Jan-15	9-Jan-15	12-Jan-15					
Day		1	2	3		$u_A(R_T)$			
Speed	Fr	RTm (N)	RTm (N)	RTm (N)	Mean	StDev	Range	Range /Mean	samples
1	0.1	6.25	6.28	6.28	6.270	0.019	0.129	2.10%	32
2	0.13	10.81	10.77	10.81	10.800	0.023	0.128	1.20%	32
3	0.17	18.02	17.77	17.92	17.900	0.124	0.341	1.90%	32

TruFoam Model

M2 Summary

		13-Jan-15	14-Jan-15	15-Jan-15	16-Jan-15					
Day		1	2	3	4		$u_A(R_T)$			
Speed	Fr	RTm (N)	RTm (N)	RTm (N)	RTm (N)	Mean	StDev	Range	Range/Mean	samples
1	0.10	6.11	6.15	6.14	6.08	6.117	0.052	0.285	4.7%	44
2	0.13	10.48	10.38	10.32	10.25	10.377	0.126	0.817	7.9%	44
3	0.17	17.34	17.25	17.13	17.00	17.211	0.227	1.531	8.9%	44

M2 Summary - Discard Day 1

		13-Jan-15	14-Jan-15	15-Jan-15	16-Jan-15					
Day		1	2	3	4		$u_A(R_T)$			
Speed	Fr	RTm (N)	RTm (N)	RTm (N)	RTm (N)	Mean	StDev	Range	Range/Mean	samples
1	0.10		6.15	6.14	6.08	6.115	0.044	0.161	2.6%	33
2	0.13		10.38	10.32	10.25	10.336	0.059	0.224	2.2%	33
3	0.17		17.25	17.13	17.00	17.158	0.117	0.446	2.6%	33

Values reported above are the means of the 10 or 11 repeats done in each setup

mean/stdev of all runs

max-min of all runs

FIGURES

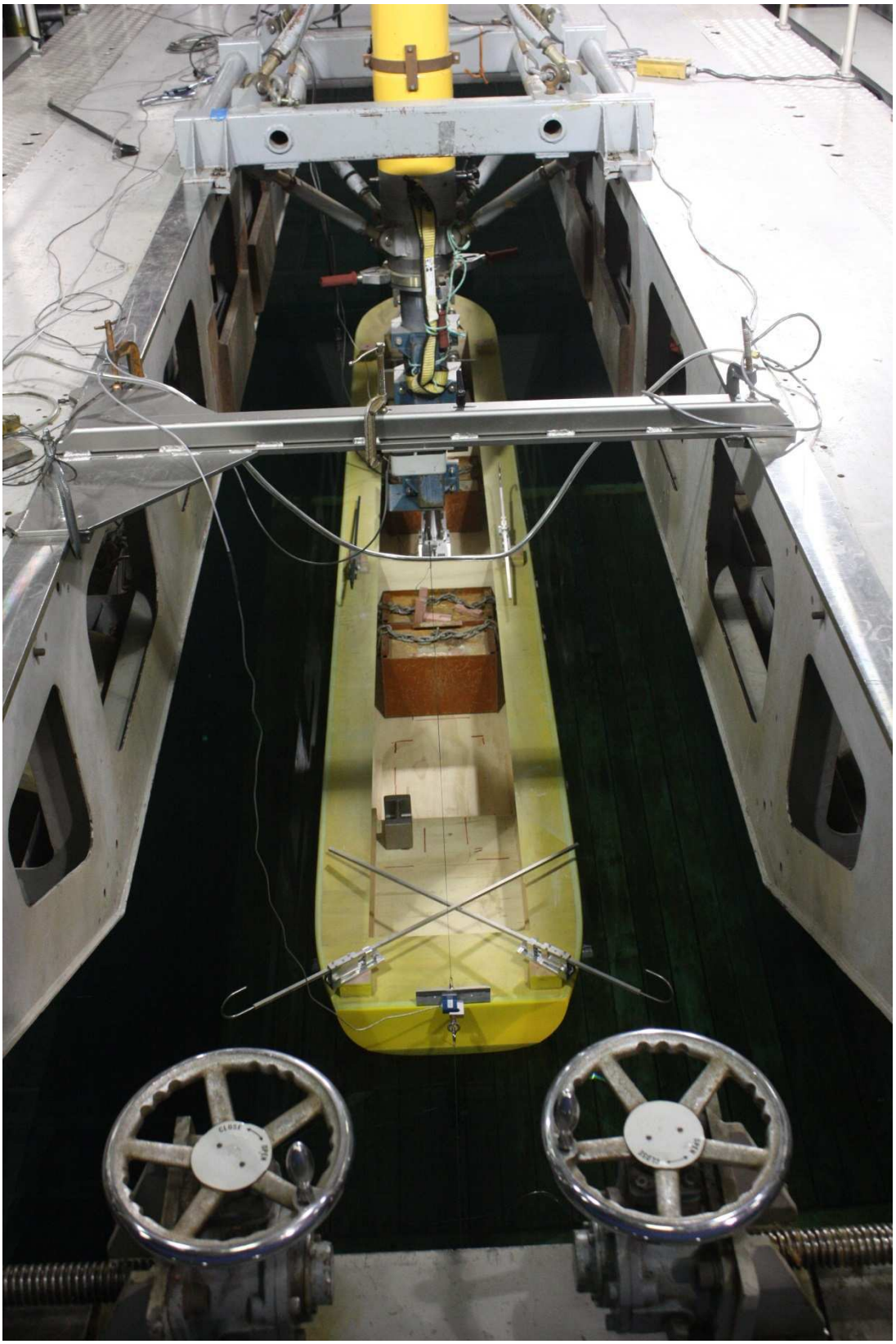


Figure 1: OCRE 931 as installed in the Towing Tank

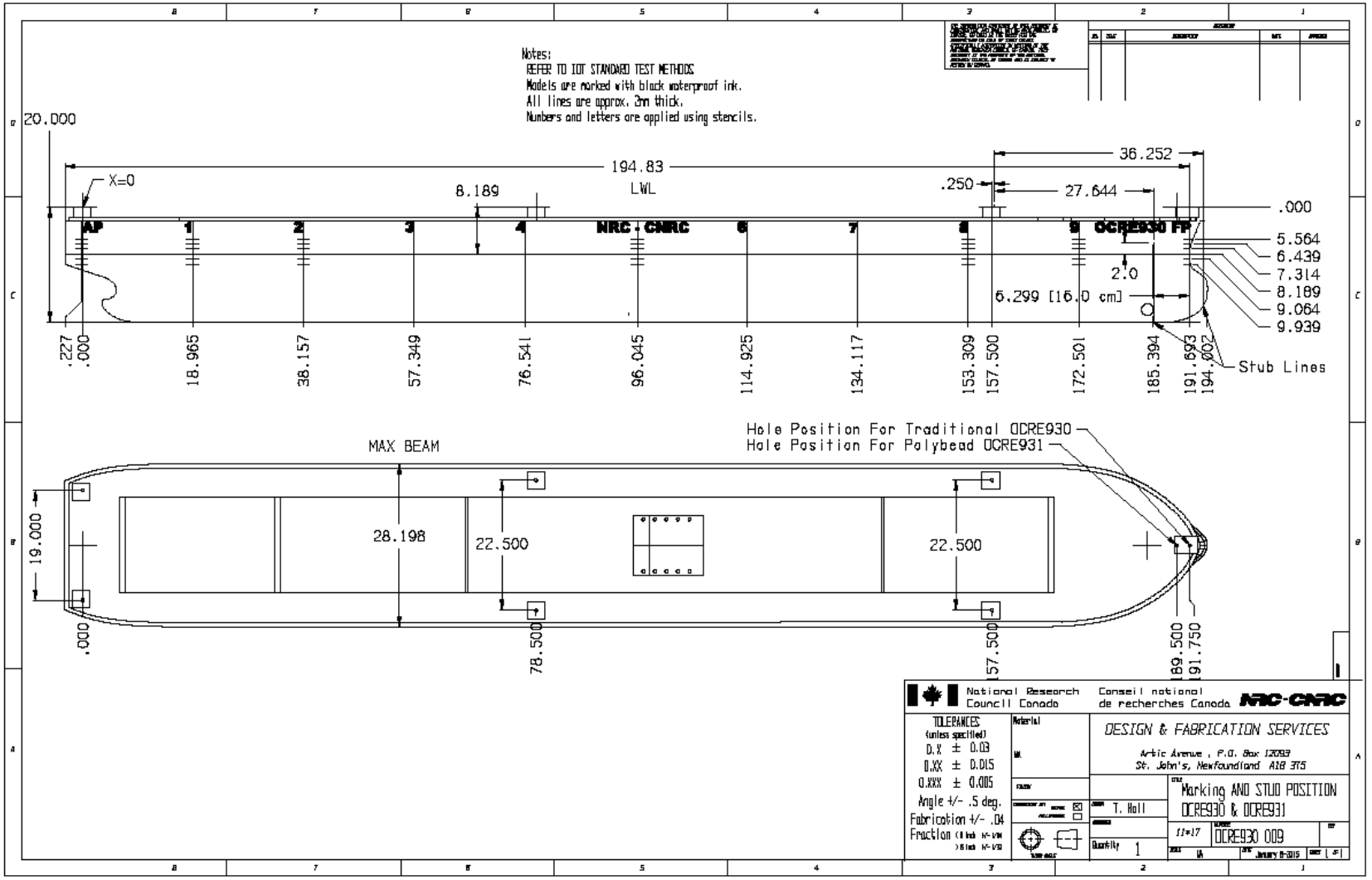


Figure 2: Turbulence Stimulation for OCRE 930/931

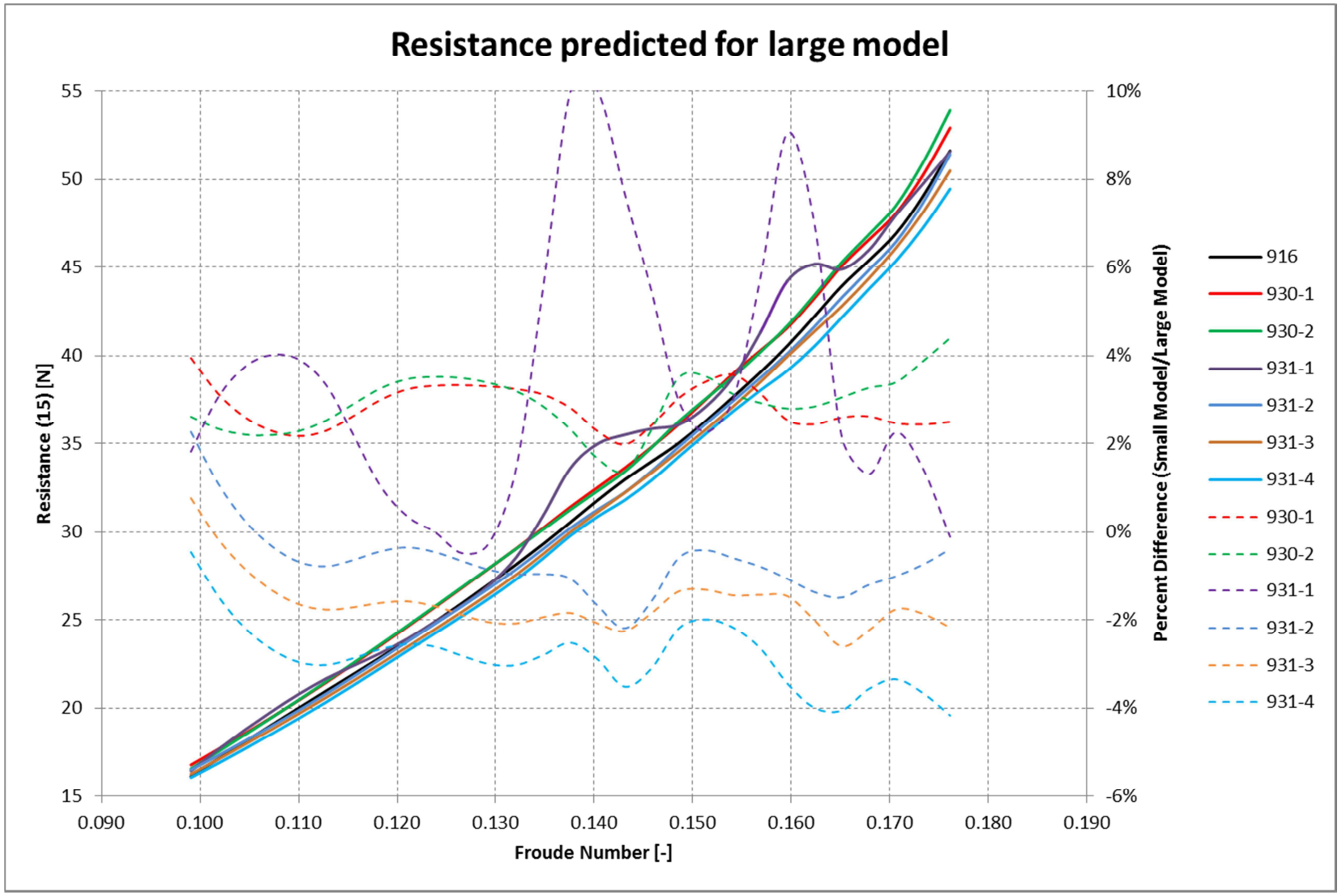


Figure 3: Resistance at 15 deg C in Fresh Water – prediction at size of large model (OCRE916)

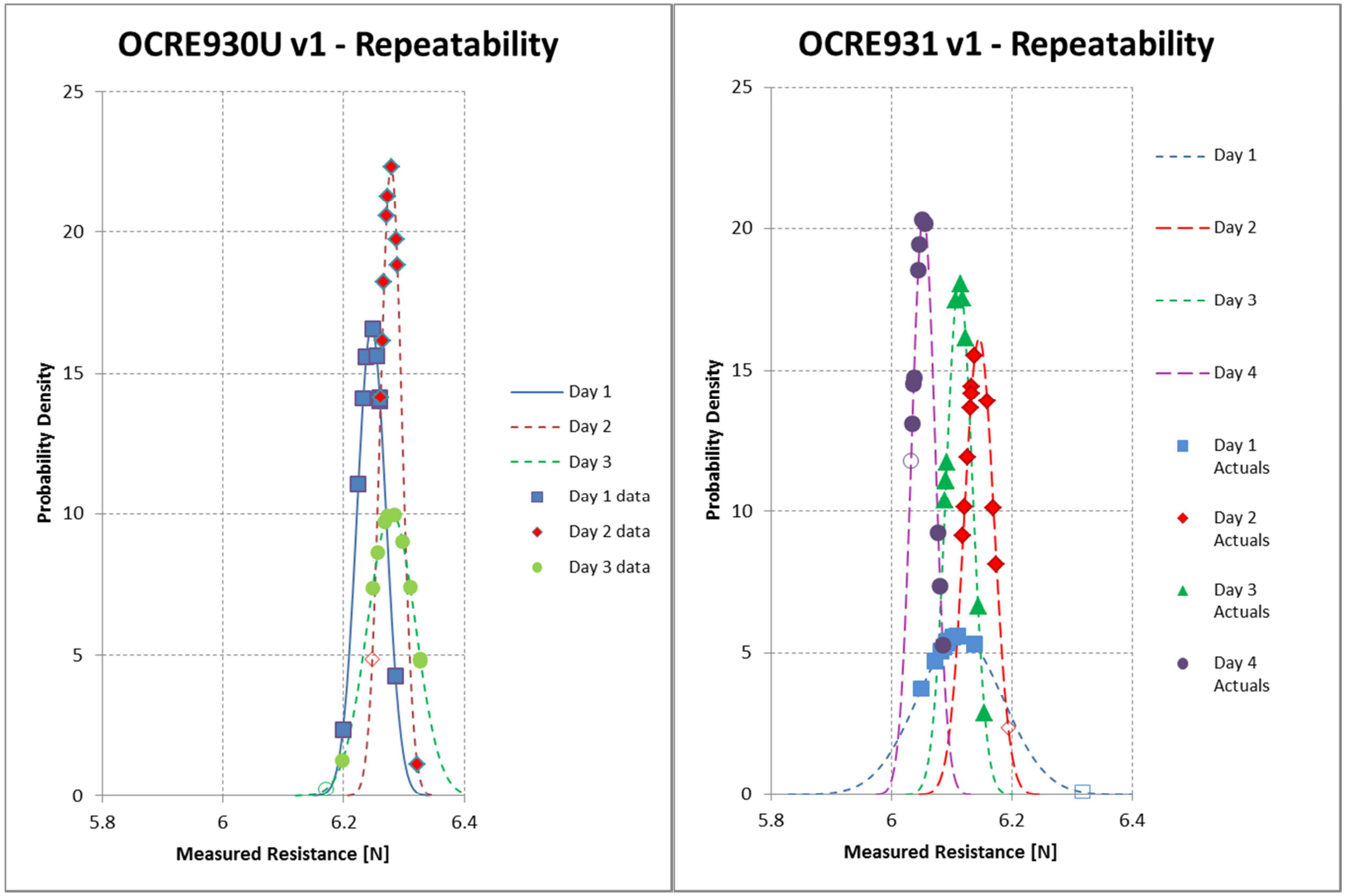


Figure 4: Repeatability at Fr=0.10

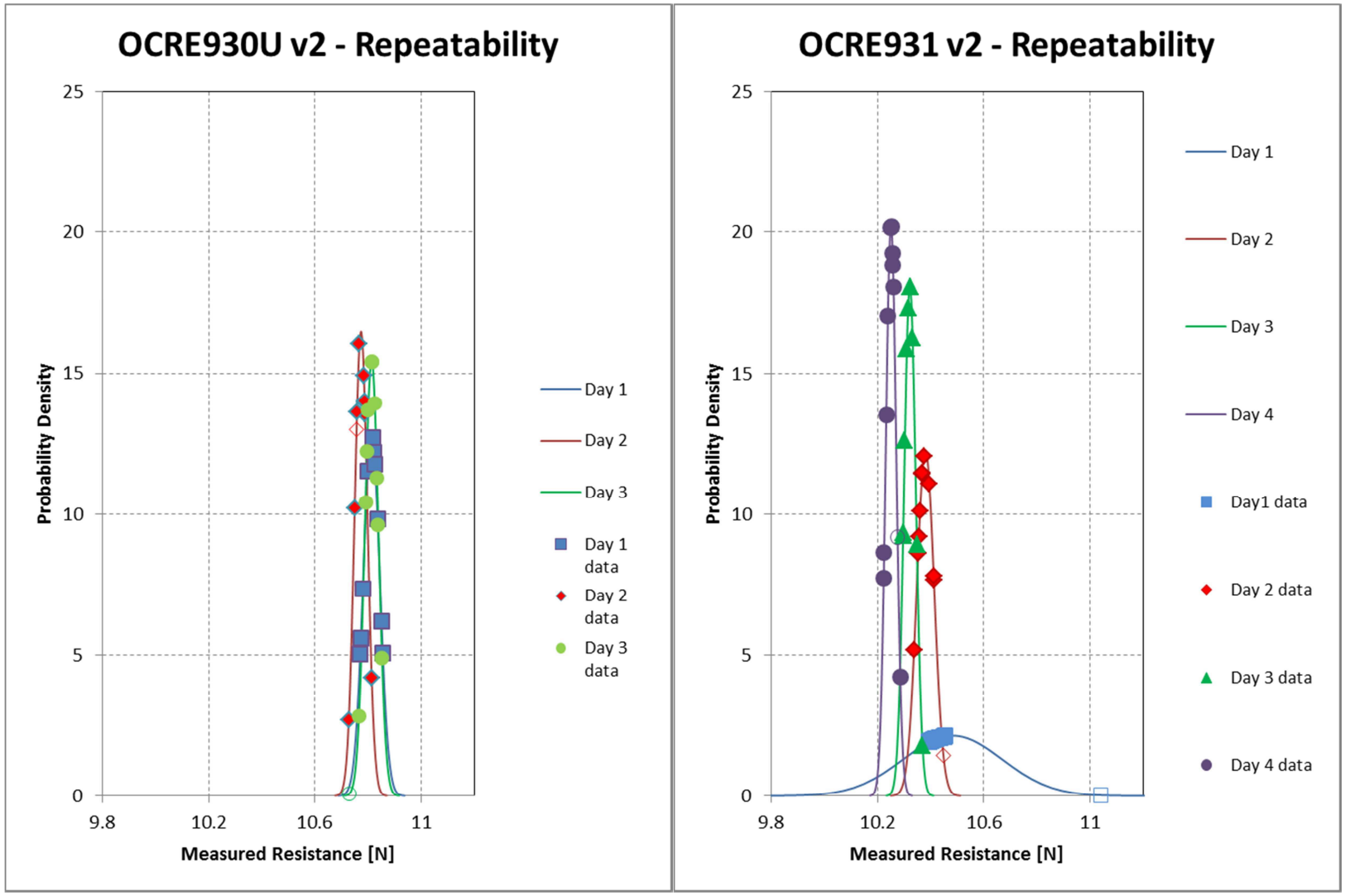


Figure 5: Repeatability at Fr=0.13

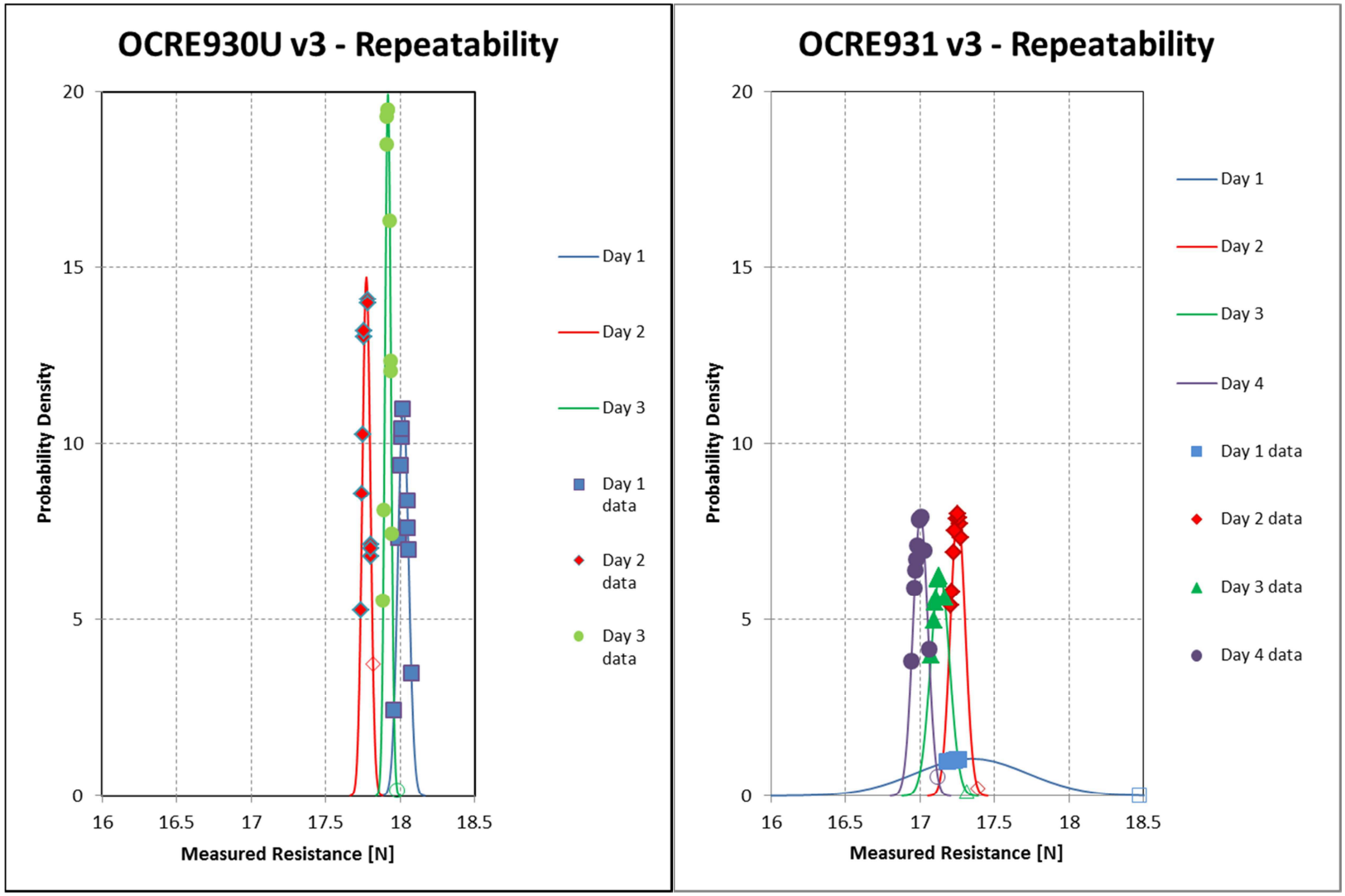


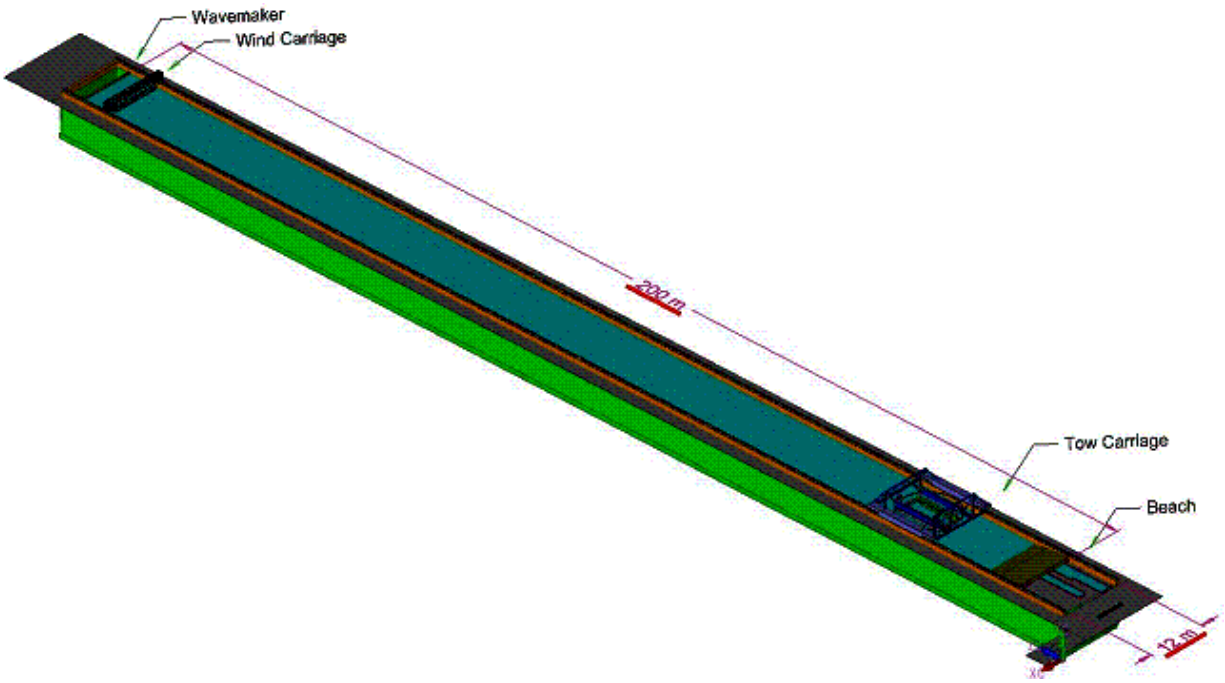
Figure 6: Repeatability at Fr=0.17

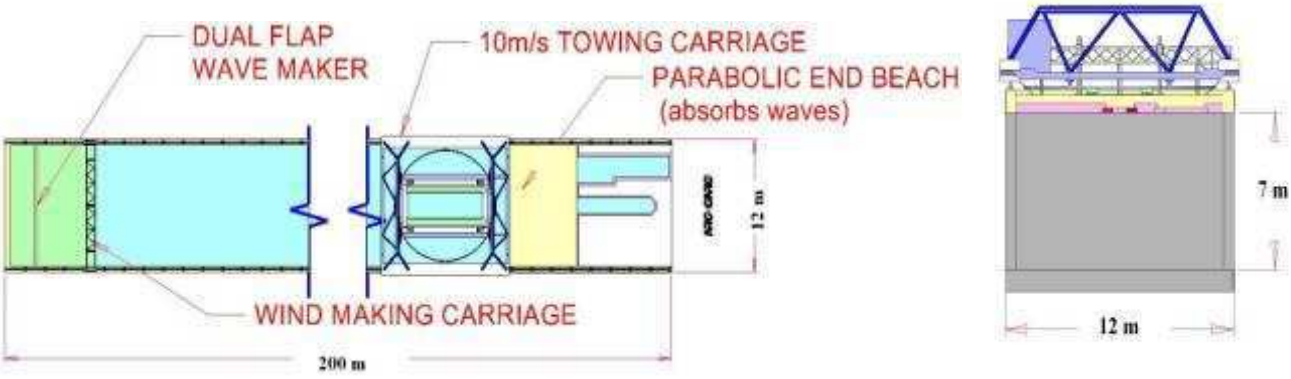
Appendix A – Description of Towing Tank

NRC-OCRE Towing Tank

Description: Rectangular tank - 200m long, 12m wide and 7m deep, models are towed through still water or waves by a carriage spanning the width of the tank, model rigging is facilitated by two trim docks and a moveable overhead crane (4000 kg).

Carriage: Single manned carriage with 8 wheel synchronous motor drive, test frame adjustable for model size, 80,000 kg mass, 746 kW power, speed range .001 m/s - 10.0 m/s, manual service carriage for wind and current generation.





Wave Generator: Dual flap hydraulic wave board with digital computer control, regular and irregular waves program controlled, maximum wave height 1m (regular) or 0.5m significant (irregular).

Wave Absorber: Parabolic corrugated surface beach with transverse slats, 20m long with 10.5 slope at water line, flexible side absorbers.

Current Generation: maximum surface current speed 0.3 m/s @ 10m from nozzles.

Wind Generation: 12 fan bank with gusting capability, maximum wind speed 12 m/s @ 10m from fans.

Model Size Range: ships models up to 12m in length, floating structures 0.5m - 4m diameter.

Instrumentation: Force measurement, strain gauge load cells, capacitance and sonic wave probes, model position, Qualisys optical tracking, accelerometer arrays and motions package for model motions, propeller characteristics, open water propeller dynamometer, propulsion and control system for free-running models, under and above water video, transient recorders, and flow measurement.

Data Acquisition: A Windows based distributed client/server system using Intelligent Measurement and Control (IMC) Cronos Compact CRC-400-11 portable data acquisition system enclosures connected to a GDAC data acquisition server via Ethernet. Each CRC-400-11 chassis has an aggregate sample rate limit of 400 kHz.

Tests Performed:
(1) resistance and propulsion
(2) wake survey
(3) flow visualization
(4) propeller open water
(5) seakeeping
(6) floating and moored structures
(7) loads due to wind and current
(8) lift and drag
(9) dynamics of underwater vehicles

Appendix B – Model Hydrostatics and Floatation QA

Panamax Bulk Carrier - OCRE 930/931

Load Test Condition

HYDROSTATICS WITHOUT APPENDAGES Scale 1: 45

	Ship	Model
LENGTH BETWEEN PERPENDICULARS, m	219.37	4.8748
LENGTH ON THE WATERLINE, m	222.71	4.9490
LENGTH OVERALL, m	226.20	5.0266
MAXIMUM WATERLINE BEAM, m	32.24	0.7164
DRAFT AT MIDSHIPS, m	13.50	0.3000
DRAFT ABOVE DATUM AT AFT PERPENDICULAR, m	13.50	0.3000
DRAFT ABOVE DATUM AT FWD PERPENDICULAR, m	13.50	0.3000
TRIM, deg.	0.00	0.0000
EQUIVALENT LEVEL KEEL DRAFT ABOVE BASELINE, m	13.50	0.3000
PARALLEL MIDDLE BODY WRT AP, m	81.22	1.8050
TO, m	149.08	3.3130
CENTRE OF BUOYANCY WRT AP, m	112.10	2.4911
CENTRE OF BUOYANCY ABOVE BASELINE, m	7.04	0.1564
CENTRE OF FLOTATION WRT AP, m	105.01	2.3336
WATERPLANE AREA, sq. m	6779.02	3.3477
WETTED SURFACE AREA, sq.m	11701.67	5.7786
WETTED SURFACE AREA, (EXCLUDING TRANSOM) sq.m	11671.73	5.7638
MIDSHIP SECTIONAL AREA, sq.m	432.49	0.2136
TRANSVERSE METACENTRIC RADIUS, m	6.64	0.1476
LONGITUDINAL METACENTRIC RADIUS, m	302.76	6.7280
VOLUME OF DISPLACEMENT, cu. m	83547.92	0.9168
DISPLACEMENT, (tonnes @ FS in SW)(kg @ MS in FW)	85636.62	915.784

APPENDAGES

CENTRE OF BUOYANCY WRT AP, m	NA	NA
VOLUME OF DISPLACEMENT, cu. m	NA	NA
WETTED SURFACE AREA, sq.m	NA	NA

Panamax Bulk Carrier - OCRE 930/931

Load Test Condition

COEFFICIENTS OF FORM FOR NAKED HULL

COEFFICIENTS BASED ON: LENGTH BETWEEN PERPENDICULAR
MAXIMUM BEAM
EQUIVALENT LEVEL KEEL DRAFT

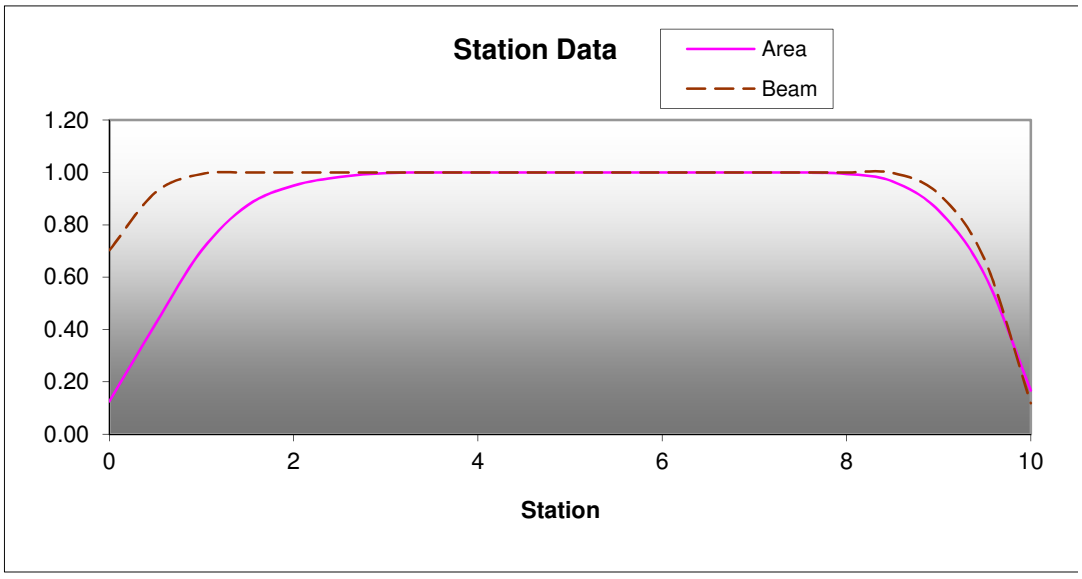
L/B	6.805
L/T	16.249
B/T	2.388
LCB %L FORWARD OF AP	51.102
LCF %L FORWARD OF AP	47.870
BLOCK COEFFICIENT	0.875
MIDSHIP COEFFICIENT	0.994
PRISMATIC COEFFICIENT	0.881
WATERPLANE COEFFICIENT	0.959
CIX Long. Inertia of waterplane	0.906
CIY Trans. Inertia of waterplane	0.892
BM/B	0.206
BML/L	1.338
BEAM - DISPLACEMENT RATIO (CIRCB)	0.737
DRAFT - DISPLACEMENT RATIO (CIRCT)	0.309
LENGTH - DISPLACEMENT RATIO (CIRCM)	5.018
WETTED SURFACE - DISPLACEMENT RATIO (CIRCS)	6.123
BM - DISPLACEMENT RATIO	0.152
BML - DISPLACEMENT RATIO	6.926

Panamax Bulk Carrier - OCRE 930/931

Load Test Condition

SECTIONAL AREA AND BEAM CURVES

Station	Area	Beam
0	0.126	0.703
0.5	0.421	0.924
1	0.702	0.994
1.5	0.875	1.000
2	0.950	1.000
2.5	0.983	1.000
3	0.998	1.000
3.5	1.000	1.000
4	1.000	1.000
4.5	1.000	1.000
5	1.000	1.000
5.5	1.000	1.000
6	1.000	1.000
6.5	1.000	1.000
7	1.000	1.000
7.5	1.000	1.000
8	0.995	1.000
8.5	0.966	0.998
9	0.854	0.918
9.5	0.609	0.666
10	0.167	0.118



Definitions:
Area = Station Area / Max. Sectional Area
Beam = Station Beam / Max. Section Beam

OCRE-LM-2015-001

Model:	OCRE930			Base model with unsanded DURATEK finish
Date:	January 8, 2015			
Condition:	1			
Description:	Load			
Trim	0	deg		
Scale	45			
Test Temp	15.4	deg C		
Rho	998.78	kg/m^3		
Volume of Displacement	0.9168	m^3		
Displacement	915.7	kg FW		
Model as launched	134.0	kg	299.0	lb
Lifting Bar	0.0	kg	0.0	lb
Levelling Mass	0	kg		
Model Lightship	134.0	kg		
Tow Post	13.8	kg	30.4	lb
Target Ballast	767.9	kg	1692.9	
Actual Ballast	767.9	kg	767.9	
Actual Displacement	915.7	kg		
Displacement Error	0.0	kg	0.00%	

201.6	201.7	109.5	108.1	140
2	5			

	Draft		Freeboard					
			target	actual		Average	Variance	
				Port	Stbd		Port	Stbd
Location	m FS	m MS	mm MS	mm MS	mm MS	mm MS	mm MS	mm MS
FP	13.5	0.3000	**208**	208	208	208	0	0
Midship	13.5	0.3000	**208**	208	208.5	208.25	0	0.5
AP	13.5	0.3000	**208**	208	208.5	208.25	0	0.5

Model:	OCRE930								
Date:	January 9, 2015								
Condition:	1								
Description:	Load								
Trim	0	deg							
Scale	45								
Test Temp	15.4	deg C							
Rho	998.78	kg/m^3							
Volume of Displacement	0.9168	m^3							
Displacement	915.7	kg FW							
Model as launched	134.0	kg	299.0	lb					
Lifting Bar	0.0	kg	0.0	lb					
Levelling Mass	0	kg							
Model Lightship	134.0	kg							
Tow Post	13.8	kg	30.4	lb					
Target Ballast	767.9	kg	1692.9						
Actual Ballast	767.9	kg	767.9		201.6	201.7	109.5	108.1	140
					2	5			
Actual Displacement	915.7	kg							
Displacement Error	0.0	kg	0.00%						

	Draft		Freeboard					
		target	actual		Average	Variance	
			Port	Stbd		Port	Stbd
Location	m FS	m MS	mm MS	mm MS	mm MS	mm MS	mm MS	mm MS
FP	13.5	0.3000	**208**	208	208	208	0	0
Midship	13.5	0.3000	**208**	208	208.5	208.25	0	0.5
AP	13.5	0.3000	**208**	208	208.5	208.25	0	0.5

OCRE-LM-2015-001

Model:	OCRE930									
Date:	January 12, 2015									
Condition:	1									
Description:	Load									
Trim	0	deg								
Scale	45									
Test Temp	15.4	deg C								
Rho	998.78	kg/m^3								
Volume of Displacement	0.9168	m^3								
Displacement	915.7	kg FW								
Model as launched	134.9	kg	301.0	lb						
Lifting Bar	0.0	kg	0.0	lb						
Levelling Mass	0	kg								
Model Lightship	134.9	kg								
Tow Post	13.8	kg	30.4	lb						
Target Ballast	767.0	kg	1691.0							
Actual Ballast	766.8	kg	766.8		201.6	201.7	109.5	108.1	140	
					0.9	5				
Actual Displacement	915.5	kg								
Displacement Error	0.2	kg	0.02%							

	Draft			Freeboard					
			target	actual		Average	Variance		
				Port	Stbd		Port	Stbd	
Location	m FS	m MS	mm MS	mm MS	mm MS	mm MS	mm MS	mm MS	
FP	13.5	0.3000	**208**	208	208	208	0	0	
Midship	13.5	0.3000	**208**	209	210	209.5	1	2	Verified stbd mid gage
AP	13.5	0.3000	**208**	208	209	208.5	0	1	

Model:	OCRE931			Polybead model
Date:	January 13, 2015			
Condition:	1			
Description:	Load			
Trim	0	deg		
Scale	45			
Test Temp	15.4	deg C		
Rho	998.78	kg/m^3		
Volume of Displacement	0.9168	m^3		
Displacement	915.7	kg FW		
Model as launched	96.1	kg	214.4	lb
Lifting Bar	0.0	kg	0.0	lb
Levelling Mass	5	kg		
Model Lightship	91.1	kg		
Tow Post	13.8	kg	30.4	lb
Target Ballast	810.8	kg	1787.5	
Actual Ballast	810.8	kg	810.8	

201.6	201.7	109.5	140	140
2	5	5	5	1

Actual Displacement	915.7	kg							
Displacement Error	0.0	kg	0.00%						
Start of Test		Draft			Freeboard				
				target	actual		Average	Variance	
					Port	Stbd		Port	Stbd
Location	m FS		m MS	mm MS	mm MS	mm MS	mm MS	mm MS	mm MS
FP	13.5		0.3000	**208**	208	208	208	0	0
Midship	13.5		0.3000	**208**	208	208	208	0	0
AP	13.5		0.3000	**208**	208	208	208	0	0
End of Test		Draft			Freeboard				
				target	actual		Average	Variance	
					Port	Stbd		Port	Stbd
Location	m FS		m MS	mm MS	mm MS	mm MS	mm MS	mm MS	mm MS
FP	13.5		0.3000	**208**	208	208	208	0	0
Midship	13.5		0.3000	**208**	210	208.5	209.25	2	0.5
AP	13.5		0.3000	**208**	207	207	207	-1	-1

OCRE-LM-2015-001

Model:	OCRE931			Polybead model
Date:	January 14, 2015			Model left in overnight
Condition:	1			Checked gages - same as night before
Description:	Load			
Trim	0	deg		
Scale	45			
Test Temp	15.4	deg C		
Rho	998.78	kg/m^3		
Volume of Displacement	0.9168	m^3		
Displacement	915.7	kg FW		
Model as launched	96.1	kg	214.4	lb
Lifting Bar	0.0	kg	0.0	lb
Levelling Mass	5	kg		
Model Lightship	91.1	kg		
Tow Post	13.8	kg	30.4	lb
Target Ballast	810.8	kg	1787.5	
Actual Ballast	810.8	kg	810.8	
Actual Displacement	915.7	kg		
Displacement Error	0.0	kg	0.00%	

201.6	201.7	109.5	140	140
2	5	5	5	1

	Draft		Freeboard					
			target	actual		Average	Variance	
				Port	Stbd		Port	Stbd
Location	m FS	m MS	mm MS	mm MS	mm MS	mm MS	mm MS	mm MS
FP	13.5	0.3000	**208**	208	208	208	0	0
Midship	13.5	0.3000	**208**	210	208.5	209.25	2	0.5
AP	13.5	0.3000	**208**	207	207	207	-1	-1

Model:	OCRE931		Polybead model
Date:	January 15, 2015		Model was removed Jan 14 and re-installed
Condition:	1		Model re-weighed - weight up 0.6 lbs
Description:	Load		Adjust ballast
Trim	0	deg	
Scale	45		
Test Temp	15.4	deg C	
Rho	998.78	kg/m^3	
Volume of Displacement	0.9168	m^3	
Displacement	915.7	kg FW	

Model as launched	96.4	kg	215.0	lb
Lifting Bar	0.0	kg	0.0	lb
Levelling Mass	5	kg		
Model Lightship	91.4	kg		
Tow Post	13.8	kg	30.4	lb
Target Ballast	810.6	kg	1786.9	
Actual Ballast	810.6	kg	810.6	

201.6	201.7	109.5	140	140
2	5	5	5	0.75

Actual Displacement	915.7	kg	
Displacement Error	0.0	kg	0.00%

	Draft			Freeboard				
			target	actual		Average	Variance	
Start of Test				Port	Stbd		Port	Stbd
Location	m FS	m MS	mm MS	mm MS	mm MS	mm MS	mm MS	mm MS
FP	13.5	0.3000	**208**	208	208	208	0	0
Midship	13.5	0.3000	**208**	209.5	209.5	209.5	1.5	1.5
AP	13.5	0.3000	**208**	207	207.5	207.25	-1	-0.5

OCRE-LM-2015-001

Model:	OCRE931			Polybead model
Date:	January 16, 2015			
Condition:	1			
Description:	Load			
Trim	0	deg		
Scale	45			
Test Temp	15.4	deg C		
Rho	998.78	kg/m^3		
Volume of Displacement	0.9168	m^3		
Displacement	915.7	kg FW		
Model as launched	96.4	kg	215.0	lb
Lifting Bar	0.0	kg	0.0	lb
Levelling Mass	5	kg		
Model Lightship	91.4	kg		
Tow Post	13.8	kg	30.4	lb
Target Ballast	810.6	kg	1786.9	
Actual Ballast	810.6	kg	810.6	
Actual Displacement	915.7	kg		
Displacement Error	0.0	kg	0.00%	

201.6	201.7	109.5	140	140
2	5	5	5	0.75

	Draft		Freeboard					
			target	actual		Average	Variance	
				Port	Stbd		Port	Stbd
Location	m FS	m MS	mm MS	mm MS	mm MS	mm MS	mm MS	mm MS
FP	13.5	0.3000	**208**	208	208	208	0	0
Midship	13.5	0.3000	**208**	209.5	209.5	209.5	1.5	1.5
AP	13.5	0.3000	**208**	209	207	208	1	-1

Freeboard check done prior to removal

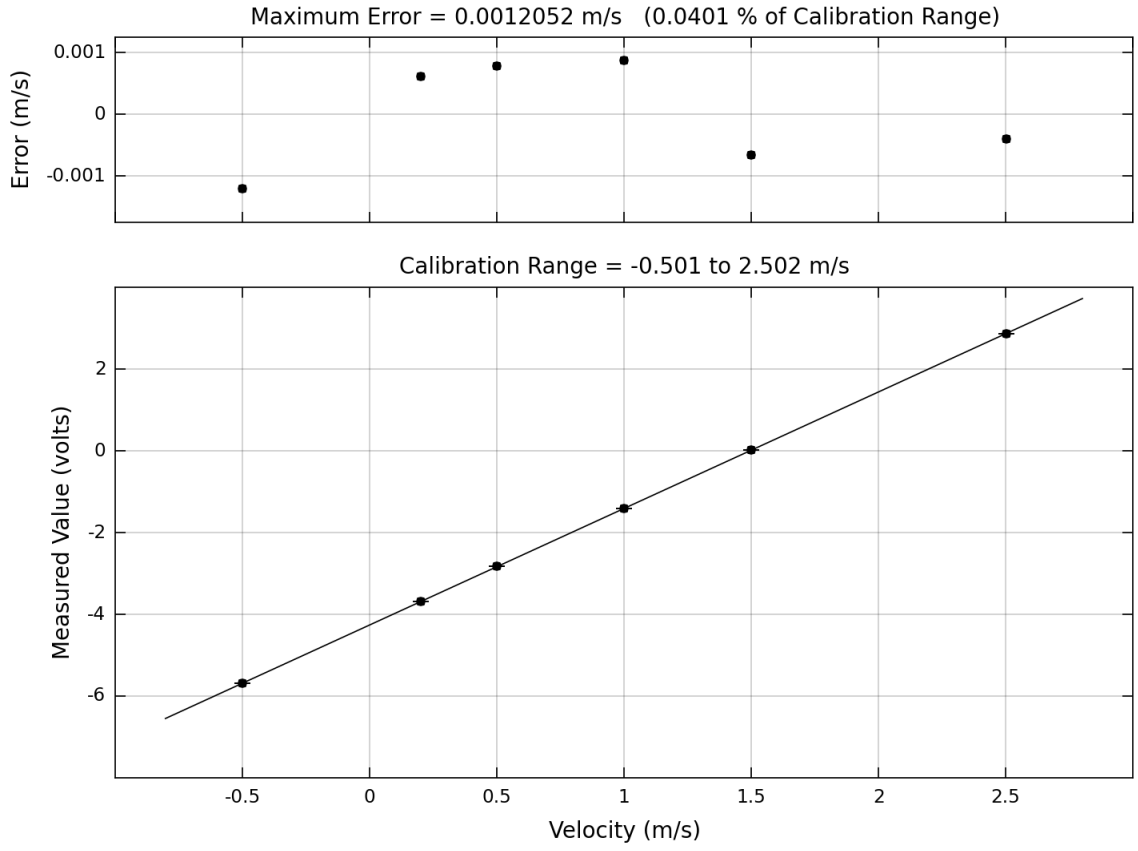
Model weight upon removal was 215.4 lbs with wet slings

Appendix C – Calibrations

Model Construction Technique Evaluation
Calibration of Carriage Speed
Calibrated 2015-01-07 17:37Z

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

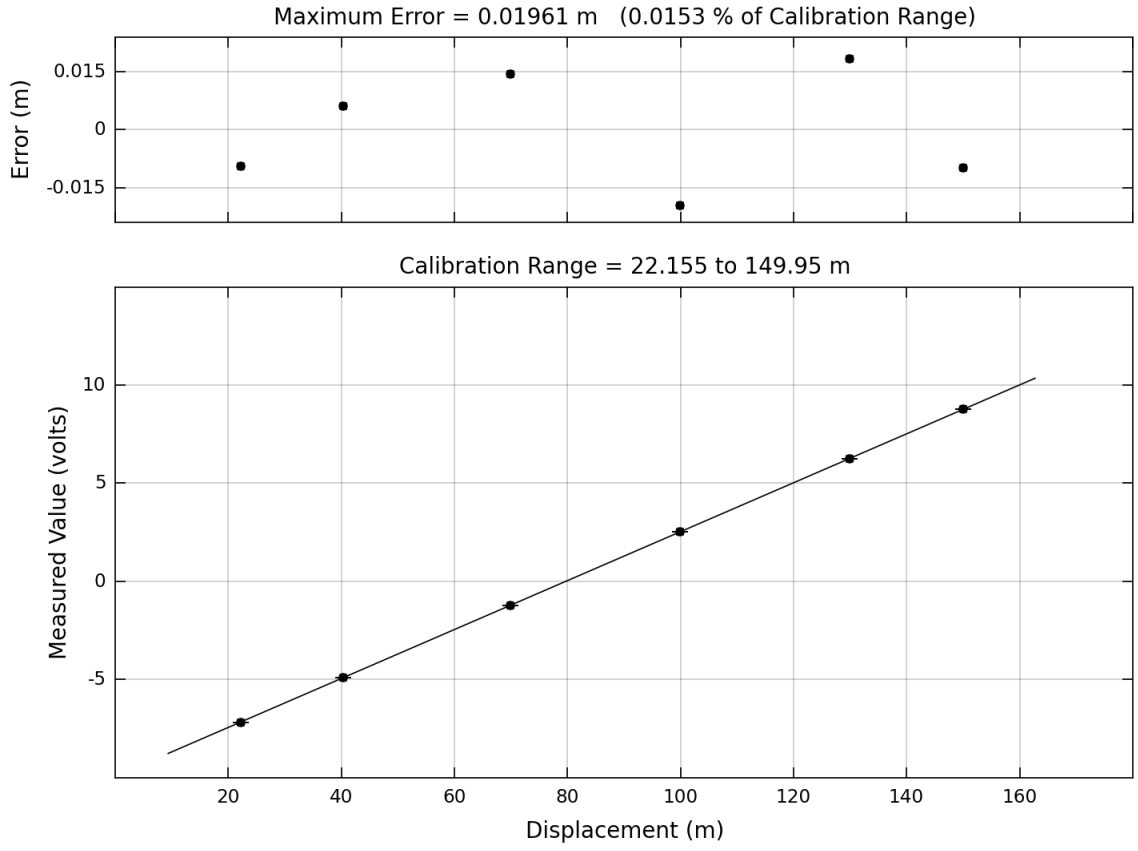
Data Point #	Physical Value (m/s)	Measured Value (volts)	Fitted Curve Value (m/s)	Error (m/s)	Definition of Calibration Curve
1	-0.50100	-5.7008	-0.50221	-0.0012052	Polynomial Degree = 1 (Linear Fit)
2	0.20000	-3.6973	0.20061	0.00060901	$Y = C_0 + C_1 \cdot V$
3	0.50100	-2.8388	0.50178	0.00078180	where $Y(t)$ = Velocity (m/s),
4	1.0000	-1.4160	1.0009	0.00087269	$V(t)$ = measured value (volts),
5	1.5010	0.0078630	1.5003	-0.00065358	C_0 = 1.4976 m/s,
6	2.5020	2.8621	2.5016	-0.00040477	C_1 = 0.35079 m/s/volt,



Model Construction Technique Evaluation
Calibration of Carriage Position
Calibrated 2014-12-09 14:20Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:**
Data Source: SJS-TOWDAS:50001 Channel 3	**Programmable Gain:**	**Excitation:**
Sensor Model:	**Plug-In Gain:**	

Data Point #	Physical Value (m)	Measured Value (volts)	Fitted Curve Value (m)	Error (m)	Definition of Calibration Curve
1	22.155	-7.1810	22.146	-0.0094353	Polynomial Degree = 1 (Linear Fit)
2	40.308	-4.9148	40.314	0.0061175	$Y = C_0 + C_1 \cdot V$
3	69.920	-1.2202	69.934	0.014359	where $Y(t)$ = Displacement (m),
4	99.918	2.5172	99.898	-0.019610	$V(t)$ = measured value (volts),
5	129.92	6.2641	129.94	0.018381	C_0 = 79.717 m,
6	149.95	8.7589	149.94	-0.0098127	C_1 = 8.0173 m/volt,

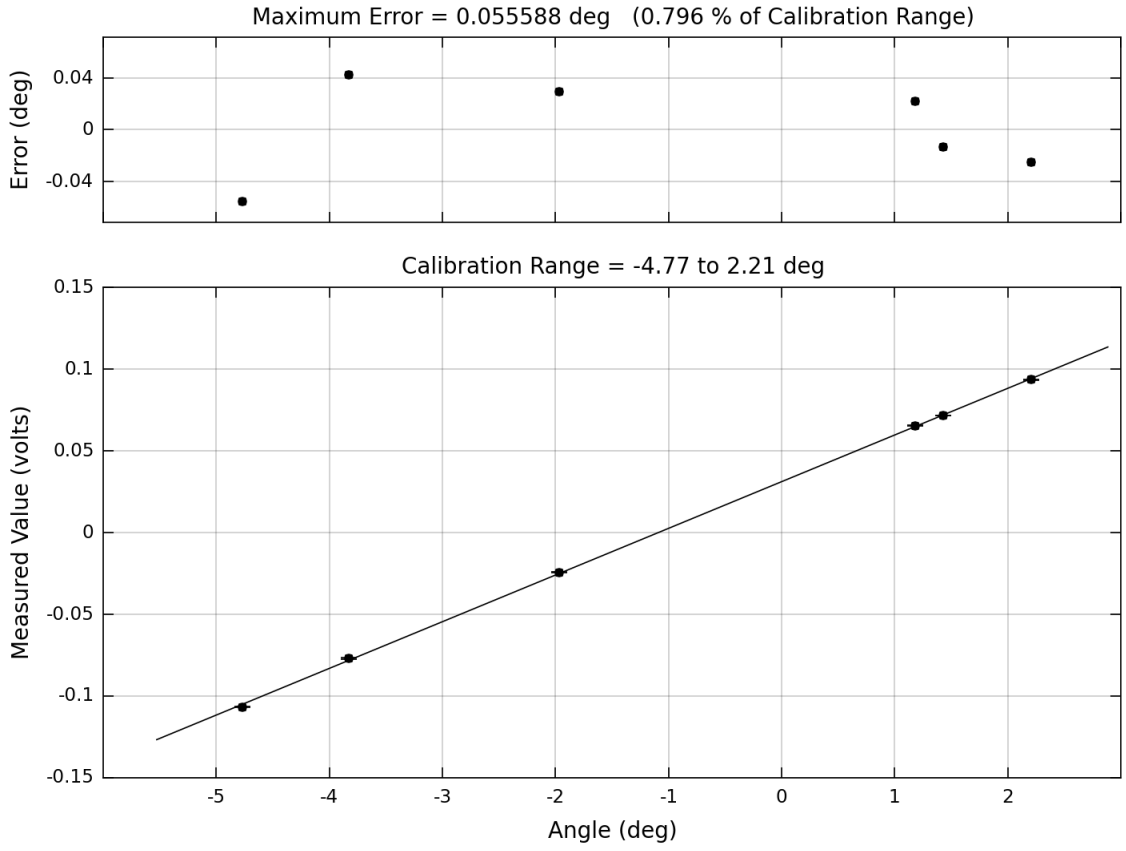


National Research Council Canada
Ocean, Coastal and River Engineering

Model Construction Technique Evaluation
Calibration of Gimbal Pitch
Calibrated 2015-01-07 14:56Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:**
Data Source: SJS-TOWDAS:50001 Channel 9	**Programmable Gain:**	**Excitation:**
Sensor Model: 200165 waters WPM pot	**Plug-In Gain:**	

Data Point #	Physical Value (deg)	Measured Value (volts)	Fitted Curve Value (deg)	Error (deg)	Definition of Calibration Curve
1	-4.7700	-0.10685	-4.8256	-0.055588	Polynomial Degree = 1 (Linear Fit)
2	-3.8300	-0.077195	-3.7871	0.042877	$Y = C_0 + C_1 \cdot V$
3	-1.9700	-0.024463	-1.9403	0.029663	where $Y(t)$ = Angle (deg),
4	1.1800	0.065266	1.2022	0.022164	$V(t)$ = measured value (volts),
5	1.4300	0.071382	1.4163	-0.013667	C_0 = -1.0836 deg,
6	2.2100	0.093317	2.1846	-0.025450	C_1 = 35.022 deg/volt,



National Research Council Canada

Ocean, Coastal and River Engineering

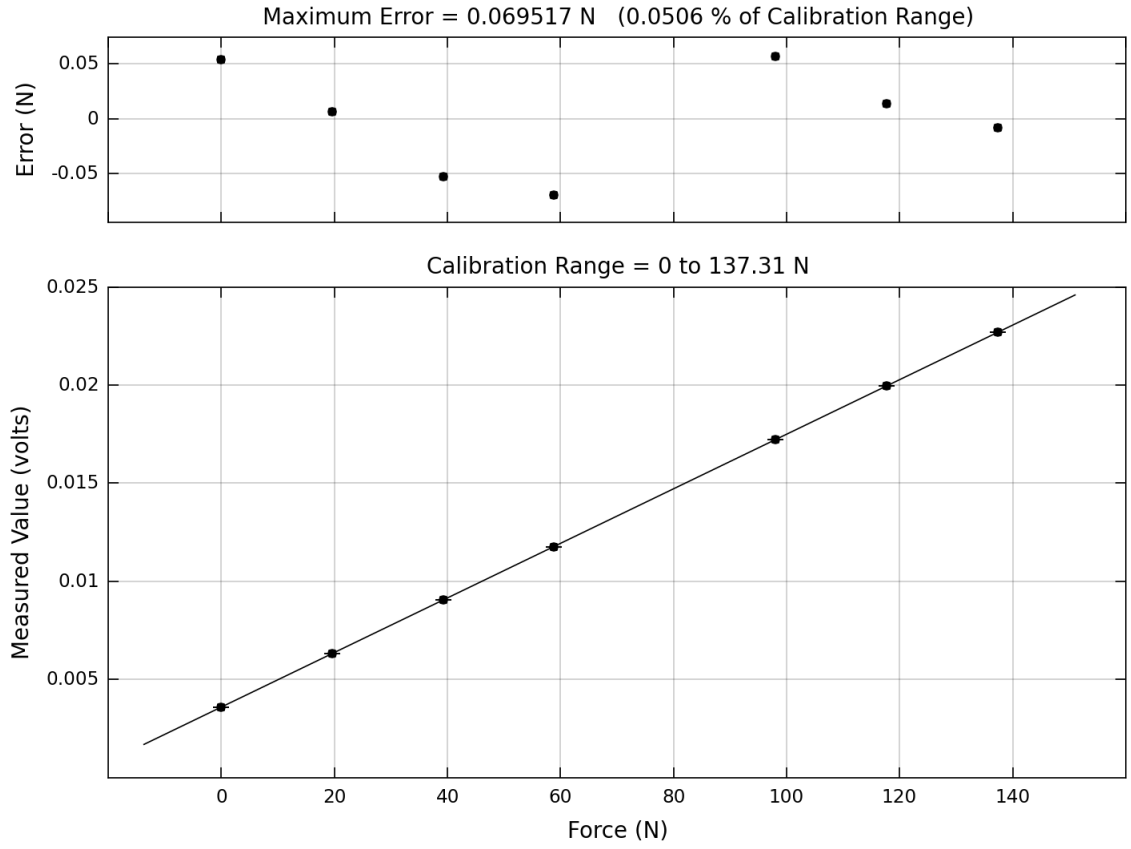
Model Construction Technique Evaluation

Calibration of Inline load

Calibrated 2015-01-07 14:14Z

Test Facility: CWT	**Serial #:** K725251	**Filter Frequency:**
Data Source: SJS-TOWDAS:50001 Channel 11	**Programmable Gain:**	**Excitation:**
Sensor Model: 9363-D3-50-20P1 50lb S type	**Plug-In Gain:**	

Data Point #	Physical Value (N)	Measured Value (volts)	Fitted Curve Value (N)	Error (N)	Definition of Calibration Curve
1	0.0000	0.0035950	0.053924	0.053924	Polynomial Degree = 1 (Linear Fit)
2	19.616	0.0063170	19.622	0.0061338	$Y = C_0 + C_1 \cdot V$
3	39.232	0.0090374	39.180	-0.052480	where $Y(t)$ = Force (N),
4	58.848	0.011764	58.778	-0.069517	$V(t)$ = measured value (volts),
5	98.080	0.017238	98.137	0.056618	C_0 = -25.791 N,
6	117.70	0.019961	117.71	0.013677	C_1 = 7189 N/volt,
7	137.31	0.022687	137.30	-0.0083552	



National Research Council Canada

Ocean, Coastal and River Engineering

Model Construction Technique Evaluation
Calibration of Sinkage FP
Calibrated 2015-01-07 17:05Z

Test Facility: CWT	**Serial #:** A10328	**Filter Frequency:**
Data Source: SJS-TOWDAS:50001 Channel 15	**Programmable Gain:**	**Excitation:**
Sensor Model: Yo yo pot	**Plug-In Gain:**	

Data Point #	Physical Value (mm)	Measured Value (volts)	Fitted Curve Value (mm)	Error (mm)
1	0.0000	0.36458	0.074019	0.074019
2	25.000	0.73529	24.873	-0.12703
3	50.000	1.1099	49.930	-0.069845
4	75.000	1.4870	75.158	0.15751
5	150.00	2.6053	149.97	-0.034652

Definition of Calibration Curve

Polynomial Degree = 1 (Linear Fit)

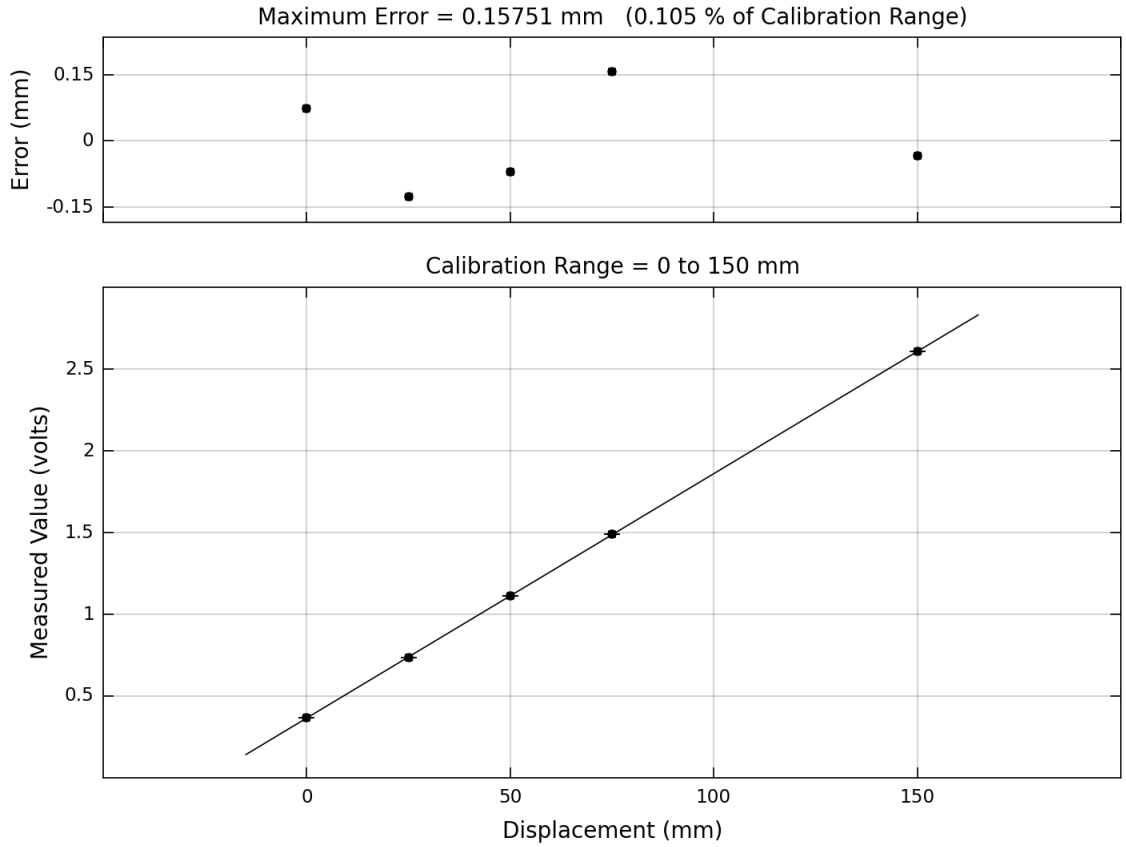
$Y = C_0 + C_1 \cdot V$

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

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

C_0 = -24.314 mm,

C_1 = 66.895 mm/volt,



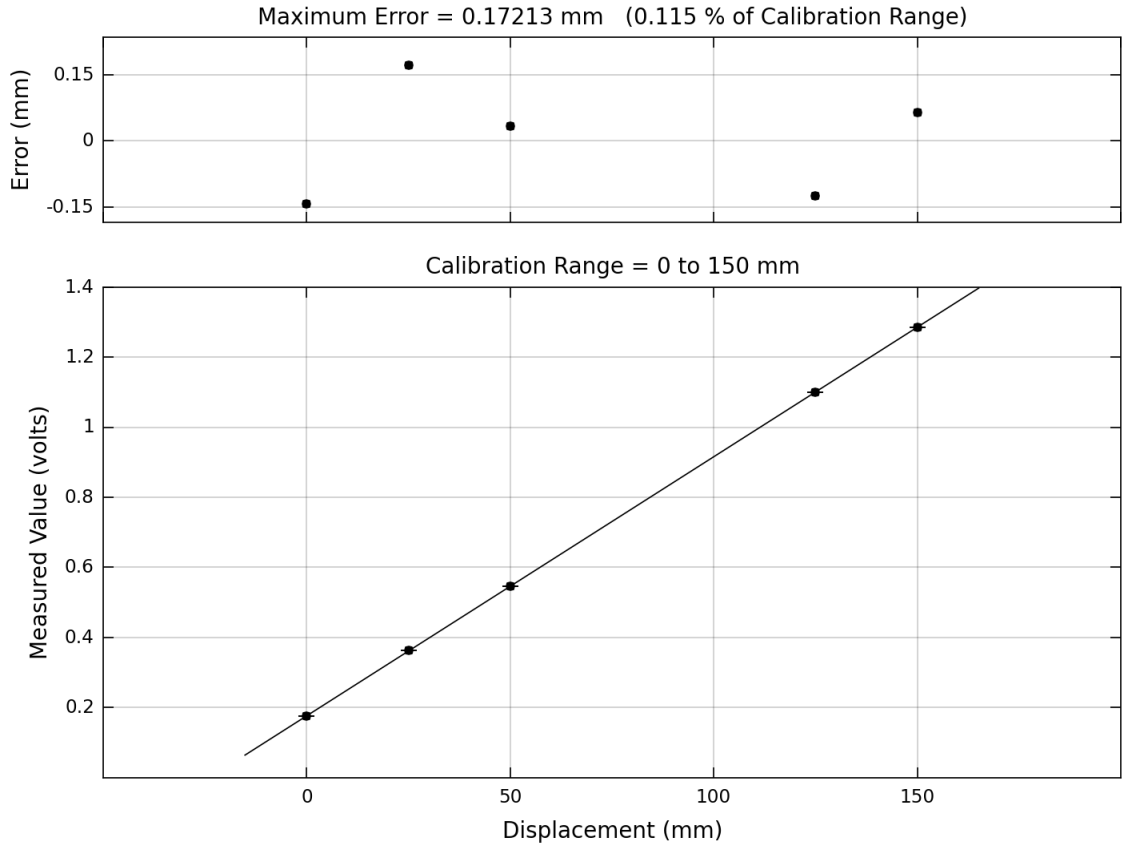
National Research Council Canada

Ocean, Coastal and River Engineering

Model Construction Technique Evaluation
Calibration of Sinkage AP
Calibrated 2015-01-07 17:17Z

Test Facility: CWT	**Serial #:** A10329	**Filter Frequency:**
Data Source: SJS-TOWDAS:50001 Channel 16	**Programmable Gain:**	**Excitation:**
Sensor Model: Yo yo pot	**Plug-In Gain:**	

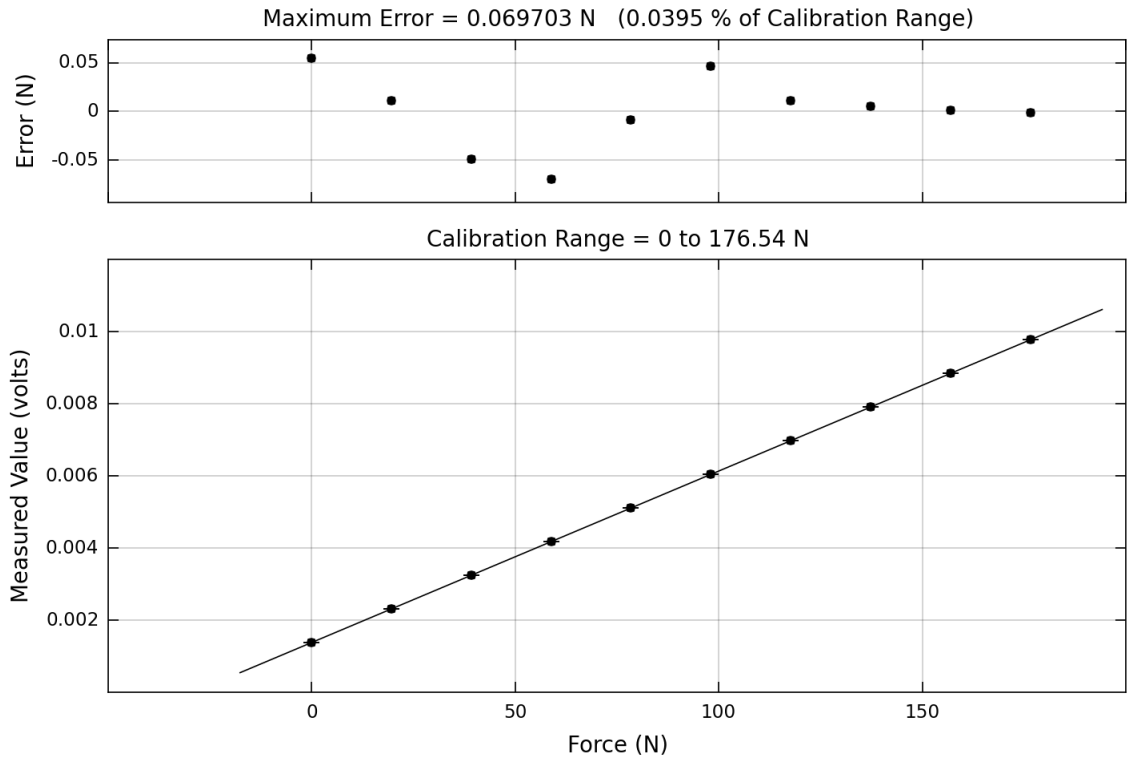
Data Point #	Physical Value (mm)	Measured Value (volts)	Fitted Curve Value (mm)	Error (mm)	Definition of Calibration Curve
1	0.0000	0.17491	-0.14391	-0.14391	Polynomial Degree = 1 (Linear Fit)
2	25.000	0.36214	25.172	0.17213	$Y = C_0 + C_1 \cdot V$
3	50.000	0.54600	50.033	0.032638	where $Y(t)$ = Displacement (mm),
4	125.00	1.0995	124.88	-0.12492	$V(t)$ = measured value (volts),
5	150.00	1.2858	150.06	0.064061	C_0 = -23.794 mm,
					C_1 = 135.21 mm/volt,



Model Construction Technique Evaluation
Calibration of Tow Force
Calibrated 2015-01-06 17:55Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:**
Data Source: SJS-TOWDAS:50001 Channel 17	**Programmable Gain:**	**Excitation:**
Sensor Model: Single Component Balance Gimble	**Plug-In Gain:**	

Data Point #	Physical Value (N)	Measured Value (volts)	Fitted Curve Value (N)	Error (N)	Definition of Calibration Curve
1	0.0000	0.0013861	0.054510	0.054510	Polynomial Degree = 1 (Linear Fit)
2	19.616	0.0023169	19.627	0.010510	$Y = C_0 + C_1 \cdot V$
3	39.232	0.0032470	39.183	-0.048998	where $Y(t)$ = Force (N),
4	58.848	0.0041790	58.778	-0.069703	$V(t)$ = measured value (volts),
5	78.344	0.0051091	78.335	-0.0089548	C_0 = -29.09 N,
6	98.080	0.0060503	98.126	0.046469	C_1 = 21026 N/volt,
7	117.70	0.0069816	117.71	0.011303	
8	137.31	0.0079142	137.32	0.0054853	
9	156.93	0.0088469	156.93	0.0012502	
10	176.54	0.0097797	176.54	-0.0018725	

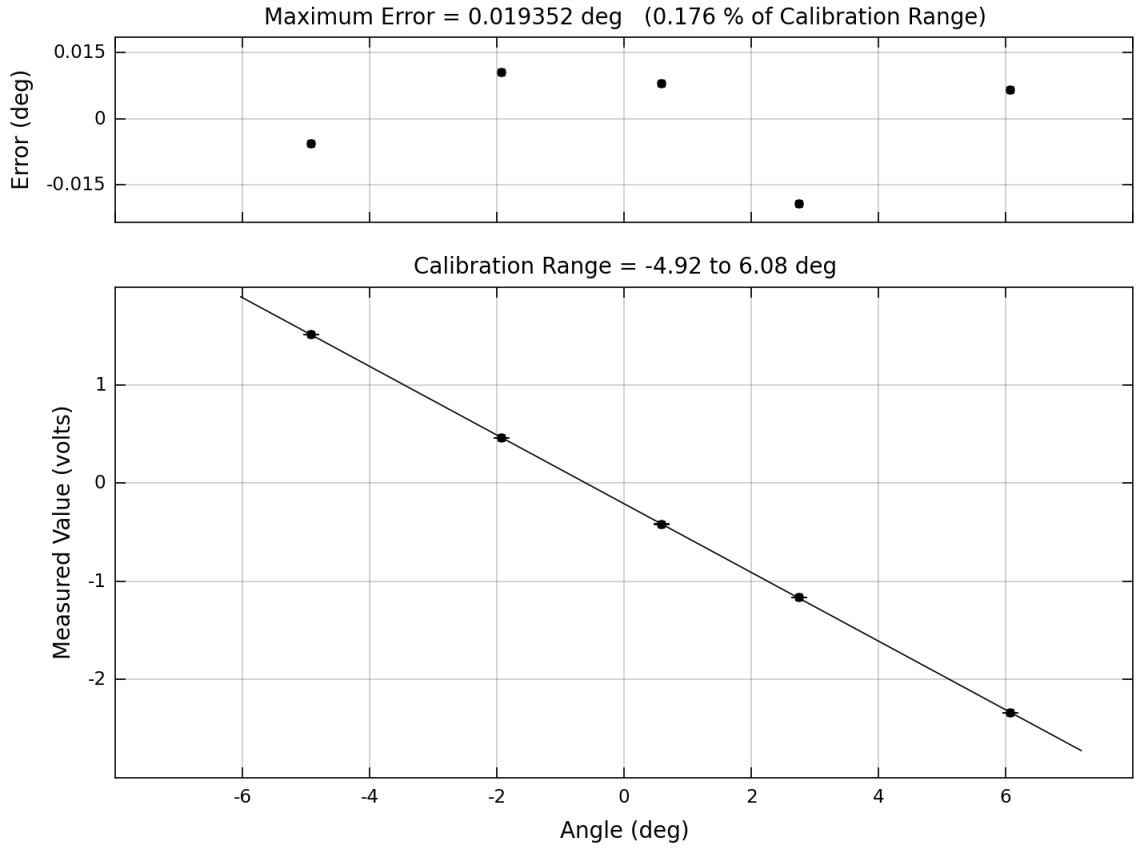


National Research Council Canada
Ocean, Coastal and River Engineering

Model Construction Technique Evaluation
Calibration of Pitch
Calibrated 2015-01-07 15:18Z

Test Facility: CWT	**Serial #:**	**Filter Frequency:**
Data Source: SJS-TOWDAS:50001 Channel 28	**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	-4.9200	1.5157	-4.9257	-0.0056672	Polynomial Degree = 1 (Linear Fit)
2	-1.9200	0.45972	-1.9096	0.010436	$Y = C_0 + C_1 \cdot V$
3	0.59000	-0.41822	0.59800	0.0079995	where $Y(t)$ = Angle (deg),
4	2.7500	-1.1649	2.7306	-0.019352	$V(t)$ = measured value (volts),
5	6.0800	-2.3399	6.0866	0.0065840	C_0 = -0.59651 deg,
					C_1 = -2.8562 deg/volt,

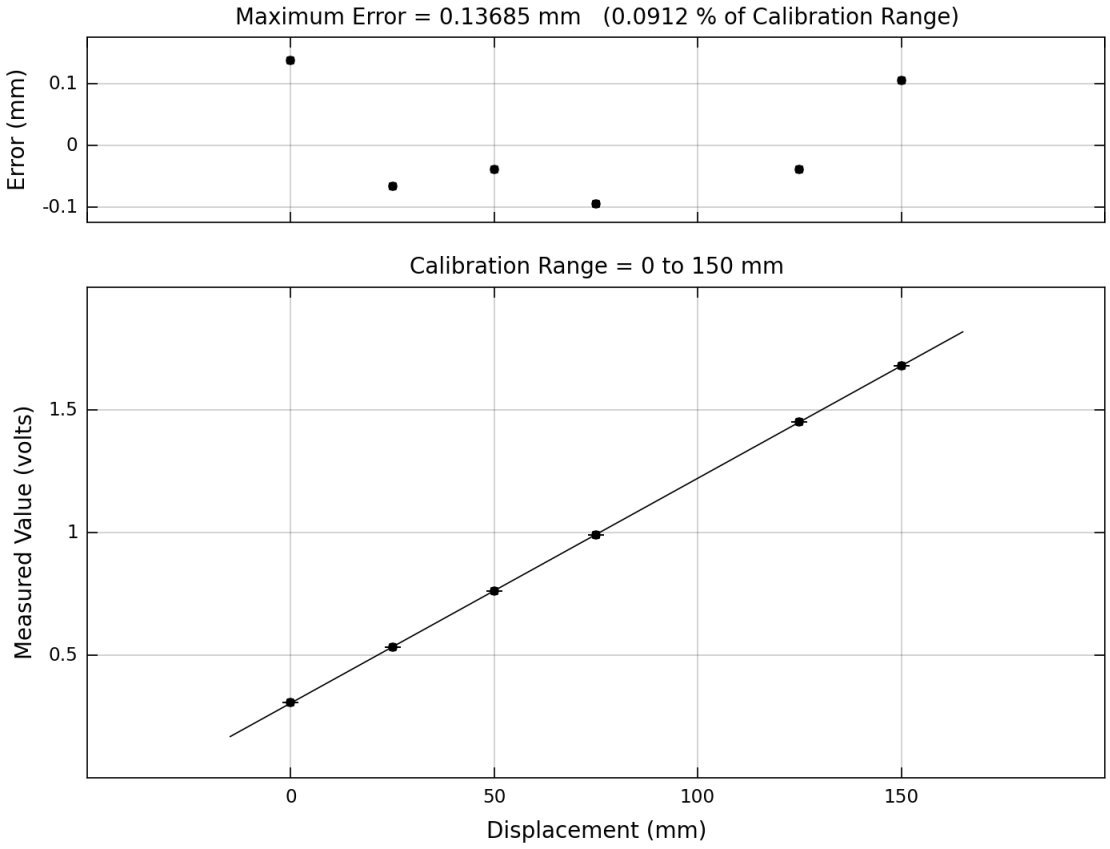


National Research Council Canada
Ocean, Coastal and River Engineering

Model Construction Technique Evaluation
Calibration of Sinkage AP
Calibrated 2015-01-09 18:02Z

Test Facility: Towing Tank	**Serial #:** A10329	**Filter Frequency:**
Data Source: SJS-TOWDAS:50001 Channel 16	**Programmable Gain:**	**Excitation:**
Sensor Model: Yo yo pot	**Plug-In Gain:**	

Data Point #	Physical Value (mm)	Measured Value (volts)	Fitted Curve Value (mm)	Error (mm)	Definition of Calibration Curve
1	0.0000	0.30442	0.13685	0.13685	Polynomial Degree = 1 (Linear Fit)
2	25.000	0.53182	24.933	-0.067247	$Y = C_0 + C_1 \cdot V$
3	50.000	0.76134	49.961	-0.039431	where $Y(t)$ = Displacement (mm),
4	75.000	0.99009	74.905	-0.095435	$V(t)$ = measured value (volts),
5	125.00	1.4491	124.96	-0.038983	C_0 = -33.059 mm,
6	150.00	1.6797	150.10	0.10425	C_1 = 109.04 mm/volt,



National Research Council Canada
Ocean, Coastal and River Engineering

Appendix D – Description of new data acquisition system

Sept 2014

OCRE St. John's Towing Tank Facility - Data Acquisition System

Software

GDAC for Windows was developed by the Instrumentation and Visualization Group at OCRE. It is a general-purpose, portable, data acquisition system, usable in a wide range of scenarios from fixed facilities to field tests.

GDAC is designed to easily add support for any data acquisition hardware from any manufacturer. It can be extended to acquire data from non-traditional sources such as custom designed software / hardware and custom protocols on network or serial streams. Many devices are already supported, including IMC, National Instruments, IOtech, Qualisys, GPS, and OCRE's own Dynamic Positioning and Remote Control systems.

GDAC is a distributed client-server system. Many remote or local clients can connect to servers to acquire data, configure devices, perform calibrations, or monitor channels. It can scale to support many devices with many channels per device by adding new servers. Even though it's a distributed system, data from all devices is synchronized.

GDAC offers all the software tools necessary for a successful project, including:

- Services to pull data from devices and make it available to any client.
- Data acquisition clients capable of streaming and plotting data on-the-fly from multiple servers.
- Calibration software to make calibration of device channels consistent and easier.
- An application to configure devices, channels, and services.
- A tool to quickly view acquisition results, including test properties, configurations, custom variables, and plots of channel data. This tool can

also export data in different file formats, including Comma Separated Values (CSV) and MATLAB MAT files.

- Extensions for MATLAB and IGOR to directly load GDAC generated data.

Hardware

The OCRE SJ Towing Tank Facility DAS consists of an Intelligent Measurement and Control (IMC) Cronos Compact CRC-400-11 portable data acquisition system enclosure connected to a GDAC data acquisition server via Ethernet. The CRC-400-11 has been populated with 4 of IMC Model DCB2-8 Strain Gauge Amplifier cards for a total of 32 analog differential input amplifier channels. Each DCB2-8 card has an analog to digital converter per channel. The card has programmable excitation, low pass filter cut-off frequency, amplifier input voltage range, and sample rate per channel. The CRC-400-11 chassis has an aggregate sample rate limit of 400 KHz. The DCB2-8 amplifier has a maximum low pass filter cut-off frequency of 2 KHz and an unfiltered bandwidth of 5 KHz.

Via GDAC, there are a number of configuration options. These are shown in the table on the following page.

Channel	Mode	Excitation Voltage (V)	Voltage Input Range (mV)	Low Pass Filter Cutoff Freq (Hz)	Notes
1-24	DC	5, 10	5,10,25,50,100 250,500,1000, 2500, 5000, 10000	1,2,5,10,20,50, 100,200,500, 1000,2000	1,2,3,5,6
1-24	Full Bridge	5	5,10,25,50,100 250,500,1000, 2500, 5000	1,2,5,10,20,50, 100,200,500, 1000,2000	1,2,3,4,5,6
1-24	Full Bridge	10	5,10,25,50,100 250,500,1000, 2500, 5000,10000	1,2,5,10,20,50, 100,200,500, 1000,2000	1,2,3,4,5,6
25-32	DC	15	5,10,25,50,100 250,500,1000, 2500, 5000,10000	1,2,5,10,20,50, 100,200,500, 1000,2000	2,3,5,6

Notes:

1. Each group of 8 channels must have identical supplies (i.e. 1-8 must have the same supply, 9-16 must have the same supply, and 17-24 must have the same supply).
2. For a given range, the actual range is +/- (e.g. a range of 10 mV is +/- 10 mV).
3. Supplies of 5 and 10 are + (e.g + 5 V) whereas a supply of 15 V is actually +/- 15 V.
4. All channels have Bridge Resistance set to 350 Ohm.
5. All channels have Filter Characteristic set to Butterworth.
6. All channels have Filter Type set to Low Pass.

Appendix E – Run Log

National Research Council Canada | Conseil national de recherches Canada

NRC-CNRC

TEST LOG

OCEAN, COASTAL & RIVER ENGINEERING (OCRE)

Clearwater Towing Tank(CWT)

Model Construction Technique Evaluation

DATE	TIME	WAIT TIME ACTUAL	Speed (m/s)	FILENAME(.DAC)	RUN DESCRIPTION	Video Track #	COMMENTS
7-Jan-15	8:00						
"	to						Calibrations and set up for model
"	16:00						
"							
8-Jan-15	8:00						Model prep and ballast
"							
"	13:30			XPULL_001	X pull		0.5kg increments
"							
"	14:10		0.9970	M1A1_001	Rough up run		
"							Rezo tow force, pitch, and sinkage instruments
"	14:25		0.9970	M1A1_002	Rough up run		
"							
"	14:35	0:11	3 speeds	M1A1_003	Repeatability test 1		0.6902, 0.9203, 1.1887 m/s
"	14:46	0:10	3 speeds	M1A1_004	Repeatability test 2		
"	14:56	0:11	3 speeds	M1A1_005	Repeatability test 3		
"	15:07	0:10	3 speeds	M1A1_006	Repeatability test 4		Water temp 15.4°
"	15:17	0:10	3 speeds	M1A1_007	Repeatability test 5		
"	15:27	0:11	3 speeds	M1A1_008	Repeatability test 6		
"	15:38	0:10	3 speeds	M1A1_009	Repeatability test 7		
"	15:48	0:10	3 speeds	M1A1_010	Repeatability test 8		
"	15:58	0:10	3 speeds	M1A1_011	Repeatability test 9		
"	16:08	###########	3 speeds	M1A1_012	Repeatability test 10		
"							
"				XPULL_002	X pull		
9-Jan-15							
"	8:10			XPULL_003	X pull		0.5kg increments
"	8:37						Rezero sinkage pots
"	8:40	0:10	0.9970	M1A1_R_001	Rough up		
"	8:50	0:10	0.9970	M1A1_R_002	Rough up		
"	9:00	0:10	3 speeds	M1A1_R_003	Resistance run		0.6902, 0.9203, 1.1887 m/s
"	9:10	0:10	3 speeds	M1A1_R_004	Resistance run		0.7669, 0.9970, 1.1120 m/s
"	9:20	0:10	2 speeds	M1A1_R_005	Resistance run		0.9586, 1.3037 m/s
"	9:30	0:10	2 speeds	M1A1_R_006	Resistance run		1.0736, 1.2654 m/s
"	9:40	0:10	2 speeds	M1A1_R_007	Resistance run		0.8436, 1.2270 m/s
"	9:50	0:13	2 speeds	M1A1_R_008	Resistance run		1.0353, 1.1503 m/s
"	10:03	0:10	2 speeds	M1A1_R_009	Resistance run		1.0736, 1.2654 m/s
"	10:13	0:13	2 speeds	M1A1_R_010	Resistance run		0.8436, 1.2270 m/s

National Research Council Canada | Conseil national de recherches Canada

TEST LOG

Clearwater Towing Tank(CWT)

OCEAN, COASTAL & RIVER ENGINEERING (OCRE)

Model Construction Technique Evaluation

DATE	TIME	WAIT TIME ACTUAL	Speed (m/s)	FILENAME(.DAC)	RUN DESCRIPTION	Video Track #	COMMENTS
"	10:26	0:11	3 speeds	M1A1_R_011	Resistance run		0.6902, 0.9203, 1.1887 m/s
"							
"	10:37	0:10	3 speeds	M1A1_R_012	Repeatability test 1		0.6902, 0.9203, 1.1887 m/s
"	10:47	0:11	3 speeds	M1A1_R_013	Repeatability test 2		
"	10:58	0:10	3 speeds	M1A1_R_014	Repeatability test 3		
"	11:08	0:10	3 speeds	M1A1_R_015	Repeatability test 4		
"	11:18	0:10	3 speeds	M1A1_R_016	Repeatability test 5		
"	11:28	0:10	3 speeds	M1A1_R_017	Repeatability test 6		
"	11:38	0:10	3 speeds	M1A1_R_018	Repeatability test 7		
"	11:48	0:12	3 speeds	M1A1_R_019	Repeatability test 8		
"	12:00	###########	3 speeds	M1A1_R_020	Repeatability test 9		
"							
"				XPULL_004	X pull		0.5kg increments ran out of time repeat
"				XPULL_005			ok
"							Remove model from tank
"	14:30						Cal new aft yo yo pot
"							Change sign on gimbal pitch encoder
"							

Note

temp daily in saving parameters
fwd pot voltage 1.17 volts, keep all model in this range

12-Jan-15							
"							Own The Podium (OTP) were in the tank between 0700 - 0900.
"							
"	9:00						Model prep and ballast
"	10:33			XPULL_006	X pull		0.5kg increments
"	10:55						Rezo sinkage instruments, tow force, and pitch
"							
"	11:00	0:10	0.9970	M1A2_001	Rough up run		
"	11:10	0:20	0.9970	M1A2_002	Rough up run		Water temp 15.4°
"	11:20		0.9970	M1A2_003	Rough up run		
"							
"	11:30	0:10	3 speeds	M1A2_004	Resistance run		0.6902, 0.9203, 1.1887 m/s
"	11:40	0:10	3 speeds	M1A2_005	Resistance run		0.7669, 0.9970, 1.1120 m/s
"	11:50	0:10	2 speeds	M1A2_006	Resistance run		0.9586, 1.3037 m/s
"	12:00	0:10	2 speeds	M1A2_007	Resistance run		1.0736, 1.2654 m/s
"	12:10	0:10	2 speeds	M1A2_008	Resistance run		0.8436, 1.2270 m/s

National Research Council Canada | Conseil national de recherches Canada

TEST LOG

Clearwater Towing Tank(CWT)

OCEAN, COASTAL & RIVER ENGINEERING (OCRE)

Model Construction Technique Evaluation

DATE	TIME	WAIT TIME ACTUAL	Speed (m/s)	FILENAME(.DAC)	RUN DESCRIPTION	Video Track #	COMMENTS
"	12:20	0:10	2 speeds	M1A2_009	Resistance run		1.0353, 1.1503 m/s
"	12:30	0:12	2 speeds	M1A2_010	Resistance run		1.0736, 1.2654 m/s
"	12:42	0:10	2 speeds	M1A2_011	Resistance run		0.8436, 1.2270 m/s
"	12:52	0:10	3 speeds	M1A2_012	Resistance run		0.6902, 0.9203, 1.1887 m/s
"							
"	13:02	0:10	3 speeds	M1A2_013	Repeatability test 1		0.6902, 0.9203, 1.1887 m/s
"	13:12	0:10	3 speeds	M1A2_014	Repeatability test 2		
"	13:22	0:10	3 speeds	M1A2_015	Repeatability test 3		
"	13:32	0:10	3 speeds	M1A2_016	Repeatability test 4		
"	13:42	0:10	3 speeds	M1A2_017	Repeatability test 5		
"	13:52	0:11	3 speeds	M1A2_018	Repeatability test 6		
"	14:03	0:10	3 speeds	M1A2_019	Repeatability test 7		
"	14:13	0:10	3 speeds	M1A2_020	Repeatability test 8		
"	14:23	0:14	3 speeds	M1A2_021	Repeatability test 9		
"	14:37			Xpull_007			
"							Remove model from tank
"							

13-Jan-15							
"							Own The Podium (OTP) were in the tank between 0700 - 0900.
"							
"	9:00	1:42					Model prep and ballast
"	10:42	0:34		XPULL_008	X pull		0.5kg increments
"							Rezo sinkage instruments, tow force, and pitch
"	11:16	0:10		M2A1_001	Rough up		0.9979 m/s
"	11:26	0:10		M2A1_002	Rough up		Water temp 15.5°
"	11:36	0:10		M2A1_003	Resistance run		0.6902, 0.9203, 1.1887 m/s
"	11:46	0:11		M2A1_004	Resistance run		0.7669, 0.9970, 1.1120 m/s
"	11:57	0:10		M2A1_005	Resistance run		0.9586, 1.3037 m/s
"	12:07	0:10		M2A1_006	Resistance run		1.0736, 1.2654 m/s
"	12:17	0:10		M2A1_007	Resistance run		0.8436, 1.2270 m/s
"	12:27	0:10		M2A1_008	Resistance run		1.0353, 1.1503 m/s
"	12:37	0:10		M2A1_009	Resistance run		1.0736, 1.2654 m/s
"	12:47	0:10		M2A1_010	Resistance run		0.8436, 1.2270 m/s
"	12:57	0:13		M2A1_011	Resistance run		0.6902, 0.9203, 1.1887 m/s
"							
"	13:10	0:10		M2A1_012	Repeatability test 1		0.6902, 0.9203, 1.1887 m/s
"	13:20	0:10		M2A1_013	Repeatability test 2		
"	13:30	0:10		M2A1_014	Repeatability test 3		
"	13:40	0:15		M2A1_015	Repeatability test 4		
"							Went out on water in boat to check turbelence studs, therefore disturbed water
"	13:55	0:10		M2A1_016	Repeatability test 5		

National Research Council Canada | Conseil national de recherches Canada

TEST LOG

Clearwater Towing Tank(CWT)

OCEAN, COASTAL & RIVER ENGINEERING (OCRE)

Model Construction Technique Evaluation

DATE	TIME	WAIT TIME ACTUAL	Speed (m/s)	FILENAME(.DAC)	RUN DESCRIPTION	Video Track #	COMMENTS
"	14:05	0:10		M2A1_017	Repeatability test 6		
"	14:15	0:10		M2A1_018	Repeatability test 7		
"	14:25	0:10		M2A1_019	Repeatability test 8		
"	14:35	##########		M2A1_020	Repeatability test 9		
"							
"	15:02			XPULL_009			
"							
"							

14-Jan-15							
"							Own The Podium (OTP) were in the tank between 0700 - 0900.
"							
"							Check floatation
"	9:15	0:26		XPULL_010	X pull		0.5kg increments
"							Rezo sinkage instruments, tow force, and pitch
"	9:41	0:10		M2A2_001	Rough up		0.9979 m/s
"	9:51	0:10		M2A2_002	Rough up		Water temp 15.5°
"	10:01	0:10		M2A2_003	Resistance run		0.6902, 0.9203, 1.1887 m/s
"	10:11	0:10		M2A2_004	Resistance run		0.7669, 0.9970, 1.1120 m/s
"	10:21	0:10		M2A2_005	Resistance run		0.9586, 1.3037 m/s. Water temp 15.45C
"	10:31	0:10		M2A2_006	Resistance run		1.0736, 1.2654 m/s
"	10:41	0:10		M2A2_007	Resistance run		0.8436, 1.2270 m/s
"	10:51	0:10		M2A2_008	Resistance run		1.0353, 1.1503 m/s
"	11:01	0:10		M2A2_009	Resistance run		1.0736, 1.2654 m/s
"	11:11	0:10		M2A2_010	Resistance run		0.8436, 1.2270 m/s
"	11:21	0:13		M2A2_011	Resistance run		0.6902, 0.9203, 1.1887 m/s
"							
"	11:34	0:10		M2A2_012	Repeatability test 1		0.6902, 0.9203, 1.1887 m/s
"	11:44	0:10		M2A2_013	Repeatability test 2		
"	11:54	0:10		M2A2_014	Repeatability test 3		
"	12:04	0:10		M2A2_015	Repeatability test 4		
"	12:14	0:11		M2A2_016	Repeatability test 5		
"	12:25	0:11		M2A2_017	Repeatability test 6		
"	12:36	0:10		M2A2_018	Repeatability test 7		
"	12:46	0:10		M2A2_019	Repeatability test 8		
"	12:56	##########		M2A2_020	Repeatability test 9		
"							
"	13:15			XPULL_011			
"							Remove model from tank
"							

National Research Council Canada | Conseil national de recherches Canada

TEST LOG

Clearwater Towing Tank(CWT)

OCEAN, COASTAL & RIVER ENGINEERING (OCRE)

Model Construction Technique Evaluation

DATE	TIME	WAIT TIME ACTUAL	Speed (m/s)	FILENAME(.DAC)	RUN DESCRIPTION	Video Track #	COMMENTS
15-Jan-15							
"							Own The Podium (OTP) were in the tank between 0700 - 0900.
"							Model prep and ballast
"	10:31	0:31		XPULL_012	X pull		0.5kg increments
"							Rezo sinkage instruments, tow force, and pitch
"	11:02	0:10		M2A3_001	Rough up		0.9979 m/s
"	11:12	0:10		M2A3_002	Rough up		Water temp 15.5°
"	11:22	0:10		M2A3_003	Resistance run		0.6902, 0.9203, 1.1887 m/s
"	11:32	0:11		M2A3_004	Resistance run		0.7669, 0.9970, 1.1120 m/s
"	11:43	0:10		M2A3_005	Resistance run		0.9586, 1.3037 m/s
"	11:53	0:10		M2A3_006	Resistance run		1.0736, 1.2654 m/s
"	12:03	0:10		M2A3_007	Resistance run		0.8436, 1.2270 m/s
"	12:13	0:10		M2A3_008	Resistance run		1.0353, 1.1503 m/s
"	12:23	0:10		M2A3_009	Resistance run		1.0736, 1.2654 m/s
"	12:33	0:10		M2A3_010	Resistance run		0.8436, 1.2270 m/s
"	12:43	0:10		M2A3_011	Resistance run		0.6902, 0.9203, 1.1887 m/s
"							
"	12:53	0:10		M2A3_012	Repeatability test 1		0.6902, 0.9203, 1.1887 m/s
"	13:03	0:12		M2A3_013	Repeatability test 2		
"	13:15	0:10		M2A3_014	Repeatability test 3		
"	13:25	0:10		M2A3_015	Repeatability test 4		
"	13:35	0:10		M2A3_016	Repeatability test 5		
"	13:45	0:10		M2A3_017	Repeatability test 6		
"	13:55	0:10		M2A3_018	Repeatability test 7		
"	14:05	0:10		M2A3_019	Repeatability test 8		
"	14:15	##########		M2A3_020	Repeatability test 9		
"							
"	14:31			XPULL_013			
"							

16-Jan-15							
"	8:23			XPULL_014	X pull		0.5kg increments
"	8:44						Rezo sinkage, tow force, and pitch
"	8:49	0:11		M2A4_001	Rough up		0.9979 m/s
"	9:00	0:10		M2A4_002	Rough up		Water temp 15.6°
"	9:10	0:11		M2A4_003	Resistance run		0.6902, 0.9203, 1.1887 m/s
"	9:21	0:09		M2A4_004	Resistance run		0.7669, 0.9970, 1.1120 m/s
"	9:30	0:10		M2A4_005	Resistance run		0.9586, 1.3037 m/s
"	9:40	0:10		M2A4_006	Resistance run		1.0736, 1.2654 m/s
"	9:50	0:11		M2A4_007	Resistance run		0.8436, 1.2270 m/s
"	10:01	0:10		M2A4_008	Resistance run		1.0353, 1.1503 m/s
"	10:11	0:10		M2A4_009	Resistance run		1.0736, 1.2654 m/s

National Research Council Canada | Conseil national de recherches Canada

TEST LOG

Clearwater Towing Tank(CWT)

OCEAN, COASTAL & RIVER ENGINEERING (OCRE)

Model Construction Technique Evaluation

DATE	TIME	WAIT TIME ACTUAL	Speed (m/s)	FILENAME(.DAC)	RUN DESCRIPTION	Video Track #	COMMENTS
"	10:21	0:10		M2A4_010	Resistance run		0.8436, 1.2270 m/s
"	10:31	0:10		M2A4_011	Resistance run		0.6902, 0.9203, 1.1887 m/s
"							
"	10:41	0:10		M2A4_012	Repeatability test 1		0.6902, 0.9203, 1.1887 m/s
"	10:51	0:10		M2A4_013	Repeatability test 2		
"	11:01	0:10		M2A4_014	Repeatability test 3		
"	11:11	0:10		M2A4_015	Repeatability test 4		
"	11:21	0:11		M2A4_016	Repeatability test 5		
"	11:32	0:10		M2A4_017	Repeatability test 6		
"	11:42	0:10		M2A4_018	Repeatability test 7		
"	11:52	0:10		M2A4_019	Repeatability test 8		
"	12:02	##########		M2A4_020	Repeatability test 9		
"							
"	12:18			XPULL_015			
"							Decomission