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Publisher's version / Version de l'éditeur:
https://doi.org/10.4224/40001905
Technical Report (National Research Council of Canada. Ocean, Coastal and River Engineering); no. OCRE-TR-2017-008, 2018-02-01

NRC·CNRC Ocean, Coastal and River Engineering

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St. John’s

February 2018

National Research Council Canada Conseil national de recherches Canada

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

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Report Number: **OCRE-TR-2017-008**

Program	**Project Number**	**Publication Type**
Marine Vehicles	A1-008210 and A1-009236	Technical Report

Title (and/or other title)
Seakeeping Interaction Model Tests for a Corvette and Rigid-hull Inflatable Boat

Author(s) – Please specify if necessary, corporate author(s) and Non-NRC author(s)
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Client(s)
Defence Research and Development Canada - Atlantic Research Centre (DRDC Atlantic)

Key Words (5 maximum)	**Pages**	**Confidentiality Period**
seakeeping, interaction, RHIB	150	

Security Classification	**Distribution**	**How long will the report be Classified/Protected?**
UNCLASSIFIED	UNLIMITED	

Limited Distribution List (mandatory when distribution is Limited)

Date:	**VER #**	**Description:**	**Prepared by:**	**Check by:**
20/03/2017	1	Draft	C. Muselet	K. McTaggart, D. Perrault
24/09/2017	2	Draft with comments addressed	C. Muselet	K. McTaggart
16/02/2018	3	Final	C. Muselet	

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Executive Summary

Model experiments were carried out for the Department of National Defence in the towing tank of the National Research Council in St. John's to investigate seakeeping interaction in head seas and following seas of a corvette and rigid-hull inflatable boat (RHIB) operating alongside the corvette at midships with 1.5 m lateral gap, at forward speed of 8 knots.

Models of scale 1:11.625 were used for these tests. The corvette model was towed by the carriage and free to heave, pitch and roll. The RHIB model was self-propelled, with speed and heading controlled by an autopilot system. The models were tested both side by side and alone at a forward speed of 8 knots, and the RHIB was also tested alone at a forward speed of 4 knots to examine the effect of speed on seakeeping.

The wave conditions included regular waves of 1/50 steepness at 14 full-scale wave frequencies ranging from 0.7 to 2.0 rad/s full-scale, and an irregular seastate defined by a Bretschneider spectrum with significant height of 1.25 m and peak wave period of 7.5 s full-scale.

Heave, pitch and roll motions of the corvette were measured, and motion displacements of the RHIB were measured in all six degrees of freedom, along with the propeller shaft speed and steering angle.

Comparison of the motions of the vessels in the different test configurations showed that the RHIB expectedly had little effect on the corvette motions, while the motions of the RHIB were affected significantly by the proximity of the corvette. In particular, roll and yaw motions were increased, as the corvette generated lateral wave action for the RHIB. On the other hand, in following seas surge, heave and pitch motions of the RHIB were attenuated by the presence of the corvette. Trends observed in irregular seas were consistent with those observed in regular waves. The effect of speed on seakeeping of the RHIB alone was quantified. A large set of experimental data was provided for validation of the numerical tool for prediction of seakeeping interaction.

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List of Abbreviations and Notations

Acronyms

DND	Department of National Defence
DRDC	Defence Research and Development Canada
NRC	National Research Council
OCRE	Ocean, Coastal and River Engineering
RHIB	Rigid-hull inflatable boat
DOF	Degrees of freedom

Geometry of ship

B	Beam, m
B_{WL}	Beam of waterline, m
BM_T	Transverse metacentric radius, m
GM_T	Transverse metacentric height, m
KB	Distance from keel to the centre of buoyancy, m
KM_T	Distance from keel to the transverse metacenter, m
I	Second moment of area of the waterplane, m^4
LCB	Longitudinal centre of buoyancy
LCF	Longitudinal centre of flotation
L_{OA}	Length overall, m
L_{WL}	Length of waterline, m
G	Centre of gravity
L_{PP}	Length between perpendiculars
T	Draft
V	Immersed volume, m^3
VCB	Vertical centre of buoyancy, m
VCG	Vertical centre of gravity, m

Seakeping experiments

a	Wave amplitude
k	Wave slope
f	Wave frequency
λ	Wavelength
ω, ω_W	Circular wave frequency
ω_e	Encounter circular wave frequency
T	Wave period
ζ	Linear damping coefficient
m_0	Zeroth spectral moment (record variance)
N	Number of wave encounters (average of number of up-and down-crossings N_{WD} and N_{WU})
T_{AV}	Average period of zero up- or down-crossing cycles
T_P	Peak period
T_{PD}	Spectrum peak period, calculated using the peak period

Hm_0 Significant height estimate $Hm_0 = 4 * \sqrt{m_0}$
Hs Wave significant height
I_{xx} Roll mass moment of inertia of a vessel about its center of gravity
I_{yy} Pitch mass moment of inertia of a vessel about its center of gravity
I_{zz} Yaw mass moment of inertia of a vessel about its center of gravity
k_{xx} Roll radius of inertia
k_{yy} Pitch radius of inertia
k_{zz} Yaw radius of inertia
St Dev, STD Standard deviation

<u>Autopilot</u>
P Proportional
I Integral
D Derivative
K_P Proportional gain
K_I Integral gain
K_D Derivative gain
LQR Linear quadratic regulator
t_0 Time at start of experiment run
Δx Surge position error
Δy Sway position error
v_c Carriage speed velocity
δ_r Rudder input
N_d Shaft speed demand
u Surge velocity relative to the carriage (or corvette)
v Sway velocity
ψ Yaw angle
$\dot{\psi}$ Yaw rate
ψ_d Desired heading

<u>Units</u>
deg degree
Hz Hertz
kg kilogram
kt, kts knot(s)
m meter
mV/V millivolt per volt
n.d. non-dimensional
N Newton
N-m Newton-meter
rad radians
s, sec second

t, MT tonne

General/standard values

g	Gravitational acceleration, 9.808 m/s^2
ρ_f	Water density, fresh water at 15°C, 999.10 kg/m^3
ρ_s	Water density, seawater at 15°C, 1026.02 kg/m^3

1 Introduction

This document describes the work done by the National Research Council of Canada (NRC) for Defence research and Development Canada (DRDC) to carry out seakeeping interaction model tests for a ship and rigid-hull inflatable boat (RHIB) operating at forward speed in head and following seas. The objective of these tests is to provide insight into hydrodynamic effects during launch and recovery operations, and to provide validation data for numerical predictions of ship motions in waves. The scale was 1:11.625.

The experiments were carried out over two test sessions. During the first session in May 2016, seakeeping model tests were completed for the ship alone. The implementation of the RHIB model autopilot did not perform satisfactorily at the time, and a second test session was planned in December 2016, when all tests involving the RHIB model were completed.

2 Test requirements

DRDC requested seakeeping interaction model tests to be carried out for a navy ship and a rigid-hull inflatable boat. The RHIB model would represent existing and anticipated future RHIBs of approximately 9 m in length (full scale). At the scale chosen for the tests, the existing ship model would represent a 70 m corvette.

The corvette model was towed by the carriage, and was free to pitch and heave. The RHIB model was self-propelled, with speed and heading controlled by an autopilot.

Tests were conducted in head and following seas for the following combinations:

- Corvette with forward speed of 8 knots full scale, which corresponds to operational conditions for launch and recovery.
- Corvette and RHIB at forward speed of 8 knots full scale, with RHIB alongside the corvette at midships with 1.5 m full scale lateral gap.
- RHIB with forward speeds of 8 knots and 4 knots full scale, with the purpose to examine the variation of RHIB seakeeping with speed.

Regular wave model tests were conducted for 14 full-scale wave frequencies of 0.7, 0.8, 0.9, …, 2.0 rad/s, with a wave steepness of 1/50, in both head seas and following seas.

Irregular wave model tests were conducted using a Bretschneider spectrum with a significant wave height of 1.25 m and a peak wave period of 7.5 seconds, full scale, in both head and following seas.

The definition and characteristics of the waves are shown in Table 6.

At the model test speed for 8 knots (1.2 m/s in the towing tank), no wall interference effects affect the corvette for tests in head seas regular waves. The ITTC-recommended minimum frequency to avoid wall interference in head seas (Ref 4) corresponds for this case to 0.106 Hz, or 0.67 rad/s, full scale. In head seas irregular waves, the corvette could be encountering wall interference effects for the lowest frequencies in the spectrum.

3 Facility

The Towing Tank is 200 m long, 12 m wide and 8 m high to the top of the wall. It is filled with fresh water to a constant depth of 7 m and is equipped with a dual flap wave-maker at the west end. Phasing of wave-maker motions is automatically chosen to optimize the wave profiles. The wave-maker is installed on a raised level with the lower and upper hinges located 4.0 m and 1.2 m below the water level, respectively. This computer controlled hydraulic dry-back wave-maker system can generate unidirectional regular and irregular waves within its performance envelope. Waves are absorbed at the opposite (east) end of the tank by a parabolic beach constructed of a steel frame and covered with wooden slats. Flexible side beaches covering the entire length of the tank can be deployed in between runs to absorb the lateral waves and minimize the time between runs.

4 Models

4.1 Corvette model

Existing model OCRE928 was selected for these tests. The nominally 6 m long model was fabricated in 2014 by NRC OCRE as a model of a “Notional Destroyer”, using Design 24 of the NRC Hull Series. For the purpose of the present project, the model was deemed to represent a smaller ship, a corvette at scale 1: 11.625. The hull lines are shown in Figure 1.

By using this model to represent a smaller vessel than it was originally designed for, the model scale wave frequencies were kept below the 1.2 Hz limit of the tow tank wave-maker operating envelope, and the displacement of the RHIB model at the test scale provided sufficient room to accommodate the propulsion and control equipment and instrumentation.

Autoship™ software was used to calculate hydrostatic properties of the corvette at a floatation corresponding to full scale draft of 2.51 m. Results are provided in Appendix A at full scale (seawater) and at model scale (freshwater). The corvette main particulars are summarized in Table 1 below.

Table 1 Corvette particulars

	Full Scale	Model Scale (1:11.625)
Displacement	772.19 t (saltwater)	479.5 kg (freshwater)
L_{OA}	72.34 m	6.223 m
L_{PP}	70.08 m	6.028 m
L_{WL}	70.19 m	6.038 m
B_{WL}	8.24 m	0.709 m
Draft	2.51 m	0.216 m
LCB (from midships)	-1.093 m	-0.094 m

The forward speed of 8 knots corresponds to Froude number 0.157 for the corvette.

The OCRE928 model is made of fiberglass laminate over a polystyrene foam core with ¾ inch plywood structure and Renshape for areas requiring reinforcement, as described in the OCRE standard construction method (Ref 1). The model is permanently fitted with twin A-bracket shaft supports. For these tests, the model was outfitted with shafts, propeller hubs and fairings. Rudders and propellers were not fitted. Photographs of the model are shown in Figure 2.

The model has the waterline and ten stations marked, as described in Figure 3. The figure also shows the locations of milled reference surfaces that can accommodate trim hooks for trimming the model.

A gimbal was fastened into the model. Once connected to the yaw-restrained heave post of the carriage tow post, this allowed the model freedom to pitch, roll and heave. The pitch pivot point of the gimbal was located in the model along the propeller shaft line and at the nominal longitudinal centre of buoyancy (LCB), as illustrated in Figure 4. Locations are defined from the CAD origin, which is at Station 0 and at the height of the baseline.

To determine the mass properties of the bare model outfitted with shafts and propeller hubs (lightship), a CAD solid model of OCRE928 was developed. This method is deemed to have lower uncertainty than the results of a physical determination swinging the model in a relatively heavy swing frame. The mass calculated in the CAD model was checked against the measured mass of the physical bare hull model. The location and mass of each individual components added into the model was measured. The centre of gravity and total inertia were calculated by summing all the components. The mass properties of the ballasted model were determined by adding numerically each piece of ballast. The floatation trim confirmed the longitudinal centre of gravity, and the vertical centre of gravity was verified by performing an inclining experiment.

4.2 RHIB model

A commercially available model of a RHIB hull, named "Wiking hull", was sourced from the German company Kehrer Modellbau.

The hull structure is made from epoxy resin with fiberglass between 120 and 280 grams per square meter, cured at temperatures around 60 degrees Celsius. Hull and superstructure are joined together.

The hull is shown in Figure 5. It was purchased to represent a 9.3 m RHIB at the scale 1:11.625, based on the listed nominal length of 800 mm. The model hull was scanned by NRC Design and Fabrication Services in Ottawa, and reverse-engineered to produce digital hull lines and a solid model in CAD software KeyCreator. The actual length overall of the model hull is 0.788 m, and beam is 0.322 m. At the test scale of 1:11.625, this represents a 9.16 m RHIB hull.

The main particulars of the RHIB hull, at target displacement of 7200 kg full scale (4.47 kg model scale) and floatation trim of 0.47 degree by the stern relative to the keel line, were derived from the CAD model and are summarized below.

Table 2 RHIB particulars

	Full Scale	Model Scale (1:11.625)
Displacement	7200 kg	4.47 kg
L_{OA}	9.16 m	0.788 m
L_{WL}	8.31 m	0.715 m
Beam	3.74 m	0.322 m
Draft at midship	0.62 m	0.053 m
trim	0.47 deg by the stern	

The forward speeds of 8 knots and 4 knots correspond to Froude numbers of 0.456 and 0.228, respectively, for the RHIB.

RHIB model local coordinate system:
Figure 6 shows the geometry of the outfitted RHIB model, and the CAD local coordinate system used for identifying locations on the RHIB model. The CAD origin is in the hull symmetry plane, at the intersection of the transom and the baseline. Note that this figure does not show the tower in its correct configuration; in reality, the tower is perpendicular to the deck.

The CAD model of the hull was used to derive basic hydrostatics. The transverse metacenter was determined as follows. The volume and waterplane area properties yielded KB=0.042 m (full scale: 0.488 m) and BM_T as I/V (where I is the second moment of area of the waterplane, and V the immersed volume). Derived from these two quantities, KM_T was 0.171 m model scale (1.988 m full scale).

The mass properties of the bare and of the fully outfitted model were determined numerically using the CAD solid model. This method was deemed to have lower uncertainty than a physical determination using a swing frame weighing significantly more than the model. Modifications to the hull, such as cutouts in the deck and stern or added polycarbonate deck cover, were represented with the appropriate shape in the CAD solid model and density was selected to match the measured weight of the removed or added part. Each component of propulsion, control and measurement equipment was weighed and was represented in the CAD model with suitably shaped solids of homogeneous density to match the measured weight. The component locations were adjusted where possible, to approach target values of metacentric height and mass moments of inertia for the outfitted hull.

The dimensional and mass properties derived numerically from the CAD model are presented in Table 3 below. It includes the location of the centre of gravity in the model coordinate system, and moments of inertia around the centre of gravity. GMt is derived from VCG and KMt.

Table 3 RHIB mass properties

	Full Scale (saltwater)	Model scale (1:11.625)
LCG	3.046 m	0.262 m
TCG	0.012 m	0.001 m
VCG	0.977 m	0.084 m
GMt	1.011 m	0.087 m
Ixx	4918 kg.m^2	0.0226 kg.m^2
Iyy	36037 kg.m^2	0.1656 kg.m^2
Izz	37778 kg.m^2	0.1736 kg.m^2
k_{xx}/Beam	0.222	
k_{yy}/L_{OA}	0.245	
k_{zz}/L_{OA}	0.251	

The RHIB model was self-propelled, with speed and heading controlled by an autopilot.

The model was fitted with a single screw outdrive unit (TFL P1) with a 35 mm diameter two-blade bronze propeller, with power provided by a brushless DC servomotor (Faulhaber model 2057 S 024), with speed controller.

The outdrive unit was turned with a Hitec HS-5646WP waterproof high torque, high voltage servomotor. The range of available steering angles was approximately ±16 deg. The adjustable trim of the outdrive unit was set to 0.89 degree for these tests (bringing the model bow up).

Other outfit items include motor controllers, radio control/telemetry electronics, autopilot electronics, instrumentation, a micro video camera, and several lithium-ion batteries (two 12.8V 4500mAh batteries composed of 12 units each, to power the data acquisition system, and one 12.8V 3300mAh battery composed of 4 units, to power the outdrive motor controller).

Figure 7 and Figure 8 show photographs of the outfitted RHIB model.

4.3 RHIB autopilot

To ensure that the test runs were consistent and could be modeled in software simulations, the RHIB model was controlled by an autopilot.

During the interaction tests, the RHIB model was required to keep station next to the corvette model, at midships with 1.5 m full scale (0.129 m model scale) lateral gap. The specified tolerances for station-keeping were ±1 m full scale (±0.086 m model scale) in sway and ±2 m full scale (±0.172 m model scale) in surge. To achieve this, OCRE customized autopilot software for a controller designed to maintain a moving position relative to the corvette model in surge and sway axes.

The autopilot is based on an inner course-keeping loop to control heading and an outer sway-keeping loop to control sway position relative to the corvette. Figure 9 shows the control block diagram. The surge axis uses an independent controller to vary speed to maintain surge position relative to the corvette. Thus, there are 3 control loops:

1. The course-keeping control is based on state feedback of a coupled yaw-sway model developed for the RHIB model. The state variables are: body-frame sway velocity v (m/s), yaw rate $\dot{\psi}$ (deg/s), and yaw angle ψ (deg). The controller was tuned using the linear quadratic regulator (LQR) method. The state feedback gains were further adjusted during model tests to tune performance. Details of the coupled yaw-sway model are provided further in this section.

2. The sway-keeping control is a proportional-integral (PI) loop controlling sway position by changing heading demand. The sway-keeping controller provides a desired heading ψ_d based on:

$$\psi_d = K_{Py}\Delta y + K_{Iy}\int_{t_0}^{t} \Delta y \; dt$$

   where t_0 represents the beginning of an experimental run and Δy represents the sway position error. Integral windup was managed on a per-run basis by initializing the controller only when the model was near the desired position.

3. The surge-keeping control is a proportional-integral-derivative (PID) loop controlling surge position with throttle. The surge controller is augmented by a feed-forward term based on tow carriage velocity. A curve relating model speed to motor shaft speed was developed for this purpose. The surge-keeping controller output is given in turns of shaft speed demand N_d, per the following equation:
$$N_d = 100\left(K_{Px}\Delta x + K_{Ix}\int_{t_0}^{t}\Delta x \ dt + K_{Dx}u + 13.7{v_c}^2 + 25.2|v_c|\right)$$
where Δx represents the surge position error, $u\left(=\frac{d\Delta x}{dt}\right)$ is the surge velocity relative to the carriage – or corvette-, v_c represents the carriage – or corvette-velocity, and the integration is handled similarly to the sway-keeping controller. The experimentally determined values $\{13.7, 25.2\}$ form a 2nd order fit of model speed to shaft speed.

The coupled yaw-sway model was identified using system identification methods with data from calm water zig-zag maneuvers carried out at the main test speed of interest (8 knots full scale, 1.2 m/s model scale). The identified continuous-time model is given by:

$$\begin{bmatrix}\dot{v}\\ \ddot{\psi}\\ \dot{\psi}\end{bmatrix} = \begin{bmatrix}-0.1624 & 0.0375 & 0\\ -16.71 & -1.674 & 0\\ 0 & 1 & 0\end{bmatrix}\begin{bmatrix}v\\ \dot{\psi}\\ \psi\end{bmatrix} + \begin{bmatrix}0.03652\\ -3.871\\ 0\end{bmatrix}\delta_r$$

where δ_r is the rudder input in degrees. The model was discretized at 20 Hz, which was the frequency of all control loops. Using this model, the state feedback gains were calculated to be $[2.6024 \quad -0.5 \quad -1]$. Therefore, the rudder input (in degrees) is given by the following control equation:

$$\delta_r = [2.6024 \quad -0.5 \quad -1][v \quad \dot{\psi} \quad (\psi - \psi_d)]^T$$

These inner-loop gains held for all test conditions.

During physical testing, the sway velocity v and surge velocity u are estimated in real-time using a Kalman filter implementation of a strap-down Inertial Navigation System (INS) with a state vector of $[x, y, z, u, v, w, \mu_x, \mu_y, \mu_z]^T$ where $\vec{\mu}$ is an estimate of the accelerometer biases. The Kalman filter uses the on-board accelerometer measurements as input and the Qualisys position as measurement. This filtering is only necessary to obtain real-time estimates of the surge and sway velocities for control. These signals are available in simulation and can be calculated during post-processing for analysis.

The sway-keeping and surge-keeping gains were tuned during testing to improve performance for each test condition, and are provided in Table 7 and Table 8.

Some difficulty was encountered in tuning the autopilot for the RHIB model, due to the presence of an un-modeled oscillatory response in the yaw axis, which resulted in a requirement to re-tune the gains calculated using the LQR method. This yaw oscillation was investigated by holding a steady rudder and observing the response at varying speeds. The oscillation in yaw was on the order of ±2° with a period of approximately 2 seconds at the model scale test speed of 1.2 m/s, in calm water. The frequency and amplitude of the oscillation were reduced at higher speeds (1.4 m/s). The exact cause of the oscillation is not known, but is likely related to some aspect of the model configuration. Further investigation into the hydrodynamic properties of this type of hull may be warranted and of value for future development. Another difficulty involved maintaining the required station-keeping tolerances for the size of the model relative to the magnitude of disturbances encountered (e.g., waves).This was due to the limitations on the available actuation.

During the seakeeping tests with the RHIB model alone, the same autopilot strategy was used as during the interaction tests. The autopilot was aiming to maintain the RHIB model at the same location in sway and surge relative to the carriage as it did in the presence of the corvette model.

5 Instrumentation and acquisition system

5.1 Water elevation:

Two capacitance probes were used to measure the wave elevation.

- The “upstream wave probe” was mounted at a fixed location in the tank, 19 m from the wave-maker and approximately 5 m from the south tank wall. Cardinal orientation for the towing tank is shown in Figure 10.

- A second wave probe with faired support rod, the “encounter wave probe”, was attached to the west end of the tow carriage, approximately 3 m north of the tank longitudinal centerline. For the seakeeping tests with the corvette alone (in May 2016), the encounter wave probe was moved to the east end of the tow carriage for the runs in following seas. For all tests involving the RHIB model (December 2016), the encounter wave probe was kept on the west side of the tow carriage, including for tests in following seas.

Both wave probes were calibrated using a linear actuator that varied the height of the probe on a flat water surface.

5.2 Corvette model measurements:

- Heave displacement (also named sinkage) was measured at the tow point location with a string potentiometer (yoyo pot). It was calibrated with a dedicated apparatus whereby the yoyo pot cable is attached to a flat plate that can be adjusted in discrete increments to a known distance from the sensor.

- Pitch angle was measured with a Heidenhain (ROD 250) optical incremental angle encoder, fitted along the gimbal pitch pivot axis. The manufacturer calibration was used.

- Roll angle was measured with a Waters WPM rotary potentiometer fitted along the gimbal roll pivot axis. To verify static heel angle, the model was also fitted with a Schaevitz LSOC gravity-referenced inclinometer. The rotary potentiometer and the Schaevitz inclinometer were calibrated using a digital inclinometer.

- The speed of the towed model was provided by the carriage speed measurement. Two measurements are available: one from the carriage control system, processing pulse count information from a touch roller, and the other from a tachogenerator connected to one of the eight drive shafts. Data analysis used the latter. Carriage speed was calibrated using carriage control set speed as reference, over a range from -0.5 to +2 m/s. Set speed is calibrated periodically, by setting up two proximity switches on the tow tank rails at a measured distance apart with companion switches on the tow carriage linked by cable to the carriage data acquisition system, and recording the time between activation of the switches during a constant speed run.

5.3 RHIB model measurements:

Motions of the RHIB model were measured with the following instruments.

- Linear accelerations in model coordinates were measured at a location along centerline, 0.133 m ahead of transom and 0.084 m above keel line (design origin), or 0.129 m aft of the centre of gravity and at the same height, using a triaxial accelerometer (Model 4030 by Measurement Specialties). The accelerometer was calibrated in all three axes using the gravitational acceleration. Accelerations were transferred to the nominal centre of gravity during data processing.

- Angular rotations were measured with three angular rate sensors (gyroscopes) (model ADXRS620Z by Analog Devices). The gyroscopes were calibrated on a rate table.

- A 3D-MEMS-based dual axis inclinometer (model SCA100T-D01-1 by muRata) was also included for measuring static pitch and roll angles during floatation setup. It was calibrated using a Mitutoyo digital protractor (Pro 3600).

- The QUALISYS Motion Capture System was used to determine orthogonal linear displacements and rotations of the RHIB model. The QUALISYS system comprised a set of two cameras mounted to the frame under the carriage, a dedicated software package, and four active infrared emitters and a receiver fitted on the RHIB model deck such that the array of cameras could track planar position and measure motions.

  Calibration of the QUALISYS was done by capturing the geometry of a QUALISYS-provided L-frame with markers. A wand of known span was then moved in the field of view of the cameras to validate the calibration and quantify the residual error. Finally, the QUALISYS frame of reference had to be rotated into a tank coordinate system with horizontal X-axis aligned with the tank travel direction, and horizontal Y-axis. This was done by capturing a marker located successively on three of the milled trim reference surfaces of the corvette model, providing displacements of known geometry across and along the length of the leveled corvette model aligned with the direction of the tank.

  QUALISYS provides the locations (X, Y, Z) of a reference location on the model in a carriage-fixed inertial frame of reference parallel with the tank frame of reference pointing towards the wave-maker, and the rotation angles. The rotation angles are the nautical Euler angles (Tait-Bryan angles) in z-y'-x" sequence: heading angle, and pitch and roll angles. QUALISYS motions were acquired for a reference location on the model chosen to suit autopilot operation, of local coordinates (0.153m, 0.005m, 0.086m) in the RHIB model coordinate system (110 mm aft and 5 mm to starboard of the nominal centre of gravity, and 2 mm above it). The QUALISYS displacements were transferred to the nominal centre of gravity during data processing and are reported at the centre of gravity (as signals "QUAL X Rot", "QUAL Y Rot", "QUAL Z"). For tests in following seas, where the model travels towards the beach, QUALISYS motions were rotated by 180° around the vertical axis to provide surge, sway and yaw in the conventional sense, in an inertial frame of reference with x-axis pointing towards the direction of travel of the vessel (cf. Section 6.5).

- Planar (X, Y) position from the QUALISYS system combined with the carriage speed measurement was used to determine RHIB model speed over ground.

RHIB model propulsion and steering parameters were measured with the following instruments.

- Steering angle was measured using the potentiometer included on top of the Hitech steering servo shaft. It was calibrated using a protractor.

- Shaft speed was measured with a Hall-effect direction-detection sensor (model A3422 by Allegro Microsystems), calibrated using a handheld digital tachometer (DT-205LR by Shimpo Instruments).

The autopilot PID gains in surge and sway were acquired during each run for record of the autopilot settings.

A small video camera was installed at the top of a central tower on the deck to assist the operator in driving the model in between runs.

5.4 Data Acquisition

Data was acquired using the NRC OCRE client/server data acquisition and control system GDAC. For the full test setup including the RHIB model, data was acquired on six separate servers as described below, before being transferred to the carriage workstation running GDAC calibration and acquisition software.

- The upstream wave probe signal was conditioned and digitized on the OEB imc signal conditioner and data server (“oebdas”).

- All carriage and corvette model signals other than pitch, including the encounter wave probe signal and carriage speed and position, were conditioned and digitized using the carriage-based imc CRC-400 signal conditioner (“towdas”).

- The gimbal pitch encoder signal was conditioned and digitized on its own dedicated pc (“das33”), equipped with Heidenhain custom counter card (IK 220) and software.

All analog data for the corvette was low pass filtered at 10 Hz, amplified as required, and digitized at a sampling rate of 50Hz.

- All data acquired from sensors located on the RHIB model was conditioned on the model using a 16-channel PCB designed in-house. The analog data was low pass filtered at 40 Hz and amplified as required, and digitized with MAX1168 16-bit analog-to-digital converters at a sampling rate of 146 Hz. It was then transferred to the carriage-based data acquisition server (“das56”) via Bluetooth radio telemetry, where it was sampled at 50 Hz.

- QUALISYS data was generated through Qualisys software on a dedicated PC (“qualidas”).

- In addition, a number of signals used to monitor parameters of the autopilot were produced by the autopilot software on dedicated server “das87”.

Network Time Protocol is used to keep all computers synchronized to a time server, with synchronization taking place every 10 minutes. While the time offset between any two acquisition servers at any point is nominally less than 100 milliseconds, according to the log of synchronization the time offset was less than 50 milliseconds for all runs but one (corvette in the regular wave of lowest frequency). Quantities impacted by a synchronization time discrepancy are the calculated phases of the corvette pitch and of the RHIB motions and driving parameters, for tests in regular waves. A 50 milliseconds time uncertainty translates into a 7 degree uncertainty in phase determination for the tests in the waves of longest period, up to a 20 degree uncertainty in phase determination for the tests in the waves of shortest period. RHIB data phases are only approximate values, as the calculation (Section 7.1) assumes that the RHIB model is always at its target location.

6 Experiments

6.1 Wave matching

Wave matching was carried out immediately prior to the first test session, in May 2016.

During wave calibration, both wave probes were present in the tank, as in the test setup. The carriage-mounted encounter probe was used as the reference probe. The carriage was positioned along the tank so that the wave probe was 100 m from the wave board. The irregular spectrum was generated for a duration of 20 minutes full scale (352 seconds model scale), using the Random Phase technique.

Results of the wave matching experiments for the regular waves and irregular wave spectrum are presented in full scale units in Appendix C. For regular waves, the maximum discrepancy between measured wave height over the full record and the target wave height was 4.5%. The actual height as produced and measured in calibration is used in analysis. For the irregular sea-state, both the spectrum frequency computed using the Delft Method and the significant height of the measured wave were within 2.5% of the target values, and there was good qualitative agreement in the spectrum shape.

Water depth was 7 m for all seakeeping experiments.

6.2 Corvette model floatation and mass properties

The outfitted corvette model was weighed, and ballast was added to achieve the target total model displacement of 479.5 kg (772.2 tons full scale), taking into account the weight of the heave post.

Six trim hooks set on the milled reference surfaces were used to verify the draft at midship and in the bow and stern, both port and starboard. The ballast was distributed to achieve level trim and no roll, based on the trim hooks.

The location of each piece of ballast was measured to calculate the mass properties of the ballasted model, the mass properties of the lightship being known from the CAD model. Ballast location was then adjusted to approach the target GM_T, and the target pitch and roll radii of gyration.

A pitch radius of gyration of 0.246*L_{WL} and a roll radius of gyration of 0.362*B_{WL} were achieved.

An inclining experiment was conducted in the trim dock with the final ballast configuration to determine experimentally GM_T. The measured GM_T was 0.085 m model scale (0.99 m at full scale).

The data of the inclining experiment and the table of loading are provided in Appendix B.

A roll decay experiment was carried out in calm water on the tow post to determine the natural roll period and roll damping of the corvette. The initial roll angle was approximately 5 degrees. The four instances of roll decay were analyzed using dedicated GEDAP procedures to determine the period and the equivalent viscous damping. The period of oscillation was determined through zero-crossing analysis. A decay analysis algorithm was used to compute viscous damping parameters based on the theory of vibration and a logarithmic decrement method. The analysis procedure is described in further details and tables of model scale results for all decay tests are presented in Appendix D. Table 4 below shows the average result values at full scale, as well as the circular frequency non-dimensionalized by $(L_{WL}/g)^{-\frac{1}{2}}$, where L_{WL} is the waterline length of the corvette.

Table 4 Corvette roll decay results

Vessel	Test	Full scale period [seconds]	Circular frequency [non-dimensional]	Linear damping coefficient ζ
Corvette	Roll decay	7.72	2.18	0.040

6.3 RHIB model floatation and mass properties

The mass properties of the RHIB model were entirely derived numerically from the CAD solid model, as described in Section 4.2.

No experimental verification of GM_T was attempted, as the vessel is not wall-sided.

The model was weighed immediately prior to testing in Dec 2016, and its total weight was found to be 4.501 kg, corresponding to a test displacement of 7248 kg full scale, slightly heavier than the numerical determination.

Draft marks were drawn on the hull (port and starboard stern, and forward), corresponding to the floatation of 0.47 degree by the stern, as illustrated in Figure 6. These marks were used as references to check the waterline. The small ballast weight was moved to starboard to correct roll.

A roll decay experiment and a pitch decay experiment were carried out in calm water to determine the natural roll and pitch periods and damping of the RHIB model. The decay tests were analyzed as described in Section 6.2 above. Plots of the time traces and tables of model scale results are presented in Appendix D for all decay tests. The initial roll angles were approximately 5 degrees. Table 5 below shows the average result values at full scale, as well as the circular frequency non-dimensionalized by $(L_{WL}/g)^{-\frac{1}{2}}$, where L_{WL} is the waterline length of the RHIB.

Table 5 RHIB Roll and pitch decay results

Vessel	Test	Full scale period [seconds]	Circular frequency [non-dimensional]	Linear damping coefficient ζ
RHIB	Roll decay	2.17	2.67	0.122
RHIB	Pitch decay	2.49	2.32	0.224

6.4 Test setup and experiments

For towing the corvette model in these experiments, a “yaw-restrained” tow post apparatus was used as interface with the carriage. The heave post is mounted in linear bearings that do not allow rotation of the heave post along its axis. By using this system, no additional guiding apparatus was required in the bow or stern of the model. The gimbal provided free heave and pitch motions. The model was also free to roll.

After the corvette model was connected to the tow post, its roll angle was verified using an inclinometer set on a milled surface. The roll angle, pitch angle and sinkage channels were set to zero.

<u>Corvette model yaw alignment:</u>
The lateral distance between the south carriage rail and points marked on the centerline of the model was measured both at the bow and stern, sighting plumb bobs hung from reference points at carriage frame level, and the model was brought parallel to the carriage rail by adjusting the tow post. The south carriage rail has been surveyed as parallel with the direction of travel of the carriage. Every time the corvette model was rotated to face either the wave-maker (head seas) or the beach (following seas), this check was done and an adjustment was made at the tow post to align the model with the longitudinal centerline of the tank.

Two digital video cameras mounted under the carriage on the south side were used to capture bow and stern quarter views of the corvette model.

The Qualisys cameras were also mounted on the south side of the carriage, covering a view area on that side of the corvette model. The interaction seakeeping experiments were therefore conducted with the RHIB model on the port side of the corvette model in head seas, and with the RHIB model on the starboard side of the corvette model in following seas.

Calibration of the QUALISYS system was carried out as described in Section 5.

The origin of the QUALISYS tank coordinate system was referenced by setting the X, Y and Z QUALISYS channels to zero while the RHIB model was held floating against the side wall of the corvette model with the front edge of the tower at deck height lined up with Station 5 (midships) of the corvette model. This reference was taken at the beginning of tests in head seas, and was renewed at the beginning of tests in following seas after rotating the corvette model.

During the tests, the autopilot was therefore aiming to keep the station of the RHIB such defined (x=3.836 m at full scale, x=330 mm model scale) alongside the corvette at midships, with 1.5 m full scale (0.129 m model scale) lateral gap. The relative location of the models is illustrated and summarized in Figure 11, in full scale dimensions, for tests in following seas. The relative positions were the same in head seas, albeit with the RHIB on the port side of the corvette. The QUALISYS Y channel was corrected during data processing to read zero when the target lateral gap was achieved.

Both wave probe signals and the corvette model heave signal were re-zeroed every morning after bringing the wave board up.

Each run in regular waves provided an analysis segment of ten wave encounters or more.

Several individual runs were required to cover the entire wave spectrum with a 20 minutes full scale repeat cycle (352 seconds model scale). The end time selected for the analysis of a given run determined the start point in the time series of the wave-board command for the next run, allowing an overlap of 3 seconds.

Wait times:
Flexible side beaches covering the entire length of the tank were deployed in between runs to absorb the lateral waves and minimize the time between runs. Wave height data was monitored to determine when the residuary tank disturbance became less than 1% of the next target wave height. Wait times varied between 12 and 22 minutes.

6.5 Coordinate system and sign conventions

For each vessel, an inertial frame of reference is defined, centered at the mean position G_0 of the centre of gravity of the vessel moving at mean speed U along the mean track. The mean track is at heading angle μ relative to the direction of the waves. For the present tests, μ is either 180° - in head seas- or 0° - in following seas-. The X-axis is horizontal facing forward along the direction of the mean track (direction of travel of the tow carriage), the Y-axis is horizontal facing to starboard, and the Z-axis is vertical pointing down.

Linear displacements of the instantaneous position of the vessel centre of gravity G relative to the moving origin G_0 are defined in this inertial frame of reference, as surge, sway and heave. The attitude of the vessel is defined by the Euler angles in yaw, pitch and roll order (nautical angles).

Wave elevation is measured and reported in the tank co-ordinate system positive upwards (positive crest). For consistency in orientation, the phase lag of motions is calculated relative to the opposite of wave elevation (positive trough).

The phase angle is negative for the response signal lagging the input (wave) signal.

Linear translations and rotations are non-dimensionalized by wave elevation a and by wave slope $k*a$, respectively. Circular frequencies are non-dimensionalized by $(L_{WL}/g)^{-\frac{1}{2}}$.

7 Data Analysis

The data were acquired in GDAC format (*.DAQ files, ref 5) and processed using in-house Python-based SWEET software. The software calls subroutines of the NRC GEDAP Data Analysis Package. It presents options for producing a report with plots and tables of statistical data in pdf format, writing results of processed data in CSV files for further analysis in a spreadsheet, and exporting time series of processed data.

Various modules of software were used for analyzing the different types of tests (regular or irregular waves), and to perform different types of analysis on the model motions.

7.1 Data processing: motions in regular waves

Data processing included the following steps, each step being applied only when the relevant model was present.

- Calibration factors were applied to all measurements.

- An offset (0.129 m) was added to the QUALISYS sway displacement signal so it would read zero when the RHIB model was at its target location. If any spikes were present on the QUALISYS signals they were removed automatically. X and Y displacements were differentiated, and filtered to remove frequencies higher than twice the wave encounter frequency. The resultant of speed along the direction of travel of the carriage was calculated and added to the measured carriage speed to yield the model forward speed. QUALISYS motions were transferred into motions at the nominal centre of gravity of the model and in the inertial coordinate system pointing into the direction of travel of the carriage.

- Time traces of the acquired data were plotted on screen. An initial time interval was selected before the run with the boat at rest. An analysis time interval was selected with the model(s) at speed in waves, avoiding any start up transient effect and ending before the reflected waves would reach the model(s).

- For corvette model motion signals heave, pitch and roll, the mean value calculated over the initial segment was subtracted from the signal.

- For RHIB model rotation rates and horizontal acceleration signals, the mean value calculated over the initial segment was subtracted from the signal.

- Motion analysis was performed on the selected analysis segment to derive the motions, velocities and accelerations of the RHIB model in the seakeeping inertial frame of reference, at the nominal centre of gravity, from the measured linear accelerations and rotation rates. A low-cut filter at half the encounter frequency was applied during this motion analysis.

- Basic statistics (minimum, maximum and mean value, and standard deviation) of all signals were calculated over the analysis segment, and logged in a CSV file.

- Frequencies above five times the expected encounter frequency were removed from the encounter wave probe signal using a rectangular low pass filter, and then a sine wave was fitted to both wave probe signal time series. The frequency, amplitude and phase of the fitted sine waves were logged.

- A sine wave was fitted to corvette model motion signals heave, pitch and roll, and to RHIB model motions issued from QUALISYS measurements (heave, pitch, roll, surge, sway, yaw), using the above determined wave encounter frequency. The sine wave was plotted superposed with the measured signal, to evaluate the quality of the fit. The amplitude and phase of the fitted sine wave were logged.

Further analysis was carried out in a spreadsheet as follows.

- The encounter wave phase angle was corrected to make the wave signal sign convention consistent with that of heave motion, and to account for the fact that the wave elevation was measured at a point other than the model motions. The encounter wave signal phase lag was augmented by π and by $\delta_p = \frac{\omega_W{}^2}{g} d$ in radians, where *d* is the distance from the model centre of gravity to the encounter wave probe, counted positive if the model centre of gravity was downstream of the wave probe along the wave propagation direction. The phase lag of each motion signal was calculated as the difference between the signal phase and the corrected phase of the wave encounter signal. For the corvette model, the centre of gravity was at the fixed location of the tow post. The longitudinal location of the RHIB model centre of gravity was considered fixed at its target location alongside the corvette model or under the carriage, as an approximation for the purpose of this calculation.

- The Response Amplitude Operators (RAO) of heave, pitch and roll, as well as surge, sway and yaw for the RHIB model, were calculated. For the RHIB model, the motions were those derived from QUALISYS measurements. More details are given in Section 8.1 about the calculation of non-dimensional motion amplitudes.

7.2 Data processing: motions in irregular waves

Data processing included the following steps, each step being applied only when the relevant model was present.

- Calibration factors were applied to all measurements.

- An offset (0.129 m) was added to the QUALISYS sway displacement signal so it would read zero when the RHIB model was at its target location. If any spikes were present on the QUALISYS signals they were removed automatically. X and Y displacements were differentiated, and filtered to remove frequencies higher than twice the highest expected wave encounter frequency. The resultant of speed along the direction of travel of the carriage was calculated and added to the measured carriage speed to yield the model forward speed. QUALISYS motions were transferred into motions at the nominal centre of gravity of the model and in the inertial coordinate system pointing into the direction of travel of the carriage.

- Time traces of the acquired data were plotted on screen. An initial time interval was selected before the run with the boat at rest. An analysis time interval was selected with the model at speed in waves, avoiding any start up transient effect.

- For corvette model motion signals heave, pitch and roll, the mean value calculated over the initial segment was subtracted from the signal.

- For RHIB model rotation rates and horizontal accelerations signals, the mean value calculated over the initial segment was subtracted from the signal.

- Basic statistics (minimum, maximum and mean value, and standard deviation) of all signals were calculated over the analysis segment, and logged in a CSV file.

- After all individual runs required to cover the entire wave spectrum were processed, the selected data segments of the single test runs were merged together with an overlap of 3 seconds model scale, forming for all channels a time series for the entire wave spectrum.

- Motion analysis was performed on the assembled time series of the linear accelerations and rotation rates, to generate the motions, velocities and accelerations of the RHIB model in the seakeeping inertial frame of reference, at the nominal centre of gravity. A low-cut filter at 80% of the lowest significant value of the encounter wave frequency was applied during this motion analysis.

- All data was converted to full scale units.

- Basic statistics (minimum, maximum and mean value, and standard deviation) of all signals were calculated over the assembled full time series, and were logged in a CSV file.

- Zero crossing analysis was performed on the assembled time series of the wave encounter signal and the heave displacement signals of each model (as derived from QUALISYS data for the RHIB model), to count the number of average up- and down-crossings, rejecting cycles narrower than half the smallest encounter period expected in the spectrum (i.e. narrower than 0.22 seconds model scale in head seas and 1.5 seconds model scale in following seas). This analysis produced the average period of zero up- or down-crossings T_{AV} and the number N of wave encounters (average of the number of down-crossing N_{WD} and number of up-crossing cycles N_{WU} detected).

- Variance spectral density analysis was carried out on the assembled time series of the wave probe signals to compute the significant wave height $Hm_0 = 4 * \sqrt{m_0}$ and the peak period T_{PD} of the wave spectrum. Variance spectral density analysis was also carried out on the assembled time series of model motions (heave, pitch and roll displacements for the corvette model, and heave, pitch, roll, surge, sway, yaw displacements as derived from the QUALISYS measurements for the RHIB model). A cosine bell data window was used in the spectral analysis, and the periodogram was smoothed with a simple moving average filter of length specified by a number of degrees of freedom per spectral estimate (42 in this case). For each of the analyzed signals, the peak period $T_{PD}$of the response spectrum was determined using the Delft method and the significant height was estimated as $Hm_0 = 4 * \sqrt{m_0}$, where m_0 is the variance of the time record.

8 Results

It was found that the RHIB linear acceleration signals were affected by noise, possibly due to the close proximity of the motors. In regular waves, these signals displayed frequencies not correlated to the wave or to other channels, in particular the QUALISYS measured motions. Thus, only RHIB motions measured with QUALISYS are presented, and not those derived from the accelerations and rates through motion analysis.

8.1 Tests in regular waves

For consistency in comparing the different tests, the amplitude of the wave as measured during wave calibration was used to non-dimensionalize the motions, and not the amplitude of the wave measured during each test. The nominal wave number was used to calculate wave slope. The measurements of encounter wave made during the tests were affected by the wave probe wire deflecting as the carriage moved, and by the presence of the model or by its wake in following seas. Test wave measurements are presented in Table 9 and Table 10.

Non-dimensional motion amplitudes (RAOs) were calculated using two different evaluations of motion amplitude:

- Motion amplitude derived from the standard deviation: $\sqrt{2} * StDev$. This measure reflects the full magnitude of response, of any frequency.
- Amplitude of the sine function fitted to the motion. This isolates the motion response at the same frequency as the encountered wave.

Both are shown superposed on the RAO plots. Unfilled markers denote data calculated using the standard deviation.

Non-dimensional motion amplitudes of each vessel were plotted against the wave circular frequency ω non-dimensionalized by $(L_{WL}/g)^{-\frac{1}{2}}$, where L_{WL} is the waterline length of the vessel. The frequency of the upstream wave probe was used. The relationship between non-dimensional circular encounter and wave frequencies is shown in Figure 18 for both the corvette and the RHIB. The plots also show the natural frequencies of the vessels.

On plots showing the phase lag of the motions relative to the wave, unfilled markers denote test points for which the motion response was predominantly at frequencies other than the encounter wave frequency, and the phase measurement is not meaningful.

Figure 19 presents the heave, pitch and roll responses of the corvette at 8 knots in regular waves, in head seas and in following seas, alone and in the presence of the RHIB. Figure 20 shows the phase lags of the corvette motion responses relative to the wave.

Non-dimensional radial frequencies up to 3.4 are usually needed for defining the RAO, and for the frequencies tested above this value, the motion responses of the corvette are small.

The non-zero roll motions of the corvette observed during the tests in head seas at the lowest tested frequencies are due to small physical asymmetries, along with the wave encounter frequency approaching the natural roll frequency of the corvette as seen in Figure 18.

As expected, the presence of the small RHIB alongside has a negligible effect on the motions of the larger vessel.

Figure 21 presents the heave, pitch and roll motions, and Figure 22 presents the surge, sway and yaw motions, of the RHIB at 8 knots in regular waves, in head seas and in following seas, both alone and alongside the corvette. The corvette has a strong influence on all motions of the RHIB, except surge and sway in head seas. In some cases, the RHIB motions are attenuated by the presence of the corvette. This is the case for heave, pitch and surge motions in following seas. The roll and yaw responses are markedly increased by the proximity of the corvette, especially in head seas, as can be expected due to the wave generated by the corvette. In head seas, roll amplitude when the RHIB is alongside the corvette peaks at two frequencies: at non-dimensional radial frequency of 1.5, which corresponds to the natural roll frequency of the RHIB, and at a lower non-dimensional frequency of 0.8. The roll response of the RHIB alongside the corvette in head seas is strongly coupled with the RHIB yaw response. Figure 23 and Figure 24 show the phase lags of the RHIB motion responses relative to the wave.

The next set of figures examines the effect on the motions of the RHIB alone, of reducing forward speed from 8 knots to 4 knots. Figure 25 presents the amplitudes of heave, pitch and roll responses. Although its heading is parallel to the direction of the waves, the RHIB exhibits non-zero roll motions during the tests, due to unavoidable asymmetries, and to the free model not maintaining a perfect heading. Figure 26 shows the surge, sway and yaw amplitudes at either forward speed. The RHIB surge response in following seas is large at the normal operation speed of 8 knots but is significantly reduced at 4 knots. The surge gain parameters of the autopilot were kept identical for both speeds in following seas. Figure 27 and Figure 28 show the effect of forward speed on phase lag of the RHIB motion responses relative to the wave. For the RHIB alone, only phases for the motions in the longitudinal vertical plane are meaningful.

Figure 29 shows the standard deviation of the RHIB driving parameters, in full scale units, as function of the wave frequency, for the RHIB alone at both speeds as well as alongside the corvette. The variations of steering angle amplitude are consistent with those observed for the yaw motion.

All results are also presented in tables. Tables from Table 11 to Table 15 show the measurements of motions for both vessels for each run, in model scale units, while Table 16 and Table 17 show the measurements of the RHIB driving parameters. Table 18 presents the non-dimensional motion amplitudes for the corvette, and Table 19 the phases of corvette motions relative to waves. Tables from Table 20 to Table 23 present the non-dimensional motion amplitudes for the RHIB, and Table 24 and Table 25 the phases of RHIB motions relative to waves.

8.2 Tests in irregular waves

Table 26 presents for each configuration tested the characteristics of the measured waves, both upstream and encounter, in full scale units, and compares them to the nominal and calibration values. These characteristics are results of zero-crossing analysis, spectrum analysis, and statistics, on the merged time series for each condition. The required minimum of 100 wave encounters was met for every configuration and test condition.

Table 27 presents the characteristics of the response spectrum of the corvette motions -notably significant height-, and statistical values of those motions, in full scale units, for each configuration tested. Significant heights of heave, pitch and roll are plotted in the two top plots of Figure 30. Consistently with the results of tests in regular waves, the corvette motions are not affected much by the presence of the RHIB alongside.

Table 28 shows the characteristics of the response spectrum of the RHIB motions -notably significant height-, and statistical values of those motions, in full scale units, for each configuration tested. Significant heights of the RHIB motions are presented plotted against forward speed in Figure 30. Roll and yaw are the motions most amplified by the presence of the corvette. Surge in following seas is reduced. These observations are consistent with the results of the tests in regular waves.

Finally, Table 29 shows the statistics of the RHIB shaft speed, steering angle and forward speed, in full scale units, for each configuration tested in irregular waves.

9 Conclusion

In conclusion, an extensive set of data was provided for validation of the numerical tool. The model tests quantified the motion responses for both vessels in the prescribed wave conditions, and quantified the effect of interaction. The motions most affected by the interaction were the roll and yaw motions of the RHIB.

10 Aknowledgements

The author would like to recognize the invaluable contribution that the numerous people in the project team made to the success of these model tests. The work of teams from the electronic and design and fabrication departments of NRC was instrumental for the success of the functional RHIB model, as was the work of the control specialists who developed the autopilot. The dedication of the tank technical personnel contributed greatly to the quality of the measurements.

11 References

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Tables

Table 6 Definition of the waves

Scale 1: **11.625**

Regular waves:

wave steepness 1/ 50

Full Scale, deep water					**Model Scale, calculated for 7 m depth**									
circular frequency ω	frequency f	period T	wave length λ	wave height	circular frequency ω	frequency f	period T	wave length λ	wave height	phase velocity	group velocity	wave number k	λ / L_{WL}	λ / L_{WL}
rad/s	Hz	sec	m	m	rad/s	Hz	sec	m	m	m/s	m/s	1/m	Corvette	RHIB
0.7	1.429	8.98	125.7	2.51	2.39	0.380	2.633	10.814	0.216	4.107	2.063	0.581	**1.79**	15.12
0.8	1.250	7.85	96.3	1.93	2.73	0.434	2.304	8.285	0.166	3.596	1.799	0.758	**1.37**	11.59
0.9	1.111	6.98	76.1	1.52	3.07	0.488	2.048	6.546	0.131	3.197	1.598	0.960	**1.08**	9.16
1	1.000	6.28	61.6	1.23	3.41	0.543	1.843	5.301	0.106	2.877	1.438	1.185	**0.88**	7.41
1.1	0.909	5.71	50.9	1.02	3.75	0.597	1.675	4.379	0.088	2.614	1.307	1.435	**0.73**	6.12
1.2	0.833	5.24	42.8	0.86	4.09	0.651	1.536	3.682	0.074	2.397	1.199	1.706	**0.61**	5.15
1.3	0.769	4.83	36.5	0.73	4.43	0.705	1.418	3.138	0.063	2.213	1.107	2.002	**0.52**	4.39
1.4	0.714	4.49	31.4	0.63	4.77	0.760	1.316	2.703	0.054	2.054	1.027	2.325	0.45	3.78
1.5	0.667	4.19	27.4	0.55	5.11	0.814	1.229	2.358	0.047	1.918	0.959	2.665	0.39	3.30
1.6	0.625	3.93	24.1	0.48	5.46	0.868	1.152	2.071	0.041	1.798	0.899	3.033	0.34	2.90
1.7	0.588	3.70	21.3	0.43	5.80	0.922	1.084	1.834	0.037	1.692	0.846	3.426	0.30	2.57
1.8	0.556	3.49	19.0	0.38	6.14	0.977	1.024	1.637	0.033	1.598	0.799	3.839	0.27	2.29
1.9	0.526	3.31	17.1	0.34	6.48	1.031	0.970	1.469	0.029	1.514	0.757	4.279	0.24	**2.05**
2	0.500	3.14	15.4	0.31	6.82	1.085	0.921	1.324	0.026	1.438	0.719	4.746	0.22	**1.85**

Irregular sea-state:

Bretschneider spectrum

Full Scale		Model Scale	
Hs	1.25 m	Hs	0.1075 m
Tp	7.5 s	Tp	2.200 s

Table 7 Autopilot gains

Test Name	Surge Gain K_{Dx}	Surge Gain K_{ix}	Surge Gain K_{Px}	Sway Gain K_{iy}	Sway Gain K_{py}
	rpm*s/m	rpm/m*s	rpm/m	°/m*s	°/m
CR_F_TP3P14_002	5	3	12	3	25
CR_F_TP3P31_001	5	3	12	3	25
CR_F_TP3P49_001	5	3	12	4	25
CR_F_TP3P70_001	5	3	12	4	25
CR_F_TP3P93_001	5	3	12	4	25
CR_F_TP4P19_001	5	3	12	4	25
CR_F_TP4P49_001	5	3	12	4	25
CR_F_TP4P83_001	5	3	12	4	25
CR_F_TP5P24_001	5	3	12	4	25
CR_F_TP5P71_001	5	3	12	4	25
CR_F_TP6P28_001	5	3	12	4	25
CR_F_TP6P98_001	5	3	12	4	25
CR_F_TP7P85_001	5	3	12	4	25
CR_F_TP8P98_002	5.697	0.0	9.398	4	25
R_F_TP3P14_002	5	3	12	4	25
R_F_TP3P31_002	5	3	12	4	25
R_F_TP3P49_001	5	3	12	4	25
R_F_TP3P70_001	5	3	12	4	25
R_F_TP3P93_001	5	3	12	4	25
R_F_TP4P19_001	5	3	12	4	25
R_F_TP4P49_001	5	3	12	4	25
R_F_TP4P83_001	5	3	12	4	25
R_F_TP5P24_001	5	3	12	4	25
R_F_TP5P71_001	5	3	12	4	25
R_F_TP6P28_001	5	3	12	4	25
R_F_TP6P98_001	5	3	12	4	25
R_F_TP7P85_002	5	3	12	4	25
R_F_TP8P98_001	5	3	12	4	25
R4_F_TP3P14_001	5	3	12	4	25
R4_F_TP3P31_001	5	3	12	4	25
R4_F_TP3P49_001	5	3	12	4	25
R4_F_TP3P70_001	5	3	12	4	25
R4_F_TP3P93_001	5	3	12	4	25
R4_F_TP4P19_001	5	3	12	4	25
R4_F_TP4P49_001	5	3	12	4	25
R4_F_TP4P83_001	5	3	12	4	25
R4_F_TP5P24_001	5	3	12	4	25
R4_F_TP5P71_001	5	3	12	4	25
R4_F_TP6P28_001	5	3	12	4	25
R4_F_TP6P98_001	5	3	12	4	25
R4_F_TP7P85_001	5	3	12	4	25
R4_F_TP8P98_001	5	3	12	4	25
CR_F_IRR_002	5	5	10	3	25
CR_F_IRR_003	5	5	10	3	25
CR_F_IRR_004	5	5	10	3	25
CR_F_IRR_006	5	5	10	3	25
CR_F_IRR_007	5	5	10	3	25
CR_F_IRR_008	5	5	10	3	25
CR_F_IRR_009	5	5	10	3	25
R_F_IRR_001	5	3	12	4	25
R_F_IRR_002	5	3	12	4	25
R_F_IRR_003	5	3	12	4	25
R_F_IRR_004	5	3	12	4	25
R_F_IRR_005	5	3	12	4	25
R_F_IRR_006	5	3	12	4	25
R_F_IRR_007	5	3	12	4	25
R4_F_IRR_001	5	3	12	4	25
R4_F_IRR_002	5	3	12	4	25
R4_F_IRR_003	5	3	12	4	25

* Gain values were being changed during test CR_F_TP8P98_002, but did not alter significantly the model tracking

Sway gain D: 0 for all tests

H: head seas, F: following seas   CR: corvette and RHIB   R4: RHIB at 4 knots
TP: wave period (full scale)   IRR: irregular waves   R: RHIB alone

Table 8 Autopilot gains, cont.

Test Name	Surge Gain K_{Dx} rpm*s/m	Surge Gain K_{ix} rpm/m*s	Surge Gain K_{Px} rpm/m	Sway Gain K_{iy} °/m*s	Sway Gain K_{py} °/m
CR_H_TP3P14_001	5	5	15	5	25
CR_H_TP3P31_001	5	5	15	7	25
CR_H_TP3P49_001	5	5	15	7	25
CR_H_TP3P70_001	5	5	20	7	25
CR_H_TP3P93_001	5	5	20	7	25
CR_H_TP4P19_001	5	5	20	6	25
CR_H_TP4P49_001	5	5	20	6	25
CR_H_TP4P83_001	5	5	20	6	25
CR_H_TP5P24_001	5	5	20	6	25
CR_H_TP5P71_002	5	5	15	3	25
CR_H_TP6P28_002	5	5	15	3	25
CR_H_TP6P98_002	5	5	15	3	25
CR_H_TP7P85_002	5	5	15	3	25
CR_H_TP8P98_003	5	5	15	3	25
R_H_TP3P14_001	5	5	15	3	25
R_H_TP3P31_001	5	5	15	3	25
R_H_TP3P49_001	5	5	15	3	25
R_H_TP3P70_001	5	5	15	3	25
R_H_TP3P93_001	5	5	15	3	25
R_H_TP4P19_001	5	5	15	3	25
R_H_TP4P49_001	5	5	15	3	25
R_H_TP4P83_001	5	5	15	3	25
R_H_TP5P24_001	5	5	15	3	25
R_H_TP5P71_001	5	5	15	3	25
R_H_TP6P28_001	5	5	15	3	25
R_H_TP6P98_002	5	5	15	3	25
R_H_TP7P85_003	5	5	15	3	25
R_H_TP8P98_002	5	5	15	3	25
R4_H_TP3P14_001	5	5	15	3	25
R4_H_TP3P31_001	5	5	15	3	25
R4_H_TP3P49_001	5	5	15	3	25
R4_H_TP3P70_001	5	5	15	3	25
R4_H_TP3P93_001	5	5	15	3	25
R4_H_TP4P19_001	5	5	15	3	25
R4_H_TP4P49_001	5	5	15	3	25
R4_H_TP4P83_001	5	5	15	3	25
R4_H_TP5P24_001	5	5	15	3	25
R4_H_TP5P71_001	5	5	15	3	25
R4_H_TP6P28_001	5	5	15	3	25
R4_H_TP6P98_001	5	5	15	3	25
R4_H_TP7P85_001	5	5	15	3	25
R4_H_TP8P98_002	5	5	15	3	25
CR_H_IRR_004	5	5	20	3	25
CR_H_IRR_005	5	5	20	3	25
CR_H_IRR_006	5	5	20	3	25
CR_H_IRR_007	5	5	20	3	25
CR_H_IRR_008	5	5	20	3	25
R_H_IRR_001	5	5	15	3	25
R_H_IRR_003	5	5	15	3	25
R_H_IRR_004	5	5	15	3	25
R_H_IRR_005	5	5	15	3	25
R_H_IRR_006	5	5	15	3	25
R4_H_IRR_001	5	5	15	3	25
R4_H_IRR_002	5	5	15	3	25
R4_H_IRR_003	5	5	15	3	25

Sway gain D: 0 for all tests

H: head seas, F: following seas — CR: corvette and RHIB — R4: RHIB at 4 knots

TP: wave period (full scale) — IRR: irregular waves — R: RHIB alone

Table 9 Tests in regular waves: measured waves, model scale

Regular waves: wave parameters, in model scale units

	Test Name	Test Time	Nominal wave Amplitude m	Wave Probe (Calibration tests) Amplitude m	Upstream Wave Probe Radial Frequency rad/s	Encounter Wave Probe Amplitude m	Forward Speed (Carriage) m/s	Encounter Wave Probe Radial Frequency rad/s
Corvette alone	HS0P31_TP3P14_001	'2016-05-12 11:39:08'	0.013	0.013	6.82	0.012	1.207	12.53
Head Seas	HS0P34_TP3P31_001	'2016-05-12 12:01:21'	0.015	0.014	6.48	0.012	1.206	11.64
	HS0P38_TP3P49_002	'2016-05-12 12:31:18'	0.016	0.016	6.14	0.012	1.207	10.77
	HS0P43_TP3P70_001	'2016-05-12 12:43:36'	0.018	0.019	5.80	0.015	1.207	9.93
	HS0P48_TP3P93_001	'2016-05-12 12:55:55'	0.021	0.021	5.46	0.017	1.207	9.11
	HS0P55_TP4P19_001	'2016-05-12 13:08:18'	0.024	0.024	5.11	0.020	1.207	8.32
	HS0P63_TP4P49_001	'2016-05-12 13:22:23'	0.027	0.027	4.78	0.024	1.207	7.57
	HS0P73_TP4P83_001	'2016-05-12 13:35:58'	0.031	0.032	4.43	0.030	1.207	6.84
	HS0P86_TP5P24_001	'2016-05-12 13:50:43'	0.037	0.038	4.09	0.036	1.207	6.15
	HS1P02_TP5P71_001	'2016-05-12 14:05:08'	0.044	0.043	3.75	0.043	1.207	5.48
	HS1P23_TP6P28_001	'2016-05-12 14:20:52'	0.053	0.053	3.41	0.053	1.207	4.84
	HS1P52_TP6P98_001	'2016-05-12 14:42:44'	0.065	0.066	3.07	0.066	1.207	4.22
	HS1P93_TP7P85_001	'2016-05-12 14:56:19'	0.083	0.082	2.73	0.084	1.207	3.64
	HS2P51_TP8P98_002	'2016-05-12 15:27:05'	0.108	0.113	2.39	0.118	1.207	3.09
Corvette alone	HS0P31_C_F_001	'2016-05-13 12:02:20'	0.013	0.013	6.82	0.011	-1.204	1.13
Following Seas	HS0P34_C_F_001	'2016-05-13 12:17:10'	0.015	0.014	6.48	0.014	-1.206	1.34
	HS0P38_C_F_001	'2016-05-13 12:32:42'	0.016	0.016	6.14	0.017	-1.207	1.52
	HS0P43_C_F_001	'2016-05-13 12:48:26'	0.018	0.019	5.80	0.018	-1.207	1.67
	HS0P48_C_F_001	'2016-05-13 13:04:31'	0.021	0.021	5.45	0.020	-1.207	1.79
	HS0P55_C_F_001	'2016-05-13 13:22:34'	0.024	0.024	5.11	0.022	-1.207	1.88
	HS0P63_C_F_001	'2016-05-13 13:39:16'	0.027	0.027	4.78	0.025	-1.207	1.96
	HS0P73_C_F_001	'2016-05-13 13:57:16'	0.031	0.032	4.43	0.029	-1.206	2.01
	HS0P86_C_F_001	'2016-05-13 14:12:40'	0.037	0.038	4.09	0.032	-1.209	2.02
	HS1P02_C_F_001	'2016-05-13 14:28:18'	0.044	0.043	3.75	0.042	-1.209	2.02
	HS1P23_C_F_001	'2016-05-13 14:46:04'	0.053	0.053	3.41	0.057	-1.208	1.99
	HS1P52_C_F_001	'2016-05-13 15:01:21'	0.065	0.066	3.07	0.067	-1.211	1.91
	HS1P93_C_F_001	'2016-05-13 15:16:23'	0.083	0.082	2.73	0.083	-1.210	1.81
	HS2P51_C_F_001	'2016-05-13 15:31:20'	0.108	0.113	2.39	0.115	-1.213	1.68
Corvette and RHIB	CR_H_TP3P14_001	'2016-12-08 09:11:06'	0.013	0.013	6.82	0.012	1.207	12.53
Head Seas	CR_H_TP3P31_001	'2016-12-08 09:46:28'	0.015	0.014	6.48	0.013	1.207	11.63
	CR_H_TP3P49_001	'2016-12-08 10:09:31'	0.016	0.016	6.14	0.015	1.207	10.77
	CR_H_TP3P70_001	'2016-12-08 10:29:38'	0.018	0.019	5.80	0.017	1.207	9.92
	CR_H_TP3P93_001	'2016-12-08 10:49:26'	0.021	0.021	5.45	0.019	1.207	9.11
	CR_H_TP4P19_001	'2016-12-08 11:08:39'	0.024	0.024	5.11	0.023	1.207	8.33
	CR_H_TP4P49_001	'2016-12-08 11:28:53'	0.027	0.027	4.78	0.027	1.207	7.58
	CR_H_TP4P83_001	'2016-12-08 11:49:15'	0.031	0.032	4.43	0.031	1.207	6.84
	CR_H_TP5P24_001	'2016-12-08 12:09:40'	0.037	0.038	4.09	0.038	1.207	6.14
	CR_H_TP5P71_002	'2016-12-20 14:13:45'	0.044	0.043	3.75	0.045	1.207	5.48
	CR_H_TP6P28_002	'2016-12-20 14:31:15'	0.053	0.053	3.41	0.055	1.207	4.84
	CR_H_TP6P98_002	'2016-12-20 14:49:21'	0.065	0.066	3.07	0.069	1.207	4.22
	CR_H_TP7P85_002	'2016-12-20 15:09:47'	0.083	0.082	2.73	0.088	1.207	3.64
	CR_H_TP8P98_003	'2016-12-20 15:28:51'	0.108	0.113	2.39	0.120	1.207	3.09
Corvette and RHIB	CR_F_TP3P14_002	'2016-12-12 10:33:54'	0.013	0.013	6.82	0.012	-1.206	1.11
Following Seas	CR_F_TP3P31_001	'2016-12-12 10:51:10'	0.015	0.014	6.47	0.013	-1.206	1.34
	CR_F_TP3P49_001	'2016-12-12 11:08:54'	0.016	0.016	6.13	0.013	-1.206	1.52
	CR_F_TP3P70_001	'2016-12-12 11:25:34'	0.018	0.019	5.80	0.017	-1.206	1.69
	CR_F_TP3P93_001	'2016-12-12 11:41:36'	0.021	0.021	5.45	0.017	-1.206	1.81
	CR_F_TP4P19_001	'2016-12-12 11:58:53'	0.024	0.024	5.11	0.016	-1.206	1.92
	CR_F_TP4P49_001	'2016-12-12 12:15:11'	0.027	0.027	4.78	0.022	-1.206	1.99
	CR_F_TP4P83_001	'2016-12-12 12:33:30'	0.031	0.032	4.43	0.026	-1.206	2.04
	CR_F_TP5P24_001	'2016-12-12 12:51:23'	0.037	0.038	4.09	0.024	-1.206	2.05
	CR_F_TP5P71_001	'2016-12-12 13:09:44'	0.044	0.043	3.75	0.049	-1.206	2.02
	CR_F_TP6P28_001	'2016-12-12 13:31:18'	0.053	0.053	3.41	0.052	-1.206	1.98
	CR_F_TP6P98_001	'2016-12-12 13:49:28'	0.065	0.066	3.07	0.061	-1.206	1.91
	CR_F_TP7P85_001	'2016-12-12 14:05:15'	0.083	0.082	2.73	0.075	-1.206	1.81
	CR_F_TP8P98_002	'2016-12-12 14:47:47'	0.108	0.113	2.39	0.115	-1.206	1.69

Table 10 Tests in regular waves: measured waves, model scale, cont.

Regular waves: wave parameters, in model scale units

	Test Name	Test Time	Nominal wave Amplitude	Wave Probe (Calibration tests) Amplitude	Upstream Wave Probe Radial Frequency	Encounter Wave Probe Amplitude	Forward Speed (Carriage)	Encounter Wave Probe Radial Frequency
			m	m	rad/s	m	m/s	rad/s
RHIB	R_H_TP3P14_001	'2016-12-14 09:04:21'	0.013	0.013	6.82	0.012	1.207	12.55
Head Seas	R_H_TP3P31_001	'2016-12-14 09:25:53'	0.015	0.014	6.48	0.013	1.207	11.64
	R_H_TP3P49_001	'2016-12-14 09:47:08'	0.016	0.016	6.14	0.015	1.207	10.76
	R_H_TP3P70_001	'2016-12-14 10:06:42'	0.018	0.019	5.80	0.017	1.207	9.92
	R_H_TP3P93_001	'2016-12-14 10:25:06'	0.021	0.021	5.45	0.020	1.207	9.11
	R_H_TP4P19_001	'2016-12-14 10:46:44'	0.024	0.024	5.11	0.023	1.207	8.32
	R_H_TP4P49_001	'2016-12-14 11:07:32'	0.027	0.027	4.78	0.027	1.207	7.57
	R_H_TP4P83_001	'2016-12-14 11:27:03'	0.031	0.032	4.43	0.032	1.207	6.84
	R_H_TP5P24_001	'2016-12-14 11:46:46'	0.037	0.038	4.09	0.038	1.207	6.14
	R_H_TP5P71_001	'2016-12-14 12:10:47'	0.044	0.043	3.75	0.044	1.207	5.48
	R_H_TP6P28_001	'2016-12-14 12:28:56'	0.053	0.053	3.41	0.055	1.207	4.84
	R_H_TP6P98_002	'2016-12-16 15:05:33'	0.065	0.066	3.07	0.068	1.207	4.23
	R_H_TP7P85_003	'2016-12-16 15:46:13'	0.083	0.082	2.73	0.088	1.207	3.64
	R_H_TP8P98_002	'2016-12-16 16:09:16'	0.108	0.113	2.39	0.118	1.207	3.09
RHIB	R_F_TP3P14_002	'2016-12-15 09:34:51'	0.013	0.013	6.82	0.013	-1.207	1.12
Following Seas	R_F_TP3P31_002	'2016-12-15 10:24:54'	0.015	0.014	6.48	0.014	-1.207	1.33
	R_F_TP3P49_001	'2016-12-15 10:47:41'	0.016	0.016	6.14	0.019	-1.207	1.52
	R_F_TP3P70_001	'2016-12-15 11:08:41'	0.018	0.019	5.80	0.024	-1.207	1.67
	R_F_TP3P93_001	'2016-12-15 11:29:42'	0.021	0.021	5.45	0.023	-1.207	1.80
	R_F_TP4P19_001	'2016-12-15 11:48:32'	0.024	0.024	5.11	0.017	-1.207	1.92
	R_F_TP4P49_001	'2016-12-15 12:41:22'	0.027	0.027	4.78	0.020	-1.207	1.98
	R_F_TP4P83_001	'2016-12-15 13:00:49'	0.031	0.032	4.43	0.034	-1.207	2.03
	R_F_TP5P24_001	'2016-12-15 13:15:40'	0.037	0.038	4.09	0.037	-1.207	2.04
	R_F_TP5P71_001	'2016-12-15 13:33:44'	0.044	0.043	3.75	0.036	-1.207	2.03
	R_F_TP6P28_001	'2016-12-15 13:49:32'	0.053	0.053	3.41	0.054	-1.207	1.98
	R_F_TP6P98_001	'2016-12-15 14:06:04'	0.065	0.066	3.07	0.065	-1.207	1.91
	R_F_TP7P85_002	'2016-12-15 14:41:15'	0.083	0.082	2.73	0.082	-1.207	1.81
	R_F_TP8P98_001	'2016-12-15 14:58:11'	0.108	0.113	2.39	0.118	-1.207	1.69
RHIB (4 kts)	R4_H_TP3P14_001	'2016-12-16 09:20:00'	0.013	0.013	6.82	0.015	0.604	9.70
Head Seas	R4_H_TP3P31_001	'2016-12-16 09:38:46'	0.015	0.014	6.48	0.016	0.604	9.06
	R4_H_TP3P49_001	'2016-12-16 09:56:07'	0.016	0.016	6.14	0.018	0.604	8.45
	R4_H_TP3P70_001	'2016-12-16 10:13:13'	0.018	0.019	5.80	0.020	0.604	7.86
	R4_H_TP3P93_001	'2016-12-16 10:32:46'	0.021	0.021	5.46	0.022	0.604	7.28
	R4_H_TP4P19_001	'2016-12-16 10:53:16'	0.024	0.024	5.11	0.025	0.604	6.72
	R4_H_TP4P49_001	'2016-12-16 11:11:47'	0.027	0.027	4.78	0.029	0.604	6.17
	R4_H_TP4P83_001	'2016-12-16 11:29:23'	0.031	0.032	4.43	0.034	0.604	5.64
	R4_H_TP5P24_001	'2016-12-16 11:50:49'	0.037	0.038	4.09	0.040	0.604	5.12
	R4_H_TP5P71_001	'2016-12-16 12:44:11'	0.044	0.043	3.75	0.047	0.604	4.62
	R4_H_TP6P28_001	'2016-12-16 13:03:19'	0.053	0.053	3.41	0.057	0.604	4.13
	R4_H_TP6P98_001	'2016-12-16 13:21:20'	0.065	0.066	3.07	0.071	0.604	3.65
	R4_H_TP7P85_001	'2016-12-16 13:39:22'	0.083	0.082	2.73	0.088	0.604	3.19
	R4_H_TP8P98_002	'2016-12-16 14:24:15'	0.108	0.113	2.39	0.120	0.604	2.74
RHIB (4 kts)	R4_F_TP3P14_001	'2016-12-19 09:35:07'	0.013	0.013	6.82	0.010	-0.603	3.96
Following Seas	R4_F_TP3P31_001	'2016-12-19 09:55:31'	0.015	0.014	6.48	0.011	-0.603	3.90
	R4_F_TP3P49_001	'2016-12-19 10:17:21'	0.016	0.016	6.14	0.013	-0.603	3.82
	R4_F_TP3P70_001	'2016-12-19 10:38:40'	0.018	0.019	5.80	0.015	-0.603	3.73
	R4_F_TP3P93_001	'2016-12-19 10:57:19'	0.021	0.021	5.46	0.017	-0.603	3.63
	R4_F_TP4P19_001	'2016-12-19 11:15:59'	0.024	0.024	5.11	0.020	-0.603	3.51
	R4_F_TP4P49_001	'2016-12-19 11:34:06'	0.027	0.027	4.78	0.024	-0.603	3.37
	R4_F_TP4P83_001	'2016-12-19 11:51:44'	0.031	0.032	4.43	0.029	-0.603	3.23
	R4_F_TP5P24_001	'2016-12-19 12:53:07'	0.037	0.038	4.09	0.034	-0.603	3.06
	R4_F_TP5P71_001	'2016-12-19 13:11:43'	0.044	0.043	3.75	0.040	-0.603	2.89
	R4_F_TP6P28_001	'2016-12-19 13:31:04'	0.053	0.053	3.41	0.050	-0.603	2.70
	R4_F_TP6P98_001	'2016-12-19 13:47:53'	0.065	0.066	3.07	0.064	-0.603	2.49
	R4_F_TP7P85_001	'2016-12-19 14:08:34'	0.083	0.082	2.73	0.085	-0.604	2.27
	R4_F_TP8P98_001	'2016-12-19 14:30:27'	0.108	0.113	2.39	0.118	-0.603	2.04

Table 11 Tests in regular waves: corvette motions amplitudes and statistics, model scale

Regular waves: corvette motions, in model scale units

		Corvette Pitch					Corvette Roll					Corvette Heave				
	Test Name	Amplitude (sine fit)	MEAN	MIN	MAX	STD	Amplitude (sine fit)	MEAN	MIN	MAX	STD	Amplitude (sine fit)	MEAN	MIN	MAX	STD
		deg	deg	deg	deg	deg	deg	deg	deg	deg	deg	mm	mm	mm	mm	mm
Corvette alone	HS0P31_TP3P14_001	0.00	0.01	-0.02	0.05	0.01	0.00	-0.02	-0.03	-0.01	0.00	0.0	1.8	1.4	1.9	0.2
Head Seas	HS0P34_TP3P31_001	0.00	0.00	-0.02	0.03	0.01	0.00	-0.02	-0.03	-0.01	0.00	0.1	2.6	2.2	2.8	0.1
	HS0P38_TP3P49_002	0.00	0.01	-0.02	0.05	0.01	0.01	-0.02	-0.03	-0.01	0.00	0.1	2.0	1.5	2.4	0.2
	HS0P43_TP3P70_001	0.00	0.00	-0.02	0.05	0.01	0.02	-0.02	-0.04	0.01	0.02	0.2	2.2	1.5	2.9	0.4
	HS0P48_TP3P93_001	0.00	0.00	-0.04	0.04	0.01	0.02	-0.02	-0.04	0.01	0.01	0.6	2.1	1.1	3.2	0.5
	HS0P55_TP4P19_001	0.00	0.00	-0.02	0.04	0.01	0.05	-0.02	-0.07	0.04	0.03	0.8	2.1	0.6	3.4	0.7
	HS0P63_TP4P49_001	0.03	0.01	-0.08	0.13	0.03	0.15	-0.02	-0.18	0.15	0.11	1.9	2.3	-0.4	5.0	1.4
	HS0P73_TP4P83_001	0.05	0.01	-0.10	0.11	0.04	0.21	-0.02	-0.25	0.21	0.15	5.6	2.1	-4.0	8.1	4.0
	HS0P86_TP5P24_001	0.02	0.01	-0.08	0.13	0.04	0.14	-0.01	-0.19	0.17	0.10	9.4	1.9	-8.8	12.4	6.6
	HS1P02_TP5P71_001	0.10	0.02	-0.27	0.37	0.12	0.58	0.00	-0.64	0.67	0.41	12.3	1.7	-12.1	15.4	8.7
	HS1P23_TP6P28_001	0.27	0.02	-0.46	0.43	0.22	1.40	0.02	-1.46	1.52	1.00	15.0	1.7	-15.9	19.9	10.7
	HS1P52_TP6P98_001	0.49	0.00	-0.75	0.69	0.37	2.22	0.02	-2.29	2.26	1.57	24.1	0.6	-26.0	25.7	17.1
	HS1P93_TP7P85_001	0.74	-0.02	-1.66	1.36	0.60	2.94	0.02	-3.06	2.99	2.08	46.3	0.2	-49.9	46.8	32.8
	HS2P51_TP8P98_002	2.21	-0.13	-2.64	2.46	1.57	3.59	0.02	-3.87	3.49	2.55	85.4	1.0	-89.7	86.3	60.5
Corvette alone	HS0P31_C_F_001	0.00	0.01	-0.04	0.05	0.01	0.00	-0.01	-0.03	0.01	0.01	0.0	2.0	1.3	2.6	0.3
Following Seas	HS0P34_C_F_001	0.00	0.00	-0.05	0.04	0.02	0.01	-0.01	-0.03	0.02	0.01	0.0	2.2	1.9	2.5	0.2
	HS0P38_C_F_001	0.00	0.00	-0.07	0.06	0.02	0.00	-0.01	-0.04	0.02	0.01	0.0	2.2	1.9	2.5	0.2
	HS0P43_C_F_001	0.00	0.00	-0.09	0.08	0.03	0.01	-0.01	-0.08	0.04	0.02	0.1	2.1	1.8	2.7	0.2
	HS0P48_C_F_001	0.00	0.00	-0.09	0.07	0.03	0.02	-0.01	-0.07	0.05	0.03	0.1	1.9	1.2	2.4	0.2
	HS0P55_C_F_001	0.00	-0.01	-0.11	0.12	0.04	0.01	-0.02	-0.12	0.07	0.03	0.3	1.9	0.7	3.6	0.4
	HS0P63_C_F_001	0.00	0.00	-0.21	0.16	0.07	0.02	-0.02	-0.21	0.16	0.06	0.3	2.1	0.7	3.6	0.5
	HS0P73_C_F_001	0.01	-0.01	-0.30	0.28	0.13	0.11	-0.01	-0.32	0.29	0.13	0.7	2.1	-0.3	4.4	0.9
	HS0P86_C_F_001	0.01	-0.02	-0.79	0.84	0.43	0.10	-0.02	-0.37	0.27	0.12	3.6	2.3	-6.0	9.9	3.3
	HS1P02_C_F_001	0.00	0.00	-0.67	0.62	0.26	0.11	-0.02	-0.38	0.39	0.17	4.3	1.9	-4.1	8.4	3.2
	HS1P23_C_F_001	0.05	0.00	-0.48	0.43	0.20	0.62	-0.01	-0.79	0.76	0.45	3.2	1.9	-5.9	8.8	3.3
	HS1P52_C_F_001	0.12	0.02	-0.38	0.35	0.14	1.32	-0.01	-1.38	1.38	0.94	15.4	1.7	-15.7	18.6	10.9
	HS1P93_C_F_001	0.16	0.04	-0.77	0.82	0.34	1.99	-0.02	-2.00	2.05	1.41	35.8	1.7	-35.5	37.6	25.4
	HS2P51_C_F_001	0.20	0.07	-0.66	0.73	0.27	2.86	-0.02	-2.89	2.95	2.03	73.8	1.4	-75.6	76.2	52.2
Corvette and RHIB	CR_H_TP3P14_001	0.00	0.00	-0.02	0.03	0.01	0.00	-0.02	-0.03	0.00	0.01	0.0	1.8	1.0	2.6	0.4
Head Seas	CR_H_TP3P31_001	0.00	0.00	-0.02	0.04	0.01	0.00	-0.02	-0.04	0.00	0.01	0.0	1.6	1.4	2.1	0.1
	CR_H_TP3P49_001	0.00	0.01	-0.02	0.05	0.01	0.00	-0.02	-0.03	0.00	0.00	0.1	1.9	1.4	2.2	0.2
	CR_H_TP3P70_001	0.01	0.01	-0.03	0.10	0.02	0.02	-0.02	-0.05	0.01	0.01	0.1	1.8	1.2	2.5	0.2
	CR_H_TP3P93_001	0.01	0.01	-0.03	0.07	0.02	0.01	-0.02	-0.04	0.01	0.01	0.5	1.3	0.4	2.5	0.4
	CR_H_TP4P19_001	0.00	0.01	-0.04	0.05	0.02	0.04	-0.02	-0.08	0.05	0.03	0.6	1.5	0.5	2.8	0.5
	CR_H_TP4P49_001	0.01	0.01	-0.08	0.11	0.03	0.15	-0.02	-0.19	0.16	0.11	1.7	1.8	-0.5	4.0	1.2
	CR_H_TP4P83_001	0.02	0.00	-0.06	0.11	0.03	0.22	-0.02	-0.26	0.23	0.16	5.1	2.2	-4.0	7.9	3.6
	CR_H_TP5P24_001	0.02	0.00	-0.08	0.09	0.04	0.14	-0.01	-0.17	0.14	0.10	9.1	1.9	-7.8	11.7	6.4
	CR_H_TP5P71_002	0.12	0.01	-0.21	0.33	0.11	0.60	-0.17	-0.79	0.47	0.42	11.7	2.1	-10.4	15.0	8.3
	CR_H_TP6P28_002	0.27	0.03	-0.40	0.58	0.20	1.45	0.02	-1.47	1.54	1.02	15.0	1.2	-16.0	17.7	10.6
	CR_H_TP6P98_002	0.51	0.02	-0.71	0.64	0.37	2.32	0.03	-2.36	2.38	1.64	24.5	1.1	-25.5	28.1	17.4
	CR_H_TP7P85_002	0.77	-0.01	-1.37	1.19	0.61	3.04	0.03	-3.13	3.01	2.15	48.3	0.1	-51.8	48.3	34.2
	CR_H_TP8P98_003	2.13	-0.08	-2.45	2.16	1.52	3.66	0.03	-3.97	3.46	2.60	86.1	0.3	-91.5	85.2	61.0
Corvette and RHIB	CR_F_TP3P14_002	0.00	0.03	-0.04	0.09	0.03	0.00	-0.02	-0.04	0.01	0.01	0.0	2.1	1.4	2.5	0.3
Following Seas	CR_F_TP3P31_001	0.00	0.02	-0.07	0.09	0.02	0.01	-0.02	-0.04	0.01	0.01	0.0	2.1	1.6	2.4	0.2
	CR_F_TP3P49_001	0.01	0.02	-0.09	0.10	0.03	0.00	-0.02	-0.05	0.01	0.01	0.0	2.3	1.8	2.8	0.2
	CR_F_TP3P70_001	0.01	0.02	-0.12	0.15	0.05	0.01	-0.02	-0.07	0.04	0.02	0.1	2.1	1.5	2.7	0.3
	CR_F_TP3P93_001	0.02	0.02	-0.15	0.19	0.07	0.02	-0.02	-0.09	0.05	0.03	0.1	1.8	1.1	2.6	0.3
	CR_F_TP4P19_001	0.01	0.01	-0.19	0.19	0.08	0.01	-0.02	-0.12	0.08	0.04	0.4	1.8	0.4	2.9	0.4
	CR_F_TP4P49_001	0.03	0.01	-0.35	0.35	0.16	0.04	-0.02	-0.20	0.15	0.07	0.4	2.3	1.0	3.8	0.5
	CR_F_TP4P83_001	0.06	0.01	-0.48	0.43	0.19	0.09	-0.02	-0.35	0.30	0.13	0.9	1.9	-0.7	4.2	1.0
	CR_F_TP5P24_001	0.03	0.01	-0.76	0.79	0.44	0.10	-0.02	-0.25	0.18	0.10	3.7	1.9	-3.5	7.7	2.9
	CR_F_TP5P71_001	0.12	0.02	-0.50	0.58	0.23	0.15	-0.02	-0.39	0.39	0.18	4.5	1.7	-3.9	7.7	3.3
	CR_F_TP6P28_001	0.23	0.00	-0.38	0.39	0.20	0.63	-0.01	-0.76	0.78	0.45	3.3	2.1	-4.8	8.7	3.1
	CR_F_TP6P98_001	0.28	-0.02	-0.66	0.48	0.25	1.35	-0.02	-1.39	1.48	0.95	15.6	2.1	-15.2	19.5	11.1
	CR_F_TP7P85_001	0.25	0.00	-0.79	0.76	0.32	2.01	-0.03	-2.04	2.05	1.43	36.8	1.1	-36.5	39.0	26.1
	CR_F_TP8P98_002	0.18	0.02	-0.28	0.37	0.17	2.87	-0.03	-2.89	2.93	2.03	75.0	0.9	-77.5	77.4	53.0

Table 12 Tests in regular waves: RHIB motions amplitudes and statistics - pitch, roll, heave-, model scale

Regular waves: RHIB motions, in model scale units

		RHIB Pitch					RHIB Roll					RHIB Heave				
	Test Name	Amplitude (sine fit)	MEAN	MIN	MAX	STD	Amplitude (sine fit)	MEAN	MIN	MAX	STD	Amplitude (sine fit)	MEAN	MIN	MAX	STD
		deg	deg	deg	deg	deg	deg	deg	deg	deg	deg	m	m	m	m	m
Corvette and RHIB Head Seas	CR_H_TP3P14_001	0.48	1.55	-0.08	3.39	0.55	0.77	3.99	2.38	5.70	0.64	0.003	-0.008	-0.015	-0.001	0.003
	CR_H_TP3P31_001	0.97	1.79	-0.74	3.93	0.87	1.26	4.21	2.08	6.45	0.97	0.005	-0.008	-0.018	0.002	0.005
	CR_H_TP3P49_001	1.74	1.95	-1.95	5.09	1.62	2.06	4.60	1.39	7.56	1.55	0.009	-0.009	-0.023	0.007	0.008
	CR_H_TP3P70_001	2.32	2.07	-2.60	5.70	2.02	2.79	4.25	0.74	7.92	2.06	0.013	-0.008	-0.028	0.012	0.011
	CR_H_TP3P93_001	2.98	1.92	-3.03	6.22	2.38	3.42	3.92	-0.27	8.27	2.50	0.018	-0.007	-0.033	0.020	0.014
	CR_H_TP4P19_001	2.86	1.75	-2.98	6.24	2.24	3.74	3.65	-1.15	8.26	2.70	0.022	-0.006	-0.037	0.024	0.017
	CR_H_TP4P49_001	2.04	1.53	-1.62	5.09	1.64	3.62	3.39	-0.93	7.63	2.59	0.026	-0.006	-0.037	0.026	0.019
	CR_H_TP4P83_001	1.55	1.46	-0.93	5.14	1.25	3.71	3.18	-1.07	7.38	2.64	0.033	-0.005	-0.041	0.030	0.023
	CR_H_TP5P24_001	1.16	1.52	-0.52	4.60	1.05	3.71	3.12	-1.17	7.05	2.64	0.041	-0.005	-0.045	0.034	0.028
	CR_H_TP5P71_002	1.41	1.36	-1.28	3.85	1.15	3.04	3.27	-0.23	6.47	2.17	0.046	0.011	-0.034	0.055	0.030
	CR_H_TP6P28_002	2.09	1.29	-2.22	4.05	1.62	2.28	3.33	0.55	5.96	1.67	0.064	0.011	-0.053	0.073	0.044
	CR_H_TP6P98_002	2.86	1.41	-2.83	5.60	2.19	2.17	3.56	0.12	6.95	1.69	0.083	0.011	-0.078	0.098	0.059
	CR_H_TP7P85_002	2.58	1.53	-3.38	5.63	2.16	2.49	3.52	-0.48	8.15	2.07	0.103	0.010	-0.108	0.120	0.075
	CR_H_TP8P98_003	1.56	1.56	-1.65	4.16	1.40	2.97	3.35	-0.35	7.35	2.17	0.131	0.010	-0.130	0.151	0.094
Corvette and RHIB Following Seas	CR_F_TP3P14_002	0.85	-0.09	-1.74	2.61	0.85	0.58	2.64	0.64	4.50	0.76	0.002	0.009	0.000	0.016	0.003
	CR_F_TP3P31_001	0.58	-0.19	-1.70	1.62	0.62	0.62	2.65	0.36	4.67	0.82	0.002	0.009	0.000	0.016	0.003
	CR_F_TP3P49_001	0.51	-0.15	-1.67	1.82	0.64	0.69	2.69	-0.14	4.69	0.95	0.002	0.010	-0.001	0.022	0.004
	CR_F_TP3P70_001	0.58	-0.12	-1.57	2.14	0.69	0.87	2.70	-1.09	6.09	1.18	0.003	0.009	-0.009	0.023	0.006
	CR_F_TP3P93_001	0.45	-0.19	-2.04	1.37	0.65	0.82	2.65	-0.78	5.32	1.24	0.003	0.009	-0.007	0.028	0.007
	CR_F_TP4P19_001	0.48	-0.17	-1.47	1.99	0.56	0.96	2.73	-0.60	5.31	1.36	0.004	0.008	-0.009	0.025	0.008
	CR_F_TP4P49_001	0.52	-0.18	-1.50	2.07	0.58	0.94	2.82	-0.49	5.33	1.22	0.005	0.009	-0.012	0.029	0.009
	CR_F_TP4P83_001	0.55	-0.17	-1.64	1.57	0.59	1.07	2.82	-1.69	6.47	1.49	0.007	0.008	-0.021	0.041	0.013
	CR_F_TP5P24_001	0.61	-0.21	-2.08	1.48	0.63	1.02	2.85	-0.46	5.62	1.39	0.008	0.008	-0.019	0.035	0.012
	CR_F_TP5P71_001	0.80	-0.15	-1.82	1.83	0.71	1.86	2.77	-0.98	6.13	1.63	0.017	0.008	-0.028	0.042	0.017
	CR_F_TP6P28_001	0.75	-0.15	-1.55	1.89	0.69	2.18	2.75	-0.12	5.48	1.59	0.028	0.008	-0.030	0.045	0.022
	CR_F_TP6P98_001	0.92	-0.16	-1.57	2.21	0.78	2.99	2.74	-0.57	6.20	2.14	0.049	0.007	-0.047	0.065	0.037
	CR_F_TP7P85_001	0.81	-0.18	-1.65	1.42	0.69	3.38	2.58	-1.06	6.51	2.42	0.071	0.005	-0.071	0.083	0.053
	CR_F_TP8P98_002	0.47	-0.21	-1.32	1.51	0.52	3.35	2.84	-0.85	7.16	2.39	0.108	0.004	-0.111	0.120	0.079
RHIB Head Seas	R_H_TP3P14_001	0.18	0.90	0.02	2.08	0.39	0.59	3.28	1.64	4.57	0.51	0.002	0.007	0.000	0.012	0.002
	R_H_TP3P31_001	0.22	0.93	-0.11	2.10	0.41	1.11	3.25	1.19	5.58	0.90	0.005	0.007	-0.003	0.016	0.004
	R_H_TP3P49_001	0.23	0.94	-0.18	2.39	0.49	1.60	3.34	0.96	6.15	1.24	0.006	0.007	-0.006	0.019	0.006
	R_H_TP3P70_001	0.28	0.89	-0.60	2.48	0.61	2.40	3.24	-0.10	6.66	1.79	0.010	0.007	-0.011	0.024	0.009
	R_H_TP3P93_001	0.24	0.87	-0.64	2.61	0.73	2.95	3.17	-0.75	7.07	2.14	0.014	0.008	-0.013	0.029	0.011
	R_H_TP4P19_001	0.14	0.89	-0.94	2.83	0.74	3.43	3.11	-1.01	7.33	2.47	0.019	0.007	-0.017	0.033	0.014
	R_H_TP4P49_001	0.10	0.91	-1.11	2.52	0.62	3.75	2.99	-1.43	7.29	2.68	0.024	0.008	-0.020	0.036	0.017
	R_H_TP4P83_001	0.00	0.90	-0.69	3.19	0.54	3.88	2.94	-1.46	7.11	2.77	0.030	0.008	-0.024	0.041	0.021
	R_H_TP5P24_001	0.08	0.84	-0.27	1.79	0.37	3.87	2.78	-1.50	6.71	2.75	0.037	0.008	-0.030	0.047	0.026
	R_H_TP5P71_001	0.11	0.84	-0.16	1.91	0.40	3.73	2.72	-1.36	6.69	2.65	0.044	0.008	-0.037	0.052	0.031
	R_H_TP6P28_001	0.08	0.87	0.01	1.75	0.35	3.71	2.57	-1.50	6.31	2.63	0.054	0.008	-0.048	0.061	0.038
	R_H_TP6P98_002	0.01	0.82	0.00	1.76	0.35	3.72	2.70	-1.21	6.65	2.64	0.070	0.009	-0.063	0.079	0.049
	R_H_TP7P85_003	0.25	0.81	-0.07	1.88	0.33	3.48	2.78	-0.90	6.33	2.47	0.090	0.009	-0.085	0.099	0.064
	R_H_TP8P98_002	0.26	0.83	0.07	1.62	0.37	3.55	2.74	-1.05	6.66	2.53	0.120	0.008	-0.118	0.128	0.085
RHIB Following Seas	R_F_TP3P14_002	0.04	0.24	-0.69	1.18	0.31	0.77	1.95	0.27	3.29	0.66	0.002	0.009	0.003	0.013	0.003
	R_F_TP3P31_002	0.07	0.21	-0.80	1.01	0.31	1.14	1.95	0.21	3.53	0.90	0.003	0.008	0.001	0.016	0.004
	R_F_TP3P49_001	0.05	0.24	-0.84	1.20	0.34	1.61	1.97	-0.34	4.03	1.20	0.004	0.009	-0.001	0.017	0.005
	R_F_TP3P70_001	0.14	0.25	-0.65	1.39	0.33	2.00	2.01	-0.57	4.27	1.49	0.006	0.008	-0.003	0.019	0.007
	R_F_TP3P93_001	0.03	0.20	-1.03	1.24	0.33	2.30	2.09	-0.52	4.59	1.67	0.009	0.008	-0.004	0.022	0.008
	R_F_TP4P19_001	0.12	0.23	-0.54	1.27	0.29	2.68	2.07	-1.08	5.06	1.97	0.012	0.007	-0.010	0.025	0.011
	R_F_TP4P49_001	0.08	0.26	-0.82	1.43	0.36	3.03	2.14	-1.24	5.35	2.16	0.017	0.006	-0.014	0.029	0.014
	R_F_TP4P83_001	0.14	0.24	-0.70	0.97	0.33	3.38	2.16	-1.48	5.68	2.41	0.023	0.006	-0.020	0.035	0.019
	R_F_TP5P24_001	0.07	0.22	-0.67	1.04	0.27	3.57	2.19	-1.71	5.89	2.53	0.029	0.005	-0.029	0.042	0.024
	R_F_TP5P71_001	0.08	0.21	-0.97	1.04	0.27	3.50	2.26	-1.47	6.02	2.48	0.036	0.005	-0.035	0.048	0.028
	R_F_TP6P28_001	0.10	0.24	-0.42	1.07	0.27	3.54	2.29	-1.37	5.97	2.51	0.047	0.005	-0.045	0.058	0.036
	R_F_TP6P98_001	0.13	0.28	-0.34	1.44	0.30	3.60	2.31	-1.36	6.21	2.55	0.062	0.004	-0.061	0.072	0.046
	R_F_TP7P85_002	0.07	0.22	-0.64	1.06	0.33	3.63	2.37	-1.32	6.26	2.57	0.082	0.003	-0.082	0.092	0.061
	R_F_TP8P98_001	0.05	0.22	-0.55	1.10	0.30	3.71	2.36	-1.54	6.43	2.63	0.114	0.002	-0.117	0.123	0.083

Table 13 Tests in regular waves: RHIB motions amplitudes and statistics - pitch, roll, heave-, model scale, cont.

Regular waves: RHIB motions, in model scale units

		RHIB Pitch					RHIB Roll					RHIB Heave				
	Test Name	Amplitude (sine fit)	MEAN	MIN	MAX	STD	Amplitude (sine fit)	MEAN	MIN	MAX	STD	Amplitude (sine fit)	MEAN	MIN	MAX	STD
		deg	deg	deg	deg	deg	deg	deg	deg	deg	deg	m	m	m	m	m
RHIB (4 kts)	R4_H_TP3P14_001	0.34	0.61	-0.35	1.81	0.33	2.21	0.38	-2.42	3.43	1.62	0.006	0.007	-0.004	0.018	0.004
Head Seas	R4_H_TP3P31_001	0.29	0.57	-0.25	1.50	0.28	2.47	0.34	-2.68	3.40	1.79	0.007	0.007	-0.003	0.019	0.005
	R4_H_TP3P49_001	0.22	0.54	-0.66	1.40	0.28	2.96	0.40	-3.15	3.93	2.13	0.011	0.007	-0.008	0.020	0.007
	R4_H_TP3P70_001	0.16	0.55	-0.26	1.57	0.28	3.17	0.36	-3.11	3.80	2.27	0.014	0.007	-0.008	0.023	0.009
	R4_H_TP3P93_001	0.12	0.53	-0.43	1.53	0.34	3.39	0.31	-3.47	3.94	2.42	0.017	0.007	-0.010	0.026	0.011
	R4_H_TP4P19_001	0.06	0.53	-0.30	1.57	0.30	3.61	0.30	-3.65	3.95	2.57	0.021	0.007	-0.015	0.029	0.014
	R4_H_TP4P49_001	0.00	0.53	-0.27	1.46	0.30	3.64	0.28	-3.67	4.01	2.59	0.026	0.007	-0.019	0.032	0.017
	R4_H_TP4P83_001	0.08	0.51	-0.44	1.43	0.33	3.86	0.28	-3.98	4.26	2.73	0.032	0.007	-0.026	0.039	0.021
	R4_H_TP5P24_001	0.01	0.49	-0.20	1.40	0.29	3.82	0.24	-3.92	4.12	2.71	0.037	0.007	-0.033	0.045	0.026
	R4_H_TP5P71_001	0.07	0.49	-0.21	1.37	0.33	3.62	0.21	-3.90	4.09	2.58	0.044	0.006	-0.039	0.051	0.030
	R4_H_TP6P28_001	0.05	0.51	-0.33	1.36	0.38	3.77	0.20	-3.77	4.07	2.68	0.055	0.006	-0.049	0.062	0.038
	R4_H_TP6P98_001	0.05	0.46	-0.44	1.45	0.37	3.91	0.19	-4.62	4.78	2.79	0.069	0.006	-0.068	0.076	0.048
	R4_H_TP7P85_001	0.04	0.47	-0.32	1.09	0.27	3.90	0.15	-3.93	4.36	2.77	0.088	0.006	-0.086	0.094	0.062
	R4_H_TP8P98_002	0.05	0.49	-0.21	1.25	0.26	4.04	0.15	-4.43	4.86	2.88	0.120	0.005	-0.122	0.128	0.085
RHIB (4 kts)	R4_F_TP3P14_001	0.04	-0.10	-0.60	0.46	0.19	1.22	0.13	-1.52	1.65	0.89	0.004	0.007	0.001	0.014	0.003
Following Seas	R4_F_TP3P31_001	0.03	-0.09	-0.57	0.39	0.19	1.44	0.13	-1.83	1.99	1.05	0.005	0.008	-0.001	0.015	0.004
	R4_F_TP3P49_001	0.03	-0.10	-0.57	0.45	0.20	1.66	0.13	-2.13	2.23	1.20	0.007	0.007	-0.002	0.017	0.005
	R4_F_TP3P70_001	0.00	-0.09	-0.64	0.54	0.21	1.89	0.13	-2.44	2.54	1.39	0.011	0.007	-0.005	0.020	0.007
	R4_F_TP3P93_001	0.01	-0.10	-0.69	0.50	0.22	2.16	0.14	-2.49	2.71	1.57	0.013	0.008	-0.007	0.022	0.009
	R4_F_TP4P19_001	0.00	-0.10	-0.71	0.49	0.22	2.48	0.13	-2.75	2.90	1.79	0.017	0.007	-0.011	0.026	0.012
	R4_F_TP4P49_001	0.02	-0.10	-0.77	0.64	0.23	2.82	0.14	-2.99	3.17	2.01	0.022	0.007	-0.015	0.033	0.015
	R4_F_TP4P83_001	0.00	-0.08	-0.73	1.76	0.25	3.10	0.14	-3.19	3.42	2.21	0.028	0.006	-0.022	0.038	0.019
	R4_F_TP5P24_001	0.06	-0.09	-0.92	1.69	0.26	3.30	0.15	-3.45	3.69	2.35	0.034	0.006	-0.029	0.044	0.024
	R4_F_TP5P71_001	0.03	-0.12	-0.62	0.47	0.20	3.36	0.14	-3.43	3.64	2.39	0.042	0.006	-0.036	0.049	0.029
	R4_F_TP6P28_001	0.03	-0.12	-0.64	0.56	0.18	3.52	0.15	-3.59	3.77	2.49	0.053	0.005	-0.047	0.060	0.037
	R4_F_TP6P98_001	0.03	-0.10	-0.63	0.55	0.20	3.63	0.16	-3.61	4.04	2.57	0.067	0.004	-0.062	0.073	0.047
	R4_F_TP7P85_001	0.03	-0.13	-0.68	0.58	0.22	3.72	0.12	-3.77	3.97	2.64	0.087	0.003	-0.083	0.092	0.061
	R4_F_TP8P98_001	0.03	-0.13	-0.80	0.40	0.22	3.89	0.11	-4.14	4.37	2.76	0.118	0.002	-0.119	0.123	0.083

Table 14 Tests in regular waves: RHIB motions amplitudes and statistics – surge, sway, yaw-, model scale

Regular waves: RHIB motions, in model scale units

		RHIB Surge					RHIB Sway					RHIB Yaw				
	Test Name	Amplitude (sine fit)	MEAN	MIN	MAX	STD	Amplitude (sine fit)	MEAN	MIN	MAX	STD	Amplitude (sine fit)	MEAN	MIN	MAX	STD
		m	m	m	m	m	m	m	m	m	m	deg	deg	deg	deg	deg
Corvette and RHII	CR_H_TP3P14_001	0.001	-0.012	-0.047	0.029	0.016	0.000	-0.005	-0.031	0.047	0.015	0.11	0.29	-2.31	3.16	1.02
Head Seas	CR_H_TP3P31_001	0.002	0.003	-0.041	0.080	0.031	0.000	0.000	-0.044	0.046	0.019	0.09	0.32	-2.24	3.21	1.21
	CR_H_TP3P49_001	0.004	-0.045	-0.128	0.013	0.032	0.000	-0.010	-0.046	0.029	0.014	0.12	0.64	-2.86	4.24	1.75
	CR_H_TP3P70_001	0.005	-0.009	-0.064	0.048	0.024	0.001	-0.007	-0.059	0.034	0.018	0.14	0.88	-3.26	6.23	1.98
	CR_H_TP3P93_001	0.007	-0.002	-0.046	0.035	0.016	0.000	-0.005	-0.054	0.045	0.020	0.03	0.95	-3.17	5.70	1.96
	CR_H_TP4P19_001	0.007	-0.010	-0.047	0.057	0.019	0.003	-0.007	-0.061	0.044	0.019	0.35	0.71	-2.99	5.37	1.84
	CR_H_TP4P49_001	0.008	0.001	-0.048	0.065	0.024	0.004	-0.004	-0.052	0.032	0.016	0.31	0.49	-3.59	5.10	1.58
	CR_H_TP4P83_001	0.010	0.014	-0.023	0.047	0.015	0.004	-0.010	-0.046	0.029	0.015	0.19	0.30	-3.17	3.73	1.15
	CR_H_TP5P24_001	0.014	0.045	-0.027	0.107	0.027	0.005	-0.007	-0.041	0.042	0.020	0.38	0.23	-4.19	3.46	1.42
	CR_H_TP5P71_002	0.014	0.021	-0.057	0.130	0.037	0.008	-0.014	-0.071	0.052	0.029	0.78	0.44	-2.70	4.07	1.35
	CR_H_TP6P28_002	0.015	0.025	-0.043	0.116	0.031	0.013	-0.011	-0.057	0.057	0.025	1.73	0.67	-2.94	5.10	1.72
	CR_H_TP6P98_002	0.015	-0.019	-0.063	0.032	0.024	0.003	0.003	-0.047	0.040	0.020	2.68	0.59	-3.94	5.14	2.14
	CR_H_TP7P85_002	0.024	-0.008	-0.101	0.113	0.037	0.012	-0.031	-0.083	0.010	0.020	2.18	0.80	-2.75	4.67	1.82
	CR_H_TP8P98_003	0.037	-0.005	-0.073	0.067	0.031	0.021	-0.020	-0.095	0.057	0.032	1.37	0.75	-4.38	3.96	1.58
Corvette and RHII	CR_F_TP3P14_002	0.078	0.021	-0.139	0.229	0.077	0.061	0.013	-0.089	0.119	0.051	2.91	-0.39	-7.07	6.33	2.56
Following Seas	CR_F_TP3P31_001	0.060	0.008	-0.129	0.258	0.069	0.025	0.003	-0.093	0.066	0.032	1.67	-0.19	-4.65	5.20	1.95
	CR_F_TP3P49_001	0.051	0.000	-0.123	0.176	0.058	0.011	-0.006	-0.068	0.037	0.025	1.00	-0.23	-4.18	3.41	1.65
	CR_F_TP3P70_001	0.056	0.008	-0.136	0.204	0.065	0.011	-0.003	-0.064	0.056	0.024	1.02	-0.22	-4.95	3.50	1.70
	CR_F_TP3P93_001	0.045	0.010	-0.120	0.190	0.058	0.000	0.005	-0.055	0.077	0.033	0.47	-0.10	-5.24	5.77	1.85
	CR_F_TP4P19_001	0.046	0.010	-0.101	0.160	0.058	0.004	0.004	-0.067	0.092	0.030	0.36	-0.13	-4.12	3.38	1.43
	CR_F_TP4P49_001	0.045	0.017	-0.095	0.167	0.052	0.002	0.002	-0.062	0.062	0.029	0.75	-0.19	-4.09	3.79	1.50
	CR_F_TP4P83_001	0.045	0.026	-0.086	0.176	0.055	0.001	0.003	-0.044	0.084	0.026	0.67	-0.17	-4.01	4.38	1.40
	CR_F_TP5P24_001	0.046	0.004	-0.150	0.152	0.061	0.011	-0.001	-0.049	0.052	0.024	0.40	-0.07	-2.98	3.07	1.29
	CR_F_TP5P71_001	0.077	0.009	-0.125	0.170	0.069	0.019	0.006	-0.057	0.076	0.025	0.53	-0.25	-4.09	2.99	1.35
	CR_F_TP6P28_001	0.094	0.001	-0.127	0.158	0.071	0.017	0.004	-0.056	0.062	0.024	0.33	-0.33	-4.11	2.36	1.25
	CR_F_TP6P98_001	0.130	0.002	-0.160	0.157	0.094	0.016	0.003	-0.048	0.061	0.027	0.73	-0.39	-4.51	2.60	1.46
	CR_F_TP7P85_001	0.156	0.006	-0.189	0.216	0.113	0.021	0.002	-0.055	0.064	0.026	0.33	-0.29	-2.63	2.64	1.03
	CR_F_TP8P98_002	0.174	0.110	-0.127	0.345	0.127	0.013	0.008	-0.043	0.065	0.025	0.06	-0.51	-3.72	3.52	1.31
RHIB	R_H_TP3P14_001	0.000	-0.016	-0.087	0.075	0.044	0.000	-0.008	-0.033	0.022	0.011	0.01	0.07	-2.50	2.00	0.86
Head Seas	R_H_TP3P31_001	0.000	-0.027	-0.091	0.025	0.024	0.000	-0.010	-0.042	0.030	0.015	0.04	0.05	-2.56	2.03	0.87
	R_H_TP3P49_001	0.001	-0.019	-0.102	0.036	0.030	0.000	-0.009	-0.041	0.023	0.012	0.01	-0.10	-2.29	2.50	1.00
	R_H_TP3P70_001	0.003	-0.008	-0.086	0.077	0.044	0.000	-0.006	-0.039	0.035	0.015	0.01	-0.03	-3.01	3.26	1.14
	R_H_TP3P93_001	0.005	-0.003	-0.059	0.052	0.028	0.000	-0.003	-0.054	0.039	0.018	0.06	-0.05	-3.43	3.25	1.49
	R_H_TP4P19_001	0.006	-0.003	-0.054	0.057	0.022	0.001	-0.005	-0.050	0.043	0.017	0.07	-0.11	-3.83	4.21	1.55
	R_H_TP4P49_001	0.008	-0.001	-0.049	0.053	0.021	0.000	-0.007	-0.050	0.053	0.020	0.05	-0.17	-3.73	4.40	1.41
	R_H_TP4P83_001	0.011	-0.005	-0.078	0.056	0.026	0.000	-0.006	-0.049	0.033	0.017	0.07	-0.06	-4.38	3.20	1.19
	R_H_TP5P24_001	0.014	0.003	-0.055	0.052	0.020	0.001	0.000	-0.043	0.036	0.017	0.06	-0.16	-2.51	2.81	0.98
	R_H_TP5P71_001	0.016	-0.001	-0.059	0.049	0.025	0.002	-0.019	-0.041	0.006	0.012	0.12	-0.14	-2.86	2.55	1.04
	R_H_TP6P28_001	0.020	0.030	-0.030	0.112	0.033	0.000	-0.001	-0.031	0.037	0.019	0.26	-0.21	-2.73	1.78	1.07
	R_H_TP6P98_002	0.027	0.011	-0.066	0.064	0.029	0.000	-0.006	-0.049	0.030	0.020	0.03	-0.08	-2.88	2.68	1.07
	R_H_TP7P85_003	0.033	-0.031	-0.116	0.049	0.042	0.001	0.000	-0.037	0.042	0.019	0.25	-0.20	-2.21	1.63	0.89
	R_H_TP8P98_002	0.052	-0.026	-0.102	0.070	0.041	0.004	0.000	-0.039	0.036	0.014	0.35	-0.22	-2.57	2.00	0.92
RHIB	R_F_TP3P14_002	0.102	0.002	-0.168	0.358	0.103	0.010	-0.005	-0.077	0.061	0.025	0.54	-0.22	-4.32	2.57	1.22
Following Seas	R_F_TP3P31_002	0.122	-0.012	-0.201	0.153	0.096	0.004	-0.002	-0.072	0.108	0.030	0.16	-0.14	-4.23	2.63	1.25
	R_F_TP3P49_001	0.125	-0.012	-0.170	0.184	0.092	0.001	0.004	-0.059	0.066	0.026	0.13	-0.20	-3.48	4.02	1.23
	R_F_TP3P70_001	0.129	-0.016	-0.198	0.150	0.096	0.009	-0.006	-0.052	0.040	0.019	0.66	-0.25	-3.16	2.73	1.13
	R_F_TP3P93_001	0.126	-0.007	-0.175	0.159	0.093	0.003	-0.005	-0.059	0.049	0.025	0.25	-0.14	-3.64	3.10	1.27
	R_F_TP4P19_001	0.134	0.006	-0.180	0.201	0.100	0.004	-0.006	-0.050	0.032	0.021	0.32	-0.19	-2.81	2.75	1.00
	R_F_TP4P49_001	0.135	-0.006	-0.163	0.162	0.097	0.001	0.000	-0.049	0.074	0.028	0.21	-0.22	-3.36	3.26	1.21
	R_F_TP4P83_001	0.142	-0.007	-0.182	0.159	0.102	0.004	-0.002	-0.036	0.045	0.017	0.47	-0.01	-2.30	2.82	1.03
	R_F_TP5P24_001	0.147	-0.002	-0.186	0.182	0.105	0.002	-0.008	-0.050	0.058	0.022	0.25	0.07	-3.11	3.58	1.08
	R_F_TP5P71_001	0.144	0.002	-0.167	0.192	0.104	0.002	-0.004	-0.047	0.047	0.018	0.35	0.16	-2.15	3.26	0.97
	R_F_TP6P28_001	0.149	-0.002	-0.178	0.168	0.106	0.000	-0.005	-0.059	0.032	0.021	0.24	0.03	-2.53	3.15	1.02
	R_F_TP6P98_001	0.160	0.001	-0.195	0.207	0.116	0.006	0.005	-0.039	0.051	0.020	0.58	-0.09	-3.47	2.27	1.09
	R_F_TP7P85_002	0.178	-0.013	-0.199	0.188	0.126	0.002	-0.007	-0.060	0.067	0.031	0.21	0.05	-3.23	3.73	1.32
	R_F_TP8P98_001	0.213	0.001	-0.227	0.236	0.151	0.003	-0.006	-0.054	0.048	0.022	0.01	0.08	-3.01	2.54	1.15

Table 15 Tests in regular waves: RHIB motions amplitudes and statistics – surge, sway, yaw-, model scale, cont.

Regular waves: RHIB motions, in model scale units

		RHIB Surge					RHIB Sway					RHIB Yaw				
	Test Name	Amplitude (sine fit)	MEAN	MIN	MAX	STD	Amplitude (sine fit)	MEAN	MIN	MAX	STD	Amplitude (sine fit)	MEAN	MIN	MAX	STD
		m	m	m	m	m	m	m	m	m	m	deg	deg	deg	deg	deg
RHIB (4 kts)	R4_H_TP3P14_001	0.002	-0.014	-0.051	0.025	0.018	0.000	-0.011	-0.032	0.020	0.010	0.04	0.03	-1.66	2.46	0.70
Head Seas	R4_H_TP3P31_001	0.003	-0.005	-0.030	0.029	0.014	0.000	-0.009	-0.033	0.015	0.011	0.04	-0.13	-1.89	1.94	0.77
	R4_H_TP3P49_001	0.004	-0.003	-0.056	0.033	0.019	0.000	-0.001	-0.045	0.030	0.015	0.01	-0.14	-3.03	3.83	1.18
	R4_H_TP3P70_001	0.005	0.001	-0.024	0.032	0.012	0.000	-0.004	-0.050	0.035	0.020	0.01	-0.10	-2.91	3.21	1.23
	R4_H_TP3P93_001	0.007	0.000	-0.035	0.041	0.016	0.000	-0.005	-0.045	0.041	0.020	0.05	-0.21	-4.21	2.86	1.60
	R4_H_TP4P19_001	0.009	-0.002	-0.067	0.054	0.026	0.000	-0.009	-0.058	0.027	0.022	0.05	-0.22	-4.82	3.53	1.44
	R4_H_TP4P49_001	0.011	0.000	-0.040	0.048	0.018	0.000	-0.008	-0.034	0.028	0.012	0.09	-0.19	-4.12	3.56	1.81
	R4_H_TP4P83_001	0.014	-0.002	-0.050	0.064	0.021	0.000	-0.007	-0.044	0.023	0.013	0.08	-0.04	-4.47	3.81	2.15
	R4_H_TP5P24_001	0.019	-0.001	-0.042	0.043	0.017	0.000	-0.007	-0.042	0.035	0.014	0.01	-0.07	-4.98	3.85	2.29
	R4_H_TP5P71_001	0.022	-0.001	-0.064	0.067	0.024	0.000	-0.009	-0.044	0.025	0.014	0.11	-0.03	-4.96	4.78	2.68
	R4_H_TP6P28_001	0.031	-0.015	-0.077	0.048	0.031	0.002	0.004	-0.020	0.031	0.014	0.39	-0.30	-5.41	4.74	3.22
	R4_H_TP6P98_001	0.043	-0.010	-0.078	0.052	0.033	0.001	0.000	-0.048	0.057	0.024	0.14	-0.02	-5.85	5.55	3.35
	R4_H_TP7P85_001	0.056	0.000	-0.102	0.101	0.049	0.000	0.004	-0.054	0.057	0.027	0.04	0.03	-5.05	5.56	2.69
	R4_H_TP8P98_002	0.085	-0.013	-0.148	0.108	0.065	0.000	-0.008	-0.064	0.061	0.034	0.38	0.18	-5.08	6.07	2.75
RHIB (4 kts)	R4_F_TP3P14_001	0.013	0.008	-0.051	0.059	0.025	0.000	-0.003	-0.036	0.044	0.017	0.08	-0.17	-5.86	5.23	2.86
Following Seas	R4_F_TP3P31_001	0.017	0.001	-0.075	0.072	0.034	0.000	-0.003	-0.051	0.039	0.019	0.01	-0.20	-6.44	5.83	2.96
	R4_F_TP3P49_001	0.020	0.003	-0.057	0.076	0.025	0.000	-0.006	-0.053	0.038	0.018	0.05	-0.14	-6.27	5.75	3.09
	R4_F_TP3P70_001	0.024	0.002	-0.093	0.105	0.044	0.000	-0.009	-0.069	0.038	0.021	0.03	-0.08	-6.12	6.12	3.25
	R4_F_TP3P93_001	0.029	-0.002	-0.084	0.074	0.030	0.000	-0.004	-0.047	0.040	0.021	0.06	-0.40	-7.18	5.49	3.44
	R4_F_TP4P19_001	0.035	-0.003	-0.090	0.083	0.034	0.000	-0.007	-0.055	0.034	0.020	0.01	-0.11	-6.79	6.25	3.51
	R4_F_TP4P49_001	0.043	0.000	-0.097	0.084	0.040	0.000	-0.004	-0.057	0.050	0.022	0.05	-0.14	-7.10	6.67	3.77
	R4_F_TP4P83_001	0.052	-0.003	-0.138	0.138	0.061	0.001	-0.002	-0.053	0.050	0.024	0.02	-0.06	-6.98	6.50	3.77
	R4_F_TP5P24_001	0.061	0.001	-0.220	0.196	0.081	0.000	-0.005	-0.064	0.077	0.029	0.08	-0.18	-7.74	7.49	3.59
	R4_F_TP5P71_001	0.070	0.003	-0.164	0.151	0.069	0.001	-0.001	-0.062	0.057	0.025	0.12	-0.26	-7.73	6.38	3.41
	R4_F_TP6P28_001	0.083	-0.003	-0.159	0.138	0.067	0.000	-0.006	-0.081	0.086	0.033	0.02	-0.16	-9.50	7.33	3.26
	R4_F_TP6P98_001	0.101	-0.001	-0.156	0.153	0.079	0.001	-0.015	-0.081	0.045	0.030	0.15	-0.04	-7.18	5.65	3.15
	R4_F_TP7P85_001	0.121	-0.005	-0.174	0.149	0.090	0.000	-0.010	-0.094	0.070	0.041	0.01	-0.05	-6.45	5.86	3.05
	R4_F_TP8P98_001	0.160	-0.006	-0.226	0.202	0.116	0.002	-0.002	-0.103	0.090	0.052	0.16	-0.18	-6.54	6.32	2.82

Table 16 Tests in regular waves: RHIB driving parameters, model scale

Regular waves: RHIB driving parameters, in model scale units

		RHIB Forward Speed				RHIB Shaft Speed				RHIB Steering Angle			
	Test Name	MEAN	MIN	MAX	STD	MEAN	MIN	MAX	STD	MEAN	MIN	MAX	STD
		m/s	m/s	m/s	m/s	rpm	rpm	rpm	rpm	deg	deg	deg	deg
Corvette and RHIB	CR_H_TP3P14_001	1.204	1.16	1.23	0.012	5509	5382	5647	57	-2.2	-7.43	4.84	2.41
Head Seas	CR_H_TP3P31_001	1.204	1.15	1.25	0.018	5584	5466	5697	55	-2.2	-8.17	4.95	2.85
	CR_H_TP3P49_001	1.210	1.14	1.28	0.024	5834	5681	5930	56	-1.9	-10.01	9.48	4.83
	CR_H_TP3P70_001	1.210	1.14	1.28	0.025	5727	5568	5836	56	-2.2	-11.19	9.28	5.11
	CR_H_TP3P93_001	1.209	1.12	1.30	0.036	5593	5495	5712	42	-2.2	-10.10	9.56	4.58
	CR_H_TP4P19_001	1.208	1.11	1.30	0.039	5492	5321	5622	69	-2.4	-9.93	7.68	3.97
	CR_H_TP4P49_001	1.207	1.09	1.30	0.044	5354	5215	5496	56	-2.0	-8.87	6.44	3.09
	CR_H_TP4P83_001	1.207	1.10	1.31	0.047	5246	5162	5399	39	-1.9	-7.67	4.23	2.19
	CR_H_TP5P24_001	1.201	1.07	1.31	0.057	5231	5167	5318	31	-2.0	-8.47	4.19	2.41
	CR_H_TP5P71_002	1.204	1.09	1.31	0.058	5268	5188	5363	30	-1.9	-7.07	4.13	2.36
	CR_H_TP6P28_002	1.205	1.11	1.31	0.052	5304	5191	5422	50	-1.5	-7.97	5.56	3.38
	CR_H_TP6P98_002	1.207	1.12	1.30	0.048	5404	5296	5484	35	-1.2	-9.22	6.10	4.23
	CR_H_TP7P85_002	1.204	1.07	1.33	0.063	5355	5191	5585	83	-2.2	-9.92	5.38	3.47
	CR_H_TP8P98_003	1.208	1.06	1.35	0.085	5257	5155	5372	44	-2.5	-9.11	2.06	2.20
Corvette and RHIB	CR_F_TP3P14_002	1.204	1.03	1.42	0.084	4978	4763	5204	89	0.4	-8.13	6.25	2.55
Following Seas	CR_F_TP3P31_001	1.204	1.00	1.47	0.080	4957	4666	5151	84	0.6	-5.63	4.42	2.01
	CR_F_TP3P49_001	1.205	1.01	1.46	0.085	4985	4779	5121	71	0.3	-5.96	5.03	2.40
	CR_F_TP3P70_001	1.203	0.93	1.47	0.103	4991	4758	5156	75	0.3	-5.55	4.87	2.28
	CR_F_TP3P93_001	1.203	0.94	1.49	0.102	4977	4778	5123	62	0.6	-5.03	5.96	2.16
	CR_F_TP4P19_001	1.207	0.97	1.44	0.109	4985	4819	5128	64	0.5	-6.17	4.41	1.80
	CR_F_TP4P49_001	1.203	0.99	1.43	0.096	5011	4861	5151	59	0.4	-6.10	4.63	2.05
	CR_F_TP4P83_001	1.207	0.92	1.48	0.113	5010	4861	5177	63	0.5	-4.64	4.59	1.62
	CR_F_TP5P24_001	1.205	0.98	1.46	0.115	5013	4833	5175	68	0.6	-5.30	5.22	1.73
	CR_F_TP5P71_001	1.207	0.94	1.49	0.132	5022	4838	5176	70	0.4	-5.76	4.79	1.85
	CR_F_TP6P28_001	1.205	0.97	1.43	0.134	4999	4838	5141	72	0.5	-5.40	4.75	2.01
	CR_F_TP6P98_001	1.206	0.93	1.50	0.178	4998	4842	5198	93	0.7	-7.13	4.78	1.93
	CR_F_TP7P85_001	1.204	0.88	1.52	0.205	4916	4687	5151	116	0.8	-4.35	4.99	1.57
	CR_F_TP8P98_002	1.210	0.88	1.53	0.209	5013	4738	5279	126	0.4	-4.46	5.65	1.85
RHIB	R_H_TP3P14_001	1.204	1.17	1.24	0.013	5190	4900	5435	118	-1.0	-6.40	2.75	1.81
Head Seas	R_H_TP3P31_001	1.207	1.17	1.25	0.014	5216	4912	5433	116	-1.0	-5.59	3.16	1.78
	R_H_TP3P49_001	1.206	1.16	1.26	0.019	5285	5087	5502	107	-1.0	-5.94	3.72	2.15
	R_H_TP3P70_001	1.208	1.12	1.27	0.026	5267	5050	5530	118	-0.8	-7.39	5.52	2.52
	R_H_TP3P93_001	1.206	1.13	1.27	0.029	5270	5136	5472	69	-0.6	-7.83	5.41	3.13
	R_H_TP4P19_001	1.207	1.13	1.28	0.033	5241	5146	5369	47	-0.7	-7.76	6.32	3.09
	R_H_TP4P49_001	1.207	1.12	1.30	0.041	5186	5080	5304	43	-0.9	-7.23	5.92	2.44
	R_H_TP4P83_001	1.207	1.10	1.31	0.050	5160	5064	5301	46	-0.9	-8.80	4.14	2.10
	R_H_TP5P24_001	1.206	1.11	1.31	0.055	5044	4928	5136	37	-0.7	-4.70	2.53	1.46
	R_H_TP5P71_001	1.205	1.10	1.31	0.062	5009	4879	5104	51	-0.6	-5.46	2.92	1.65
	R_H_TP6P28_001	1.201	1.09	1.32	0.070	4924	4845	5015	35	-0.7	-4.67	2.81	1.76
	R_H_TP6P98_002	1.208	1.08	1.34	0.084	4999	4873	5125	59	-0.7	-4.53	2.89	1.64
	R_H_TP7P85_003	1.210	1.08	1.35	0.091	5055	4940	5152	47	-0.5	-3.48	2.38	1.31
	R_H_TP8P98_002	1.210	1.01	1.38	0.115	5036	4869	5138	49	-0.8	-4.94	2.83	1.51
RHIB	R_F_TP3P14_002	1.200	1.02	1.35	0.095	4644	4290	4929	136	-0.9	-5.82	2.53	1.63
Following Seas	R_F_TP3P31_002	1.206	1.00	1.38	0.119	4674	4468	4905	114	-0.5	-4.89	3.50	1.63
	R_F_TP3P49_001	1.204	0.97	1.43	0.137	4679	4417	4882	108	-0.6	-5.45	4.15	1.75
	R_F_TP3P70_001	1.206	0.96	1.45	0.154	4696	4480	4928	106	-0.6	-6.27	3.34	1.71
	R_F_TP3P93_001	1.207	0.94	1.44	0.164	4737	4559	4913	95	-0.4	-5.21	3.41	1.61
	R_F_TP4P19_001	1.209	0.94	1.49	0.182	4705	4486	4918	100	-0.5	-4.64	3.39	1.43
	R_F_TP4P49_001	1.206	0.92	1.50	0.189	4736	4563	4904	91	-0.9	-5.98	3.12	1.72
	R_F_TP4P83_001	1.206	0.90	1.51	0.204	4731	4546	4918	98	-0.6	-5.11	3.06	1.66
	R_F_TP5P24_001	1.206	0.89	1.53	0.212	4741	4536	4927	98	-0.7	-4.60	2.49	1.44
	R_F_TP5P71_001	1.207	0.90	1.52	0.208	4760	4565	4975	99	-0.5	-4.30	4.05	1.32
	R_F_TP6P28_001	1.206	0.89	1.51	0.209	4771	4601	4970	98	-0.7	-4.55	2.54	1.40
	R_F_TP6P98_001	1.207	0.88	1.53	0.217	4784	4556	4999	111	-0.7	-5.20	2.93	1.54
	R_F_TP7P85_002	1.207	0.87	1.55	0.228	4812	4596	5051	124	-0.6	-4.22	2.95	1.62
	R_F_TP8P98_001	1.207	0.84	1.59	0.254	4784	4543	5050	155	-0.7	-4.02	2.96	1.46

Table 17 Tests in regular waves: RHIB driving parameters, model scale, cont.

Regular waves: RHIB driving parameters, in model scale units

		RHIB Forward Speed				RHIB Shaft Speed				RHIB Steering Angle			
	Test Name	MEAN	MIN	MAX	STD	MEAN	MIN	MAX	STD	MEAN	MIN	MAX	STD
		m/s	m/s	m/s	m/s	rpm	rpm	rpm	rpm	deg	deg	deg	deg
RHIB (4 kts)	R4_H_TP3P14_001	0.604	0.57	0.64	0.014	2448	2307	2600	75	-1.4	-4.26	2.21	0.88
Head Seas	R4_H_TP3P31_001	0.604	0.57	0.64	0.016	2409	2321	2506	43	-1.4	-4.10	1.11	0.98
	R4_H_TP3P49_001	0.603	0.55	0.65	0.023	2450	2358	2538	38	-0.7	-3.54	2.75	1.18
	R4_H_TP3P70_001	0.603	0.56	0.65	0.027	2423	2366	2479	22	-0.8	-4.10	3.79	1.33
	R4_H_TP3P93_001	0.603	0.54	0.66	0.032	2408	2341	2462	27	-0.9	-5.73	3.30	1.97
	R4_H_TP4P19_001	0.604	0.53	0.68	0.039	2399	2300	2522	47	-1.0	-6.41	3.38	1.95
	R4_H_TP4P49_001	0.604	0.53	0.68	0.045	2509	2443	2573	29	-0.8	-7.42	4.75	3.18
	R4_H_TP4P83_001	0.604	0.51	0.70	0.055	2445	2347	2503	30	-0.7	-7.94	5.07	3.51
	R4_H_TP5P24_001	0.604	0.50	0.71	0.065	2364	2295	2415	20	-0.7	-7.86	4.81	3.54
	R4_H_TP5P71_001	0.603	0.49	0.71	0.072	2343	2237	2444	36	-0.8	-7.85	5.69	3.85
	R4_H_TP6P28_001	0.605	0.46	0.74	0.090	2352	2249	2416	33	-1.1	-8.38	4.92	4.28
	R4_H_TP6P98_001	0.605	0.43	0.77	0.111	2293	2213	2391	36	-0.7	-8.79	5.52	4.10
	R4_H_TP7P85_001	0.607	0.40	0.82	0.132	2171	2043	2341	62	-0.7	-6.82	5.05	2.91
	R4_H_TP8P98_002	0.603	0.35	0.86	0.165	2155	2008	2378	83	-1.1	-7.45	4.54	2.93
RHIB (4 kts)	R4_F_TP3P14_001	0.603	0.53	0.68	0.041	2248	2145	2342	42	-1.0	-7.93	5.26	3.75
Following Seas	R4_F_TP3P31_001	0.604	0.51	0.70	0.049	2258	2149	2345	47	-1.0	-8.49	5.29	3.81
	R4_F_TP3P49_001	0.604	0.49	0.71	0.056	2257	2156	2334	34	-0.9	-9.06	5.56	3.93
	R4_F_TP3P70_001	0.604	0.47	0.73	0.067	2252	2119	2378	59	-1.0	-9.17	5.92	4.03
	R4_F_TP3P93_001	0.603	0.46	0.74	0.076	2248	2152	2342	33	-1.1	-9.59	5.56	4.18
	R4_F_TP4P19_001	0.604	0.45	0.75	0.089	2230	2127	2331	36	-1.2	-9.47	5.84	4.19
	R4_F_TP4P49_001	0.603	0.44	0.77	0.104	2215	2123	2322	40	-0.9	-9.13	6.01	4.31
	R4_F_TP4P83_001	0.604	0.40	0.81	0.120	2183	2019	2324	67	-1.0	-8.48	5.26	4.07
	R4_F_TP5P24_001	0.605	0.36	0.86	0.135	2138	1901	2392	95	-1.2	-8.96	5.77	3.85
	R4_F_TP5P71_001	0.603	0.37	0.84	0.144	2095	1934	2260	73	-0.9	-9.28	5.15	3.58
	R4_F_TP6P28_001	0.604	0.35	0.86	0.159	2066	1929	2221	61	-1.2	-10.20	5.31	3.29
	R4_F_TP6P98_001	0.604	0.33	0.87	0.178	2058	1891	2211	70	-1.5	-8.33	3.91	3.13
	R4_F_TP7P85_001	0.603	0.30	0.91	0.199	2028	1882	2187	77	-1.1	-7.43	4.34	2.85
	R4_F_TP8P98_001	0.602	0.26	0.95	0.232	2005	1804	2225	104	-1.0	-6.72	4.30	2.68

Table 18 Tests in regular waves: corvette motions non-dimensional amplitudes

Regular waves: corvette non-dimensional amplitudes

a: wave amplitude from calibration measurements

	Test Name	wave radial frequency	Heave amplitude		Pitch amplitude		Roll amplitude	
			from sine fit	√2*St Dev	from sine fit	√2*St Dev	from sine fit	√2*St Dev
		/ $(L_{WL(corv)}/g)^{-1/2}$	/ a		/ k*a			
Corvette alone	HS0P31_TP3P14_001	5.353	0.001	0.018	0.001	0.002	0.000	0.005
Head Seas	HS0P34_TP3P31_001	5.083	0.006	0.015	0.001	0.002	0.000	0.004
	HS0P38_TP3P49_002	4.815	0.006	0.019	0.002	0.002	0.000	0.005
	HS0P43_TP3P70_001	4.549	0.009	0.030	0.006	0.006	0.001	0.005
	HS0P48_TP3P93_001	4.280	0.029	0.031	0.005	0.005	0.001	0.005
	HS0P55_TP4P19_001	4.012	0.032	0.038	0.013	0.013	0.001	0.005
	HS0P63_TP4P49_001	3.747	0.069	0.071	0.042	0.042	0.008	0.013
	HS0P73_TP4P83_001	3.477	0.176	0.177	0.059	0.059	0.012	0.016
	HS0P86_TP5P24_001	3.210	0.247	0.248	0.038	0.039	0.005	0.017
	HS1P02_TP5P71_001	2.944	0.286	0.287	0.165	0.166	0.029	0.047
	HS1P23_TP6P28_001	2.675	0.284	0.286	0.392	0.392	0.074	0.086
	HS1P52_TP6P98_001	2.407	0.368	0.368	0.615	0.615	0.135	0.145
	HS1P93_TP7P85_001	2.140	0.566	0.567	0.827	0.827	0.208	0.239
	HS2P51_TP8P98_002	1.873	0.753	0.754	0.952	0.956	0.586	0.588
Corvette alone	HS0P31_C_F_001	5.353	0.002	0.035	0.000	0.003	0.001	0.006
Following Seas	HS0P34_C_F_001	5.083	0.001	0.019	0.002	0.004	0.001	0.007
	HS0P38_C_F_001	4.815	0.001	0.016	0.001	0.004	0.001	0.008
	HS0P43_C_F_001	4.549	0.003	0.014	0.002	0.008	0.001	0.010
	HS0P48_C_F_001	4.278	0.005	0.015	0.005	0.010	0.000	0.011
	HS0P55_C_F_001	4.013	0.012	0.022	0.003	0.013	0.001	0.017
	HS0P63_C_F_001	3.749	0.012	0.024	0.006	0.023	0.000	0.026
	HS0P73_C_F_001	3.477	0.024	0.039	0.030	0.050	0.003	0.049
	HS0P86_C_F_001	3.209	0.096	0.122	0.026	0.047	0.003	0.163
	HS1P02_C_F_001	2.944	0.099	0.106	0.031	0.067	0.000	0.102
	HS1P23_C_F_001	2.674	0.061	0.087	0.172	0.177	0.015	0.079
	HS1P52_C_F_001	2.408	0.234	0.236	0.367	0.368	0.034	0.056
	HS1P93_C_F_001	2.140	0.438	0.438	0.560	0.560	0.045	0.136
	HS2P51_C_F_001	1.872	0.651	0.651	0.759	0.760	0.052	0.103
Corvette and RHIB	CR_H_TP3P14_001	5.353	0.002	0.044	0.001	0.002	0.001	0.005
Head Seas	CR_H_TP3P31_001	5.083	0.002	0.011	0.001	0.003	0.001	0.006
	CR_H_TP3P49_001	4.815	0.006	0.017	0.001	0.002	0.001	0.006
	CR_H_TP3P70_001	4.548	0.008	0.017	0.005	0.005	0.002	0.007
	CR_H_TP3P93_001	4.280	0.025	0.029	0.004	0.004	0.002	0.007
	CR_H_TP4P19_001	4.012	0.026	0.030	0.012	0.013	0.001	0.006
	CR_H_TP4P49_001	3.747	0.063	0.064	0.041	0.041	0.003	0.011
	CR_H_TP4P83_001	3.477	0.161	0.162	0.061	0.061	0.005	0.012
	CR_H_TP5P24_001	3.210	0.239	0.240	0.037	0.037	0.007	0.014
	CR_H_TP5P71_002	2.943	0.271	0.272	0.169	0.169	0.033	0.043
	CR_H_TP6P28_002	2.675	0.283	0.284	0.404	0.404	0.074	0.078
	CR_H_TP6P98_002	2.407	0.374	0.375	0.644	0.644	0.142	0.146
	CR_H_TP7P85_002	2.140	0.591	0.592	0.855	0.856	0.216	0.244
	CR_H_TP8P98_003	1.873	0.760	0.761	0.970	0.972	0.565	0.571
Corvette and RHIB	CR_F_TP3P14_002	5.353	0.000	0.032	0.000	0.003	0.001	0.011
Following Seas	CR_F_TP3P31_001	5.078	0.001	0.021	0.002	0.004	0.000	0.010
	CR_F_TP3P49_001	4.813	0.003	0.020	0.001	0.005	0.002	0.014
	CR_F_TP3P70_001	4.548	0.003	0.020	0.003	0.009	0.003	0.021
	CR_F_TP3P93_001	4.278	0.007	0.018	0.005	0.011	0.006	0.029
	CR_F_TP4P19_001	4.013	0.015	0.025	0.002	0.015	0.002	0.033
	CR_F_TP4P49_001	3.747	0.015	0.026	0.010	0.025	0.009	0.060
	CR_F_TP4P83_001	3.478	0.027	0.043	0.025	0.052	0.015	0.076
	CR_F_TP5P24_001	3.209	0.098	0.109	0.026	0.036	0.007	0.167
	CR_F_TP5P71_001	2.943	0.104	0.109	0.042	0.072	0.034	0.091
	CR_F_TP6P28_001	2.675	0.062	0.082	0.176	0.179	0.063	0.080
	CR_F_TP6P98_001	2.408	0.237	0.239	0.373	0.374	0.077	0.099
	CR_F_TP7P85_001	2.141	0.450	0.450	0.567	0.567	0.071	0.127
	CR_F_TP8P98_002	1.872	0.661	0.662	0.761	0.761	0.048	0.063

Table 19 Tests in regular waves: corvette motions phases

	Test Name	wave radial frequency	Heave phase	Pitch phase	Roll phase
			relative to encounter wave		
		/ $(L_{WL(corv)}/g)^{-1/2}$	deg	deg	deg
Corvette alone Head Seas	HS0P31_TP3P14_001	5.353	317	290	353
	HS0P34_TP3P31_001	5.083	112	316	73
	HS0P38_TP3P49_002	4.815	191	105	186
	HS0P43_TP3P70_001	4.549	329	146	211
	HS0P48_TP3P93_001	4.280	62	163	236
	HS0P55_TP4P19_001	4.012	106	297	16
	HS0P63_TP4P49_001	3.747	188	322	17
	HS0P73_TP4P83_001	3.477	217	319	9
	HS0P86_TP5P24_001	3.210	229	5	61
	HS1P02_TP5P71_001	2.944	248	86	112
	HS1P23_TP6P28_001	2.675	277	90	104
	HS1P52_TP6P98_001	2.407	313	82	93
	HS1P93_TP7P85_001	2.140	331	78	84
	HS2P51_TP8P98_002	1.873	340	94	66
Corvette alone Following Seas	HS0P31_C_F_001	5.353	42	172	258
	HS0P34_C_F_001	5.083	169	33	340
	HS0P38_C_F_001	4.815	127	11	42
	HS0P43_C_F_001	4.549	140	229	71
	HS0P48_C_F_001	4.278	11	214	297
	HS0P55_C_F_001	4.013	344	178	153
	HS0P63_C_F_001	3.749	306	57	67
	HS0P73_C_F_001	3.477	172	41	78
	HS0P86_C_F_001	3.209	151	53	305
	HS1P02_C_F_001	2.944	159	235	208
	HS1P23_C_F_001	2.674	46	245	126
	HS1P52_C_F_001	2.408	3	246	151
	HS1P93_C_F_001	2.140	355	248	147
	HS2P51_C_F_001	1.872	352	259	132
Corvette and RHIB Head Seas	CR_H_TP3P14_001	5.353	81	257	257
	CR_H_TP3P31_001	5.083	160	298	242
	CR_H_TP3P49_001	4.815	224	135	244
	CR_H_TP3P70_001	4.548	12	130	213
	CR_H_TP3P93_001	4.280	84	156	200
	CR_H_TP4P19_001	4.012	128	281	207
	CR_H_TP4P49_001	3.747	215	307	24
	CR_H_TP4P83_001	3.477	245	309	31
	CR_H_TP5P24_001	3.210	258	10	89
	CR_H_TP5P71_002	2.943	269	70	97
	CR_H_TP6P28_002	2.675	295	73	94
	CR_H_TP6P98_002	2.407	329	74	90
	CR_H_TP7P85_002	2.140	345	74	76
	CR_H_TP8P98_003	1.873	351	73	63
Corvette and RHIB Following Seas	CR_F_TP3P14_002	5.353	7	332	223
	CR_F_TP3P31_001	5.078	260	38	316
	CR_F_TP3P49_001	4.813	157	35	237
	CR_F_TP3P70_001	4.548	158	262	326
	CR_F_TP3P93_001	4.278	49	240	353
	CR_F_TP4P19_001	4.013	6	220	54
	CR_F_TP4P49_001	3.747	328	74	224
	CR_F_TP4P83_001	3.478	185	56	218
	CR_F_TP5P24_001	3.209	156	49	204
	CR_F_TP5P71_001	2.943	144	215	47
	CR_F_TP6P28_001	2.675	50	241	50
	CR_F_TP6P98_001	2.408	358	237	28
	CR_F_TP7P85_001	2.141	354	241	15
	CR_F_TP8P98_002	1.872	358	250	50

Table 20 Tests in regular waves: RHIB motions non-dimensional amplitudes – heave, pitch, roll

Regular waves: RHIB non-dimensional test data

a: wave amplitude from calibration measurements

	Test Name	wave radial frequency	Heave amplitude		Pitch amplitude		Roll amplitude	
			from sine fit	√2*St Dev	from sine fit	√2*St Dev	from sine fit	√2*St Dev
		/ $(L_{WL(RHIB)}/g)^{-1/2}$	/ a		/ k*a			
Corvette and RHIB Head Seas	CR_H_TP3P14_001	1.842	0.212	0.298	0.220	0.257	0.138	0.221
	CR_H_TP3P31_001	1.749	0.381	0.492	0.366	0.398	0.280	0.356
	CR_H_TP3P49_001	1.657	0.551	0.700	0.578	0.616	0.488	0.641
	CR_H_TP3P70_001	1.565	0.682	0.825	0.758	0.792	0.629	0.774
	CR_H_TP3P93_001	1.473	0.835	0.967	0.937	0.969	0.816	0.922
	CR_H_TP4P19_001	1.380	0.917	1.008	1.014	1.036	0.776	0.859
	CR_H_TP4P49_001	1.289	0.952	0.988	0.990	1.003	0.559	0.634
	CR_H_TP4P83_001	1.196	1.047	1.039	1.016	1.025	0.426	0.483
	CR_H_TP5P24_001	1.105	1.086	1.043	1.003	1.008	0.315	0.401
	CR_H_TP5P71_002	1.013	1.069	0.990	0.860	0.867	0.400	0.461
	CR_H_TP6P28_002	0.921	1.217	1.175	0.637	0.657	0.584	0.638
	CR_H_TP6P98_002	0.828	1.271	1.276	0.601	0.663	0.794	0.858
	CR_H_TP7P85_002	0.736	1.262	1.290	0.699	0.823	0.726	0.859
	CR_H_TP8P98_003	0.644	1.154	1.179	0.788	0.812	0.414	0.526
Corvette and RHIB Following Seas	CR_F_TP3P14_002	1.842	0.152	0.369	0.165	0.306	0.242	0.346
	CR_F_TP3P31_001	1.750	0.107	0.332	0.179	0.336	0.168	0.253
	CR_F_TP3P49_001	1.657	0.104	0.351	0.195	0.376	0.143	0.253
	CR_F_TP3P70_001	1.565	0.155	0.426	0.236	0.451	0.158	0.266
	CR_F_TP3P93_001	1.473	0.151	0.455	0.224	0.482	0.122	0.254
	CR_F_TP4P19_001	1.381	0.180	0.490	0.261	0.520	0.131	0.216
	CR_F_TP4P49_001	1.286	0.167	0.463	0.257	0.471	0.142	0.225
	CR_F_TP4P83_001	1.196	0.218	0.568	0.293	0.577	0.150	0.229
	CR_F_TP5P24_001	1.104	0.216	0.458	0.275	0.530	0.165	0.240
	CR_F_TP5P71_001	1.013	0.390	0.553	0.526	0.654	0.226	0.283
	CR_F_TP6P28_001	0.920	0.527	0.584	0.609	0.627	0.210	0.273
	CR_F_TP6P98_001	0.828	0.742	0.799	0.830	0.838	0.254	0.307
	CR_F_TP7P85_001	0.736	0.862	0.919	0.950	0.963	0.227	0.275
	CR_F_TP8P98_002	0.645	0.948	0.984	0.888	0.897	0.124	0.193
RHIB Head Seas	R_H_TP3P14_001	1.842	0.159	0.246	0.168	0.207	0.050	0.158
	R_H_TP3P31_001	1.749	0.322	0.433	0.321	0.369	0.063	0.169
	R_H_TP3P49_001	1.657	0.396	0.514	0.447	0.493	0.064	0.194
	R_H_TP3P70_001	1.565	0.548	0.663	0.651	0.688	0.075	0.234
	R_H_TP3P93_001	1.473	0.674	0.755	0.808	0.831	0.065	0.282
	R_H_TP4P19_001	1.380	0.775	0.827	0.932	0.949	0.038	0.284
	R_H_TP4P49_001	1.289	0.857	0.883	1.025	1.036	0.028	0.240
	R_H_TP4P83_001	1.196	0.950	0.955	1.065	1.075	0.000	0.211
	R_H_TP5P24_001	1.105	0.971	0.966	1.045	1.050	0.020	0.140
	R_H_TP5P71_001	1.013	1.024	1.011	1.055	1.058	0.030	0.159
	R_H_TP6P28_001	0.921	1.019	1.013	1.034	1.039	0.022	0.138
	R_H_TP6P98_002	0.829	1.068	1.059	1.031	1.034	0.003	0.139
	R_H_TP7P85_003	0.736	1.104	1.105	0.978	0.982	0.071	0.130
	R_H_TP8P98_002	0.644	1.059	1.059	0.942	0.948	0.069	0.137
RHIB Following Seas	R_F_TP3P14_002	1.842	0.120	0.285	0.219	0.268	0.012	0.126
	R_F_TP3P31_002	1.750	0.178	0.384	0.332	0.370	0.020	0.129
	R_F_TP3P49_001	1.657	0.258	0.438	0.452	0.476	0.014	0.136
	R_F_TP3P70_001	1.565	0.339	0.509	0.545	0.573	0.037	0.129
	R_F_TP3P93_001	1.473	0.414	0.569	0.630	0.648	0.009	0.129
	R_F_TP4P19_001	1.381	0.505	0.662	0.726	0.756	0.034	0.112
	R_F_TP4P49_001	1.289	0.603	0.732	0.830	0.836	0.023	0.140
	R_F_TP4P83_001	1.196	0.712	0.830	0.927	0.935	0.039	0.126
	R_F_TP5P24_001	1.105	0.776	0.878	0.965	0.966	0.018	0.104
	R_F_TP5P71_001	1.013	0.832	0.926	0.990	0.993	0.021	0.109
	R_F_TP6P28_001	0.921	0.887	0.959	0.986	0.988	0.028	0.108
	R_F_TP6P98_001	0.828	0.941	0.998	0.999	1.000	0.036	0.117
	R_F_TP7P85_002	0.736	1.004	1.049	1.020	1.021	0.019	0.132
	R_F_TP8P98_001	0.644	1.004	1.035	0.982	0.984	0.013	0.111

Table 21 Tests in regular waves: RHIB motions non-dimensional amplitudes – heave, pitch, roll -, cont.

Regular waves: RHIB non-dimensional test data

a: wave amplitude from calibration measurements

	Test Name	wave radial frequency	Heave amplitude		Pitch amplitude		Roll amplitude	
			from sine fit	√2*St Dev	from sine fit	√2*St Dev	from sine fit	√2*St Dev
		/ $(L_{WL(RHIB)}/g)^{-1/2}$	/ a		/ k*a			
RHIB (4 kts)	R4_H_TP3P14_001	1.842	0.447	0.479	0.631	0.654	0.097	0.132
Head Seas	R4_H_TP3P31_001	1.749	0.513	0.506	0.716	0.735	0.085	0.115
	R4_H_TP3P49_001	1.657	0.675	0.625	0.831	0.846	0.062	0.111
	R4_H_TP3P70_001	1.565	0.724	0.665	0.861	0.873	0.044	0.107
	R4_H_TP3P93_001	1.473	0.797	0.732	0.930	0.938	0.032	0.131
	R4_H_TP4P19_001	1.381	0.872	0.810	0.979	0.986	0.016	0.115
	R4_H_TP4P49_001	1.289	0.939	0.873	0.997	1.002	0.000	0.115
	R4_H_TP4P83_001	1.196	0.994	0.943	1.057	1.060	0.023	0.128
	R4_H_TP5P24_001	1.105	0.986	0.955	1.032	1.035	0.004	0.110
	R4_H_TP5P71_001	1.013	1.018	0.995	1.025	1.031	0.021	0.131
	R4_H_TP6P28_001	0.920	1.041	1.029	1.052	1.055	0.014	0.152
	R4_H_TP6P98_001	0.828	1.051	1.041	1.083	1.094	0.013	0.146
	R4_H_TP7P85_001	0.736	1.081	1.073	1.097	1.101	0.012	0.108
	R4_H_TP8P98_002	0.644	1.060	1.056	1.071	1.079	0.012	0.098
RHIB (4 kts)	R4_F_TP3P14_001	1.842	0.328	0.342	0.349	0.360	0.011	0.075
Following Seas	R4_F_TP3P31_001	1.749	0.383	0.397	0.419	0.430	0.008	0.079
	R4_F_TP3P49_001	1.657	0.449	0.458	0.466	0.475	0.008	0.079
	R4_F_TP3P70_001	1.565	0.560	0.520	0.513	0.534	0.001	0.080
	R4_F_TP3P93_001	1.473	0.633	0.597	0.593	0.609	0.004	0.087
	R4_F_TP4P19_001	1.381	0.711	0.676	0.674	0.686	0.000	0.085
	R4_F_TP4P49_001	1.289	0.805	0.771	0.773	0.779	0.004	0.090
	R4_F_TP4P83_001	1.197	0.879	0.853	0.851	0.857	0.001	0.096
	R4_F_TP5P24_001	1.105	0.911	0.894	0.891	0.899	0.015	0.099
	R4_F_TP5P71_001	1.013	0.973	0.958	0.951	0.955	0.009	0.078
	R4_F_TP6P28_001	0.921	0.996	0.985	0.980	0.982	0.007	0.070
	R4_F_TP6P98_001	0.828	1.019	1.012	1.007	1.009	0.008	0.079
	R4_F_TP7P85_001	0.736	1.060	1.055	1.048	1.050	0.009	0.086
	R4_F_TP8P98_001	0.644	1.040	1.039	1.031	1.034	0.008	0.084

Table 22 Tests in regular waves: RHIB motions non-dimensional amplitudes – surge, sway, yaw

Regular waves: RHIB non-dimensional test data

a: wave amplitude from calibration measurements

	Test Name	wave radial frequency	Surge amplitude		Sway amplitude		Yaw amplitude	
			from sine fit	√2*St Dev	from sine fit	√2*St Dev	from sine fit	√2*St Dev
		/ $(L_{WL(RHIB)}/g)^{-1/2}$	/ a				/ k*a	
Corvette and RHIB Head Seas	CR_H_TP3P14_001	1.842	0.053	1.796	0.034	1.631	0.033	0.411
	CR_H_TP3P31_001	1.749	0.126	3.139	0.006	1.877	0.025	0.498
	CR_H_TP3P49_001	1.657	0.250	2.783	0.022	1.233	0.032	0.694
	CR_H_TP3P70_001	1.565	0.250	1.840	0.049	1.323	0.039	0.761
	CR_H_TP3P93_001	1.473	0.316	1.060	0.020	1.351	0.007	0.762
	CR_H_TP4P19_001	1.380	0.308	1.119	0.128	1.114	0.095	0.708
	CR_H_TP4P49_001	1.289	0.308	1.221	0.135	0.830	0.084	0.611
	CR_H_TP4P83_001	1.196	0.318	0.674	0.128	0.655	0.053	0.448
	CR_H_TP5P24_001	1.105	0.378	0.991	0.136	0.743	0.103	0.543
	CR_H_TP5P71_002	1.013	0.330	1.214	0.179	0.952	0.221	0.540
	CR_H_TP6P28_002	0.921	0.279	0.824	0.249	0.663	0.481	0.678
	CR_H_TP6P98_002	0.828	0.234	0.510	0.042	0.437	0.743	0.838
	CR_H_TP7P85_002	0.736	0.292	0.647	0.146	0.349	0.615	0.723
	CR_H_TP8P98_003	0.644	0.331	0.384	0.189	0.404	0.363	0.592
Corvette and RHIB Following Seas	CR_F_TP3P14_002	1.842	6.079	8.478	4.732	5.601	0.832	1.037
	CR_F_TP3P31_001	1.750	4.292	6.904	1.751	3.197	0.485	0.800
	CR_F_TP3P49_001	1.657	3.174	5.077	0.703	2.160	0.281	0.652
	CR_F_TP3P70_001	1.565	2.992	4.930	0.571	1.815	0.278	0.652
	CR_F_TP3P93_001	1.473	2.161	3.922	0.001	2.251	0.129	0.716
	CR_F_TP4P19_001	1.381	1.925	3.373	0.173	1.740	0.098	0.549
	CR_F_TP4P49_001	1.286	1.638	2.700	0.088	1.469	0.206	0.581
	CR_F_TP4P83_001	1.196	1.411	2.446	0.016	1.153	0.183	0.544
	CR_F_TP5P24_001	1.104	1.224	2.289	0.279	0.889	0.109	0.493
	CR_F_TP5P71_001	1.013	1.797	2.253	0.439	0.828	0.150	0.541
	CR_F_TP6P28_001	0.920	1.786	1.908	0.323	0.656	0.091	0.494
	CR_F_TP6P98_001	0.828	1.987	2.031	0.245	0.575	0.203	0.572
	CR_F_TP7P85_001	0.736	1.908	1.957	0.261	0.454	0.092	0.412
	CR_F_TP8P98_002	0.645	1.536	1.589	0.110	0.315	0.015	0.490
RHIB Head Seas	R_H_TP3P14_001	1.842	0.016	4.790	0.026	1.214	0.003	0.349
	R_H_TP3P31_001	1.749	0.013	2.453	0.017	1.507	0.012	0.358
	R_H_TP3P49_001	1.657	0.032	2.598	0.005	1.029	0.002	0.396
	R_H_TP3P70_001	1.565	0.168	3.301	0.005	1.123	0.004	0.437
	R_H_TP3P93_001	1.473	0.254	1.878	0.010	1.229	0.017	0.576
	R_H_TP4P19_001	1.380	0.257	1.287	0.023	1.018	0.019	0.595
	R_H_TP4P49_001	1.289	0.304	1.089	0.004	1.048	0.013	0.547
	R_H_TP4P83_001	1.196	0.335	1.138	0.002	0.750	0.020	0.463
	R_H_TP5P24_001	1.105	0.357	0.763	0.019	0.649	0.015	0.375
	R_H_TP5P71_001	1.013	0.375	0.814	0.042	0.389	0.033	0.417
	R_H_TP6P28_001	0.921	0.377	0.896	0.002	0.520	0.072	0.423
	R_H_TP6P98_002	0.829	0.415	0.622	0.003	0.431	0.008	0.418
	R_H_TP7P85_003	0.736	0.401	0.728	0.011	0.323	0.072	0.356
	R_H_TP8P98_002	0.644	0.457	0.517	0.032	0.179	0.093	0.346
RHIB Following Seas	R_F_TP3P14_002	1.842	7.921	11.322	0.763	2.787	0.155	0.494
	R_F_TP3P31_002	1.750	8.691	9.688	0.260	3.038	0.046	0.512
	R_F_TP3P49_001	1.657	7.697	8.008	0.072	2.232	0.035	0.487
	R_F_TP3P70_001	1.565	6.865	7.242	0.456	1.447	0.180	0.433
	R_F_TP3P93_001	1.473	5.994	6.269	0.135	1.710	0.070	0.491
	R_F_TP4P19_001	1.381	5.533	5.883	0.156	1.225	0.088	0.383
	R_F_TP4P49_001	1.289	4.936	4.986	0.043	1.466	0.058	0.470
	R_F_TP4P83_001	1.196	4.473	4.546	0.133	0.768	0.128	0.398
	R_F_TP5P24_001	1.105	3.880	3.928	0.047	0.827	0.067	0.413
	R_F_TP5P71_001	1.013	3.357	3.425	0.052	0.597	0.100	0.389
	R_F_TP6P28_001	0.921	2.823	2.843	0.002	0.556	0.066	0.404
	R_F_TP6P98_001	0.828	2.442	2.494	0.097	0.422	0.162	0.427
	R_F_TP7P85_002	0.736	2.173	2.176	0.019	0.536	0.060	0.526
	R_F_TP8P98_001	0.644	1.878	1.883	0.029	0.269	0.002	0.433

Table 23 Tests in regular waves: RHIB motions non-dimensional amplitudes – surge, sway, yaw -, cont.

Regular waves: RHIB non-dimensional test data

a: wave amplitude from calibration measurements

	Test Name	wave radial frequency	Surge amplitude		Sway amplitude		Yaw amplitude	
			from sine fit	√2*St Dev	from sine fit	√2*St Dev	from sine fit	√2*St Dev
		/ $(L_{WL(RHIB)}/g)^{-1/2}$	/ a				/ k*a	
RHIB (4 kts)	R4_H_TP3P14_001	1.842	0.138	1.992	0.033	1.131	0.011	0.282
Head Seas	R4_H_TP3P31_001	1.749	0.199	1.360	0.030	1.086	0.012	0.316
	R4_H_TP3P49_001	1.657	0.273	1.628	0.029	1.348	0.004	0.468
	R4_H_TP3P70_001	1.565	0.289	0.928	0.006	1.516	0.003	0.474
	R4_H_TP3P93_001	1.473	0.324	1.112	0.006	1.377	0.013	0.622
	R4_H_TP4P19_001	1.381	0.360	1.532	0.015	1.283	0.015	0.553
	R4_H_TP4P49_001	1.289	0.395	0.920	0.004	0.615	0.024	0.702
	R4_H_TP4P83_001	1.196	0.448	0.919	0.002	0.574	0.022	0.832
	R4_H_TP5P24_001	1.105	0.490	0.645	0.003	0.538	0.003	0.877
	R4_H_TP5P71_001	1.013	0.519	0.804	0.002	0.463	0.030	1.071
	R4_H_TP6P28_001	0.920	0.590	0.830	0.042	0.387	0.108	1.272
	R4_H_TP6P98_001	0.828	0.650	0.704	0.013	0.525	0.038	1.314
	R4_H_TP7P85_001	0.736	0.687	0.844	0.003	0.463	0.012	1.069
	R4_H_TP8P98_002	0.644	0.752	0.809	0.004	0.423	0.101	1.030
RHIB (4 kts)	R4_F_TP3P14_001	1.842	1.050	2.736	0.006	1.882	0.021	1.158
Following Seas	R4_F_TP3P31_001	1.749	1.186	3.415	0.014	1.876	0.003	1.212
	R4_F_TP3P49_001	1.657	1.232	2.209	0.018	1.556	0.015	1.224
	R4_F_TP3P70_001	1.565	1.267	3.356	0.008	1.565	0.007	1.247
	R4_F_TP3P93_001	1.473	1.371	1.996	0.015	1.389	0.017	1.335
	R4_F_TP4P19_001	1.381	1.464	2.022	0.008	1.169	0.003	1.347
	R4_F_TP4P49_001	1.289	1.573	2.062	0.006	1.140	0.014	1.457
	R4_F_TP4P83_001	1.197	1.621	2.696	0.020	1.085	0.006	1.462
	R4_F_TP5P24_001	1.105	1.623	3.032	0.004	1.081	0.021	1.374
	R4_F_TP5P71_001	1.013	1.622	2.269	0.024	0.831	0.033	1.365
	R4_F_TP6P28_001	0.921	1.565	1.795	0.005	0.894	0.005	1.286
	R4_F_TP6P98_001	0.828	1.533	1.695	0.018	0.642	0.043	1.233
	R4_F_TP7P85_001	0.736	1.482	1.560	0.002	0.705	0.004	1.213
	R4_F_TP8P98_001	0.644	1.409	1.451	0.018	0.650	0.043	1.055

Table 24 Tests in regular waves: RHIB motions phases –heave, pitch, roll

	Test Name	wave radial frequency	Heave phase	Pitch phase	Roll phase	Surge phase	Sway phase	Yaw phase
			relative to encounter wave					
		/ $(L_{WL(RHIB)}/g)^{-1/2}$	deg	deg	deg	deg	deg	deg
Corvette and RHIB Head Seas	CR_H_TP3P14_001	1.842	272	358	177	318	161	117
	CR_H_TP3P31_001	1.749	259	350	162	284	177	158
	CR_H_TP3P49_001	1.657	310	42	194	329	350	228
	CR_H_TP3P70_001	1.565	267	358	143	292	339	233
	CR_H_TP3P93_001	1.473	270	359	139	302	32	290
	CR_H_TP4P19_001	1.380	274	0	135	316	322	205
	CR_H_TP4P49_001	1.289	285	7	145	328	336	190
	CR_H_TP4P83_001	1.196	290	8	167	336	354	192
	CR_H_TP5P24_001	1.105	297	10	195	351	12	193
	CR_H_TP5P71_002	1.013	300	0	255	336	35	158
	CR_H_TP6P28_002	0.921	318	23	259	351	13	143
	CR_H_TP6P98_002	0.828	317	45	237	16	270	68
	CR_H_TP7P85_002	0.736	317	60	207	48	99	18
	CR_H_TP8P98_003	0.644	328	75	186	75	60	334
Corvette and RHIB Following Seas	CR_F_TP3P14_002	1.842	324	150	311	115	220	114
	CR_F_TP3P31_001	1.750	312	161	328	132	254	153
	CR_F_TP3P49_001	1.657	319	182	353	154	262	181
	CR_F_TP3P70_001	1.565	330	204	1	178	256	178
	CR_F_TP3P93_001	1.473	336	221	21	198	261	228
	CR_F_TP4P19_001	1.381	335	213	15	194	207	215
	CR_F_TP4P49_001	1.286	328	208	15	189	294	213
	CR_F_TP4P83_001	1.196	318	207	358	188	270	209
	CR_F_TP5P24_001	1.104	282	182	326	166	169	150
	CR_F_TP5P71_001	1.013	301	193	327	180	166	103
	CR_F_TP6P28_001	0.920	341	231	16	218	188	202
	CR_F_TP6P98_001	0.828	333	221	6	211	183	189
	CR_F_TP7P85_001	0.736	333	216	354	207	166	168
	CR_F_TP8P98_002	0.645	345	231	8	229	165	179
RHIB Head Seas	R_H_TP3P14_001	1.842	245	331	76	291	127	191
	R_H_TP3P31_001	1.749	240	328	68	148	143	294
	R_H_TP3P49_001	1.657	283	12	83	216	273	38
	R_H_TP3P70_001	1.565	267	353	41	320	277	10
	R_H_TP3P93_001	1.473	253	335	342	285	100	49
	R_H_TP4P19_001	1.380	264	345	326	304	189	48
	R_H_TP4P49_001	1.289	276	356	344	322	96	56
	R_H_TP4P83_001	1.196	282	1	14	334	78	16
	R_H_TP5P24_001	1.105	307	27	65	6	245	124
	R_H_TP5P71_001	1.013	296	15	270	358	154	6
	R_H_TP6P28_001	0.921	301	24	217	3	135	57
	R_H_TP6P98_002	0.829	316	38	24	28	112	183
	R_H_TP7P85_003	0.736	320	47	210	38	165	23
	R_H_TP8P98_002	0.644	331	59	50	55	296	174
RHIB Following Seas	R_F_TP3P14_002	1.842	303	166	306	132	236	106
	R_F_TP3P31_002	1.750	294	177	84	148	62	271
	R_F_TP3P49_001	1.657	293	186	71	163	229	53
	R_F_TP3P70_001	1.565	308	205	104	184	25	268
	R_F_TP3P93_001	1.473	332	229	210	210	113	333
	R_F_TP4P19_001	1.381	344	241	132	224	41	291
	R_F_TP4P49_001	1.289	313	210	38	195	329	146
	R_F_TP4P83_001	1.196	311	209	106	195	34	269
	R_F_TP5P24_001	1.105	335	229	153	217	137	324
	R_F_TP5P71_001	1.013	330	222	115	211	112	300
	R_F_TP6P28_001	0.921	328	220	72	211	301	257
	R_F_TP6P98_001	0.828	347	239	96	232	40	276
	R_F_TP7P85_002	0.736	332	223	336	219	272	72
	R_F_TP8P98_001	0.644	342	234	25	232	148	355

Table 25 Tests in regular waves: RHIB motions phases –heave, pitch, roll-, cont.

	Test Name	wave radial frequency / $(L_{WL(RHIB)}/g)^{-1/2}$	Heave phase (deg)	Pitch phase (deg)	Roll phase (deg)	Surge phase (deg)	Sway phase (deg)	Yaw phase (deg)
			relative to encounter wave					
RHIB (4 kts) Head Seas	R4_H_TP3P14_001	1.842	238	294	357	302	148	7
	R4_H_TP3P31_001	1.749	246	302	335	269	142	14
	R4_H_TP3P49_001	1.657	249	307	329	282	148	250
	R4_H_TP3P70_001	1.565	257	318	331	299	222	93
	R4_H_TP3P93_001	1.473	260	324	333	308	213	34
	R4_H_TP4P19_001	1.381	294	0	359	350	215	71
	R4_H_TP4P49_001	1.289	292	0	191	355	278	91
	R4_H_TP4P83_001	1.196	287	358	317	356	77	33
	R4_H_TP5P24_001	1.105	310	25	206	25	225	315
	R4_H_TP5P71_001	1.013	302	19	257	21	190	118
	R4_H_TP6P28_001	0.920	325	46	252	49	237	98
	R4_H_TP6P98_001	0.828	317	38	273	42	147	346
	R4_H_TP7P85_001	0.736	326	49	186	52	140	95
	R4_H_TP8P98_002	0.644	342	66	173	70	265	28
RHIB (4 kts) Following Seas	R4_F_TP3P14_001	1.842	315	225	184	209	282	139
	R4_F_TP3P31_001	1.749	290	199	146	183	296	130
	R4_F_TP3P49_001	1.657	290	198	206	184	201	124
	R4_F_TP3P70_001	1.565	296	233	228	219	273	121
	R4_F_TP3P93_001	1.473	313	247	292	234	230	29
	R4_F_TP4P19_001	1.381	316	247	159	235	259	100
	R4_F_TP4P49_001	1.289	322	250	166	239	10	37
	R4_F_TP4P83_001	1.197	327	253	286	243	220	99
	R4_F_TP5P24_001	1.105	326	249	11	241	258	94
	R4_F_TP5P71_001	1.013	333	255	63	247	204	33
	R4_F_TP6P28_001	0.921	328	247	338	241	255	128
	R4_F_TP6P98_001	0.828	337	254	359	249	289	82
	R4_F_TP7P85_001	0.736	336	252	45	248	324	75
	R4_F_TP8P98_001	0.644	340	254	360	251	7	201

Table 26 Tests in irregular waves: measured waves, in full scale units

Tests in irregular seas: characteristics of the measured waves, in full scale units

Tests in irregular seas: Zero-Crossing Analysis

Test	Heading	Test Name	Test Date	Test Duration (s)	Encounter Wave Probe T_{AV} (s)	Encounter Wave Probe N	Corvette Heave T_{AV} (s)	Corvette Heave N	RHIB Heave T_{AV} (s)	RHIB Heave N
Corvette (8 kts)	Head Seas	IRR_HS1P25_TP7P5	13-May-16	1200.3	3.87	307	5.66	210		
Corvette and RHIB (8 kts)		CR_H_IRR	9-Dec-16	1199.9	3.79	314	5.86	203	3.92	304
RHIB (8 kts)		R_H_IRR	14 Dec 206	1202.4	3.77	315			4.00	300
RHIB (4 kts)		R4_H_IRR	19 Dec 206	1199.7	4.33	273			4.73	252
Corvette (8 kts)	Following Seas	IRR_HS1P25_C_F	16-May-16	1199.8	10.22	106	11.93	99		
Corvette and RHIB (8 kts)		CR_F_IRR	9-Dec-16	1200.1	10.58	108	11.51	102	10.96	106
RHIB (8 kts)		R_F_IRR	20-Dec-16	1202.2	10.91	108			11.06	107
RHIB (4 kts)		R4_F_IRR	20-Dec-16	1200.8	7.80	152			7.99	150

TAV: average zero crossing period
N: number of encounters

Tests in irregular seas: Spectral Analysis

Test	Heading	Test Name	Test Date	Test Duration (s)	Encounter Wave Probe Hm_0 (m)	Encounter Wave Probe T_{PD} (sec)	Upstream Wave Probe Hm_0 (m)	Upstream Wave Probe T_{PD} (sec)	Bretschneider Spectrum Nominal Values Hm_0 (m)	Bretschneider Spectrum Nominal Values T_{PD} (sec)	Wave during calibration Hm_0 (m)	Wave during calibration T_{PD} (sec)
Corvette (8 kts)	Head Seas	IRR_HS1P25_TP7P5	13-May-16	1200.3	**1.195**	**5.25**	**1.251**	**7.38**	**1.250**	**7.50**	**1.266**	**7.32**
Corvette and RHIB (8 kts)		CR_H_IRR	9-Dec-16	1199.9	**1.242**	**5.36**	**1.310**	**7.24**				
RHIB (8 kts)		R_H_IRR	14 Dec 206	1202.4	**1.239**	**5.23**	**1.255**	**7.30**				
RHIB (4 kts)		R4_H_IRR	19 Dec 206	1199.7	**1.278**	**6.32**	**1.277**	**7.25**				
Corvette (8 kts)	Following Seas	IRR_HS1P25_C_F	16-May-16	1199.8	**1.065**	**11.17**	**1.208**	**7.34**				
Corvette and RHIB (8 kts)		CR_F_IRR	9-Dec-16	1200.1	**1.168**	**11.33**	**1.297**	**7.67**				
RHIB (8 kts)		R_F_IRR	20-Dec-16	1202.2	**1.208**	**11.95**	**1.227**	**7.01**				
RHIB (4 kts)		R4_F_IRR	20-Dec-16	1200.8	**1.201**	**8.32**	**1.184**	**7.07**				

Degrees of freedom for spectral analysis: 42

Tests in irregular seas: Statistics

Test	Heading	Test Name	Test Date	Test Duration (s)	Upstream Wave Probe MEAN (m)	Upstream Wave Probe MIN (m)	Upstream Wave Probe MAX (m)	Upstream Wave Probe STD (m)	Forward Speed **MEAN (knots)**	Forward Speed MIN (knots)	Forward Speed MAX (knots)	Forward Speed STD (knots)	Encounter Wave Probe MEAN (m)	Encounter Wave Probe MIN (m)	Encounter Wave Probe MAX (m)	Encounter Wave Probe STD (m)
Corvette (8 kts)	Head seas	IRR_HS1P25_TP7P5	13-May-16	1200.3	0.00	-1.11	1.09	0.313	**8.00**	7.98	8.01	0.003	0.09	-0.92	1.19	0.299
Corvette and RHIB (8 kts)		CR_H_IRR	9-Dec-16	1199.9	0.01	-1.13	1.15	0.328	**8.00**	6.43	9.34	0.33	0.11	-0.82	1.32	0.310
RHIB (8 kts)		R_H_IRR	14 Dec 206	1202.4	0.01	-0.95	1.19	0.314	**8.00**	6.58	9.14	0.36	0.11	-1.14	1.30	0.310
RHIB (4 kts)		R4_H_IRR	19 Dec 206	1199.7	0.01	-1.14	1.18	0.319	**4.00**	1.94	5.63	0.48	0.04	-1.27	1.31	0.319
Corvette (8 kts)	Following seas	IRR_HS1P25_C_F	16-May-16	1199.8	0.01	-1.10	1.00	0.302	**7.99**	7.96	8.01	0.011	0.10	-0.68	1.00	0.266
Corvette and RHIB (8 kts)		CR_F_IRR	9-Dec-16	1200.1	0.00	-1.11	1.25	0.324	**7.99**	4.81	10.77	0.75	-0.16	-1.26	0.83	0.292
RHIB (8 kts)		R_F_IRR	20-Dec-16	1202.2	0.01	-1.13	1.17	0.307	**7.98**	4.91	11.05	0.97	-0.12	-0.91	0.73	0.302
RHIB (4 kts)		R4_F_IRR	20-Dec-16	1200.8	0.01	-0.94	1.10	0.296	**3.99**	0.86	7.16	0.78	0.07	-0.92	1.07	0.300

Table 27 Tests in irregular waves: corvette motions, in full scale units

Tests in irregular seas: corvette motions, in full scale units

Corvette motions in irregular seas: **Spectral Analysis**

Test	Heading	Test Name	Test Date	Test Duration (s)	Corvette Pitch Hm0 (deg)	Corvette Pitch TPD (sec)	Corvette Roll Hm0 (deg)	Corvette Roll TPD (sec)	Corvette Heave Hm0 (m)	Corvette Heave TPD (sec)
Corvette (8 kts)	Head Seas	IRR_HS1P25_TP7P5	13-May-16	1200.3	**2.56**	5.47	**1.18**	7.46	**0.50**	6.49
Corvette and RHIB (8 kts)		CR_H_IRR	9-Dec-16	1199.9	**2.62**	5.59	**1.30**	7.33	**0.52**	6.69
Corvette (8 kts)	Following Seas	IRR_HS1P25_C_F	16-May-16	1199.8	**1.53**	11.99	**0.99**	7.83	**0.38**	12.62
Corvette and RHIB (8 kts)		CR_F_IRR	9-Dec-16	1200.1	**1.78**	11.60	**1.09**	7.77	**0.38**	11.96

Degrees of freedom for spectral analysis: 42

Corvette motions in irregular seas: **Statistics**

Test	Heading	Test Name	Test Date	Test Duration (s)	Corvette Pitch MEAN (deg)	Corvette Pitch MIN (deg)	Corvette Pitch MAX (deg)	Corvette Pitch STD (deg)	Corvette Roll MEAN (deg)	Corvette Roll MIN (deg)	Corvette Roll MAX (deg)	Corvette Roll STD (deg)	Corvette Heave MEAN (m)	Corvette Heave MIN (m)	Corvette Heave MAX (m)	Corvette Heave STD (m)
Corvette (8 kts)	Head seas	IRR_HS1P25_TP7P5	13-May-16	1200.3	-0.01	**-2.34**	**2.53**	0.64	0.00	**-1.02**	**0.90**	0.30	0.02	**-0.43**	**0.44**	0.126
Corvette and RHIB (8 kts)		CR_H_IRR	9-Dec-16	1199.9	-0.01	**-2.71**	**2.48**	0.66	0.03	**-1.08**	**1.01**	0.32	0.02	**-0.49**	**0.43**	0.129
Corvette (8 kts)	Following seas	IRR_HS1P25_C_F	16-May-16	1199.8	-0.01	**-1.46**	**1.41**	0.38	0.00	**-0.79**	**0.79**	0.25	0.02	**-0.30**	**0.30**	0.095
Corvette and RHIB (8 kts)		CR_F_IRR	9-Dec-16	1200.1	-0.02	**-1.68**	**1.68**	0.45	0.01	**-0.87**	**1.00**	0.27	0.02	**-0.31**	**0.34**	0.095

Table 28 Tests in irregular waves: RHIB motions, in full scale units

Tests in irregular seas: RHIB motions, in full scale units

RHIB motions in irregular seas: **Spectral Analysis**

Test	Heading	Test Name	Test Date	Test Duration (s)	**RHIB Pitch**		**RHIB Roll**		**RIB Heave**		**RHIB Surge**		**RHIB Sway**		**RHIB Yaw**	
					Hm_0 (deg)	T_{PD} (sec)	**Hm_0 (deg)**	T_{PD} (sec)	**Hm_0 (m)**	T_{PD} (sec)	**Hm_0 (m)**	T_{PD} (sec)	**Hm_0 (m)**	T_{PD} (sec)	**Hm_0 (deg)**	T_{PD} (sec)
Corvette and RHIB (8 kts)	Head Seas	CR_H_IRR	9-Dec-16	1199.9	**7.53**	2.98	**5.46**	4.83	**1.36**	5.34	**2.42**	49.5	**1.27**	24.3	**6.40**	22.1
RHIB (8 kts)		R_H_IRR	14 Dec 206	1202.4	**8.38**	3.60	**1.99**	4.84	**1.23**	5.31	**2.78**	67.5	**0.94**	549.3	**4.57**	7.2
RHIB (4 kts)		R4_H_IRR	19 Dec 206	1199.7	**10.42**	3.13	**1.13**	2.12	**1.21**	6.25	**4.35**	52.5	**0.87**	45.5	**5.94**	9.6
Corvette and RHIB (8 kts)	Following Seas	CR_F_IRR	9-Dec-16	1200.1	**5.50**	11.05	**2.62**	10.98	**0.891**	11.49	**3.37**	11.2	**1.44**	24.9	**6.14**	20.5
RHIB (8 kts)		R_F_IRR	20-Dec-16	1202.2	**6.27**	10.93	**1.33**	5.43	**0.975**	11.97	**5.17**	57.3	**1.15**	31.4	**4.79**	25.4
RHIB (4 kts)		R4_F_IRR	20-Dec-16	1200.8	**7.76**	6.91	**0.88**	11.85	**1.169**	8.24	**4.78**	70.5	**1.39**	66.8	**12.47**	11.7

Degrees of freedom for spectral analysis: 42

RHIB motions in irregular seas: **Statistics**

Test	Heading	Test Name	Test Date	Test Duration (s)	**RHIB Pitch**				**RHIB Roll**				**RHIB Heave**			
					MEAN (deg)	**MIN (deg)**	**MAX (deg)**	STD (deg)	MEAN (deg)	**MIN (deg)**	**MAX (deg)**	STD (deg)	MEAN (m)	**MIN (m)**	**MAX (m)**	STD (m)
Corvette and RHIB (8 kts)	Head Seas	CR_H_IRR	9-Dec-16	1199.9	3.4	**-3.5**	**10.3**	1.88	1.5	**-4.9**	**6.0**	1.37	-0.07	**-1.38**	**0.97**	0.340
RHIB (8 kts)		R_H_IRR	14 Dec 206	1202.4	3.0	**-3.2**	**10.5**	2.09	0.9	**-0.9**	**3.4**	0.50	0.09	**-0.99**	**1.27**	0.308
RHIB (4 kts)		R4_H_IRR	19 Dec 206	1199.7	0.4	**-9.1**	**10.0**	2.61	0.5	**-0.6**	**1.8**	0.28	0.08	**-1.06**	**1.23**	0.304
Corvette and RHIB (8 kts)	Following Seas	CR_F_IRR	9-Dec-16	1200.1	2.6	**-3.5**	**7.4**	1.38	-0.1	**-2.1**	**3.7**	0.66	0.09	**-0.88**	**0.93**	0.223
RHIB (8 kts)		R_F_IRR	20-Dec-16	1202.2	2.3	**-3.3**	**6.9**	1.57	0.2	**-0.8**	**1.3**	0.33	0.12	**-0.62**	**0.90**	0.244
RHIB (4 kts)		R4_F_IRR	20-Dec-16	1200.8	0.1	**-8.9**	**8.6**	1.94	-0.1	**-1.0**	**0.8**	0.22	0.09	**-0.94**	**1.10**	0.292

RHIB motions in irregular seas: **Statistics**

Test	Heading	Test Name	Test Date	Test Duration (s)	**RHIB Surge**				**RHIB Sway**				**RHIB Yaw**			
					MEAN (m)	**MIN (m)**	**MAX (m)**	STD (m)	MEAN (m)	**MIN (m)**	**MAX (m)**	STD (m)	MEAN (deg)	**MIN (deg)**	**MAX (deg)**	STD (deg)
Corvette and RHIB (8 kts)	Head Seas	CR_H_IRR	9-Dec-16	1199.9	-0.26	**-2.29**	**1.47**	0.606	-0.15	**-1.13**	**1.07**	0.318	0.49	**-4.6**	**6.9**	1.60
RHIB (8 kts)		R_H_IRR	14 Dec 206	1202.4	-0.22	**-2.35**	**1.53**	0.696	-0.07	**-0.92**	**0.70**	0.234	-0.06	**-4.3**	**5.0**	1.14
RHIB (4 kts)		R4_H_IRR	19 Dec 206	1199.7	-0.06	**-2.98**	**2.71**	1.087	-0.06	**-0.62**	**0.70**	0.218	-0.30	**-4.8**	**3.7**	1.48
Corvette and RHIB (8 kts)	Following Seas	CR_F_IRR	9-Dec-16	1200.1	-0.03	**-3.14**	**3.12**	0.842	0.09	**-0.83**	**1.27**	0.359	-0.33	**-7.5**	**3.9**	1.53
RHIB (8 kts)		R_F_IRR	20-Dec-16	1202.2	0.04	**-2.39**	**5.58**	1.293	-0.05	**-0.83**	**1.06**	0.288	-0.24	**-3.6**	**4.7**	1.20
RHIB (4 kts)		R4_F_IRR	20-Dec-16	1200.8	0.02	**-4.05**	**4.61**	1.196	-0.07	**-0.99**	**0.87**	0.347	-0.11	**-8.3**	**8.6**	3.12

Table 29 Tests in irregular waves: RHIB driving parameters, in full scale units

RHIB driving parameters in irregular seas: **Statistics**

Test	Heading	Test Name	Test Date	Test Duration (s)	Shaft Speed MEAN (rpm)	Shaft Speed MIN (rpm)	Shaft Speed MAX (rpm)	Shaft Speed STD (rpm)	Steering Angle MEAN (deg)	Steering Angle MIN (deg)	Steering Angle MAX (deg)	Steering Angle STD (deg)	Forward Speed MEAN (kt)	Forward Speed MIN (kt)	Forward Speed MAX (kt)	Forward Speed STD (kt)
Corvette and RHIB (8 kts)	Head Seas	CR_H_IRR	9-Dec-16	1199.9	1578	1452	1716	60	-1.7	-10.9	10.0	2.9	8.00	6.4	9.3	0.33
RHIB (8 kts)		R_H_IRR	14 Dec 206	1202.4	1521	1407	1642	50	-0.8	-11.1	8.3	2.1	8.00	6.6	9.1	0.36
RHIB (4 kts)		R4_H_IRR	19 Dec 206	1199.7	728	607	859	49	-1.2	-8.0	3.8	1.8	4.00	1.9	5.6	0.48
Corvette and RHIB (8 kts)	Following Seas	CR_F_IRR	9-Dec-16	1200.1	1446	1351	1512	25	0.4	-12.0	6.3	2.1	7.99	4.8	10.8	0.75
RHIB (8 kts)		R_F_IRR	20-Dec-16	1202.2	1407	1248	1491	40	-0.8	-6.0	3.8	1.7	7.98	4.9	11.1	0.97
RHIB (4 kts)		R4_F_IRR	20-Dec-16	1200.8	634	481	735	40	-0.9	-11.1	8.1	3.6	3.99	0.9	7.2	0.78

Figures

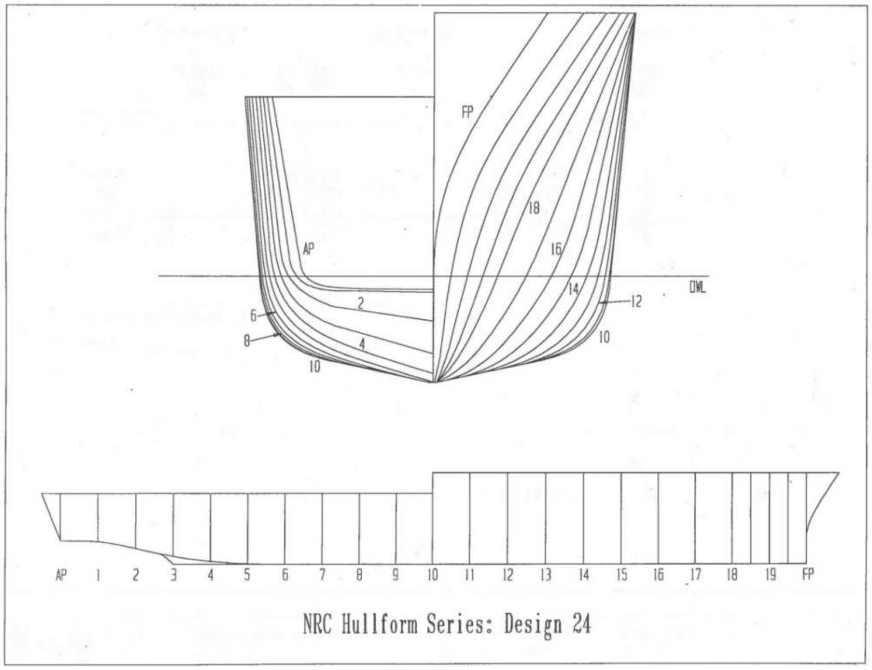


Figure 1 Corvette model hull lines

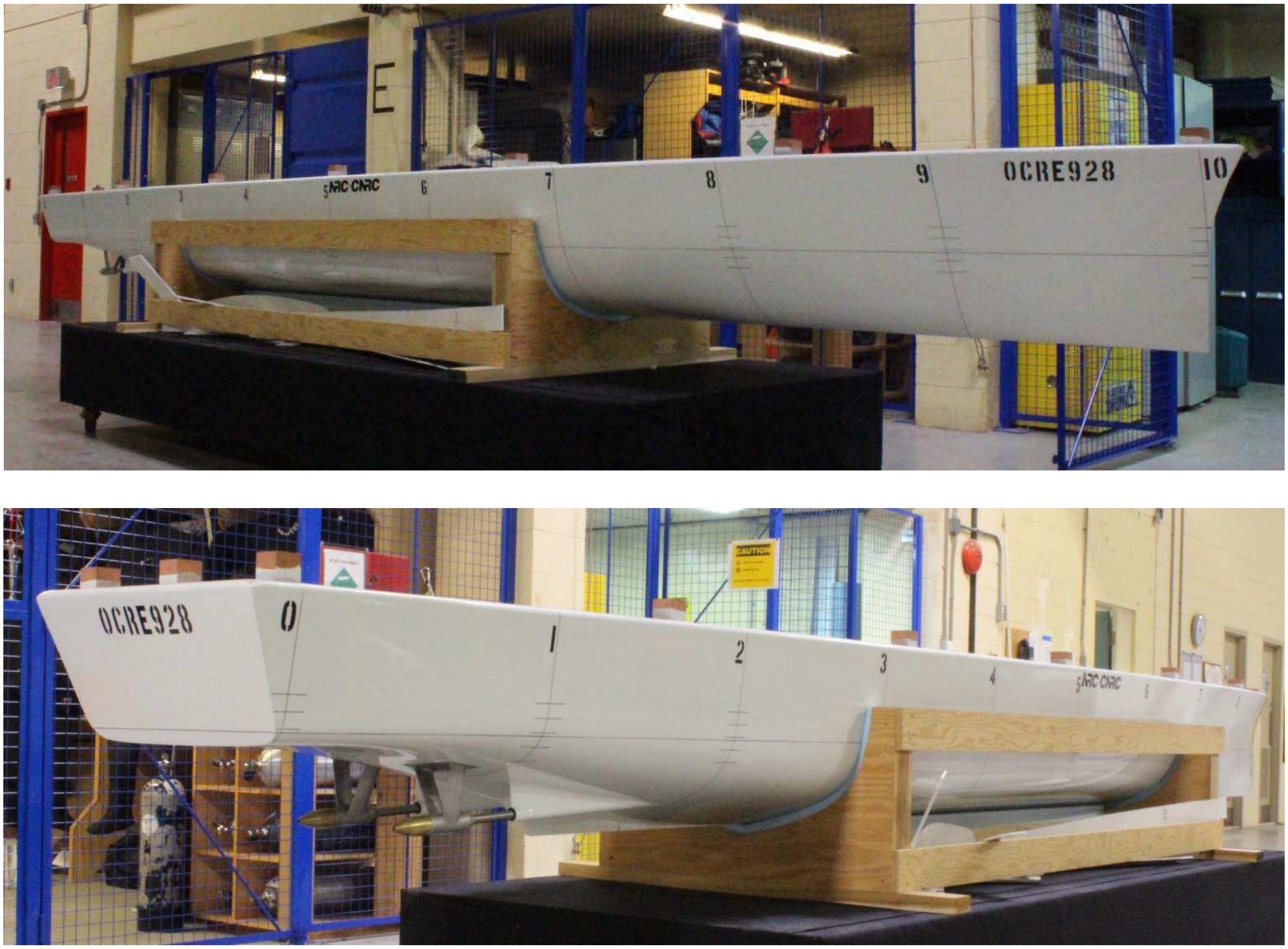


Figure 2 Photos of the corvette model: bow and stern views

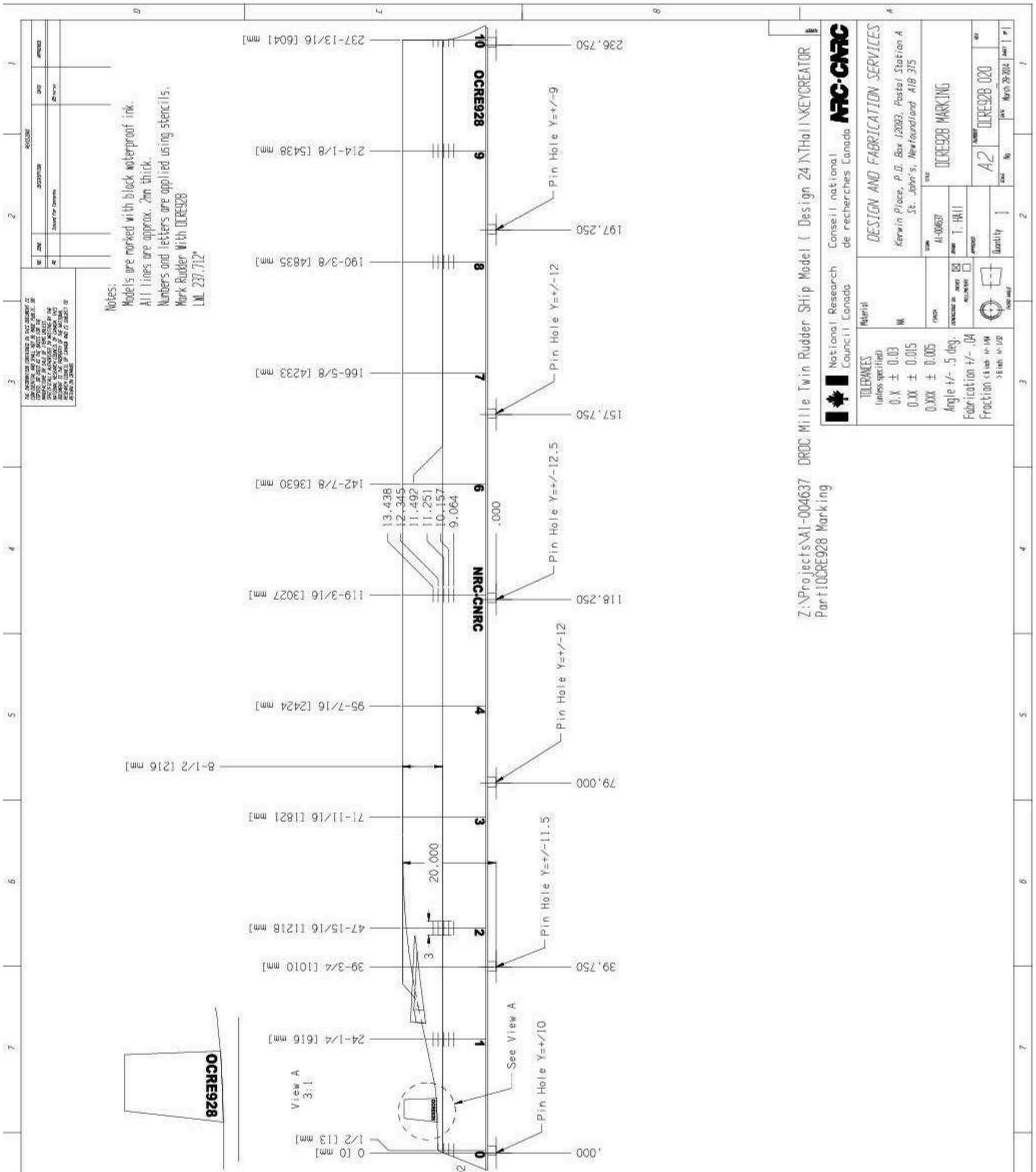


Figure 3 Corvette model marking and dimensions

Figure 4 Corvette model gimbal location

Figure 5 RHIB model hull

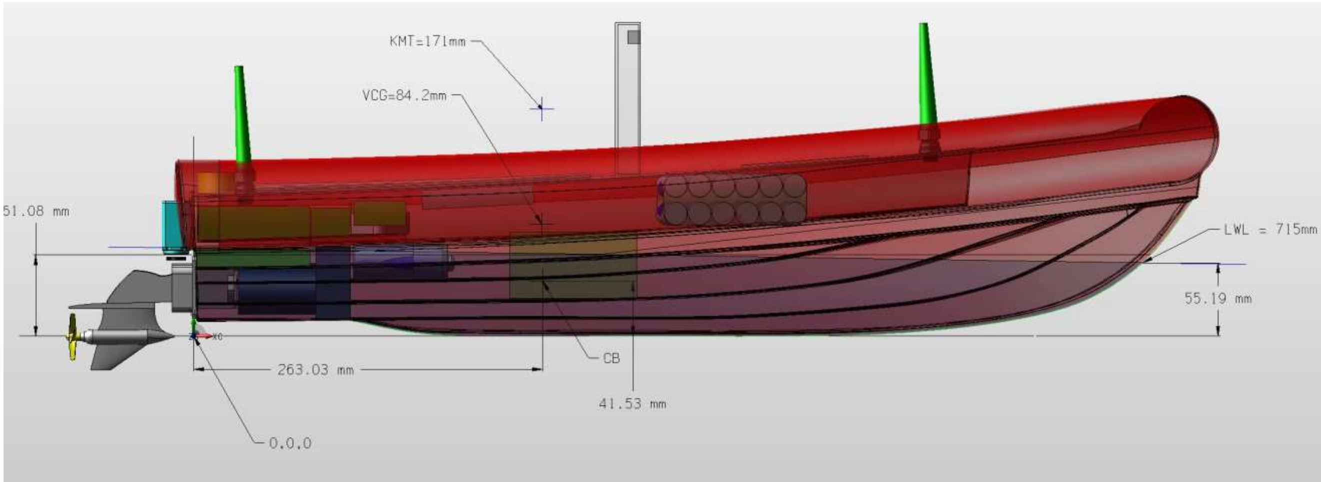


Figure 6 RHIB model layout and dimensions (tower not in final location)

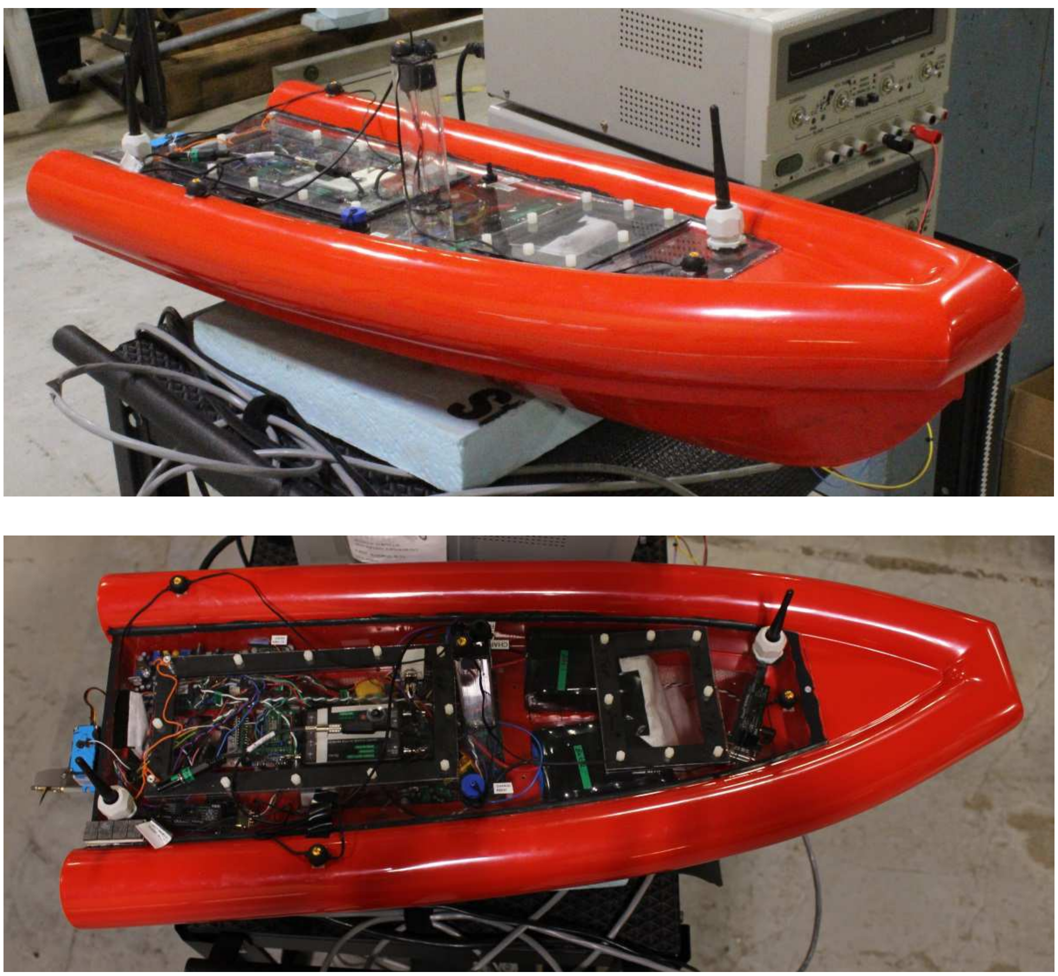


Figure 7 Photos of the RHIB model

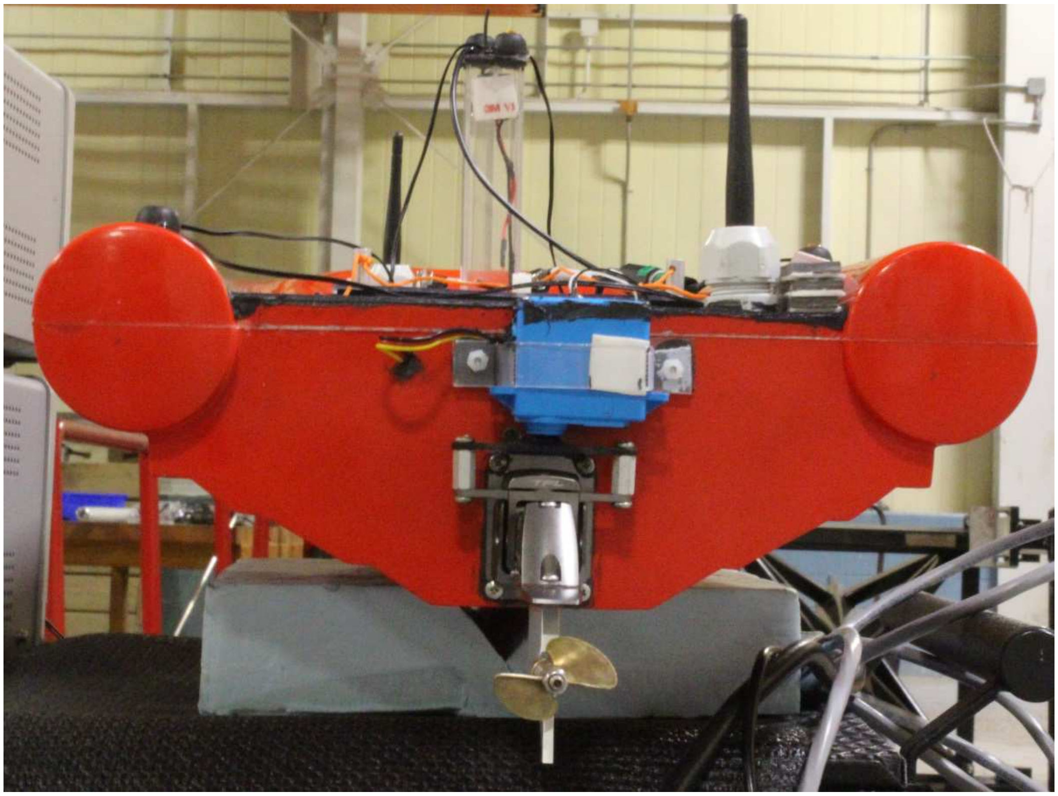


Figure 8 Stern view of the RHIB model

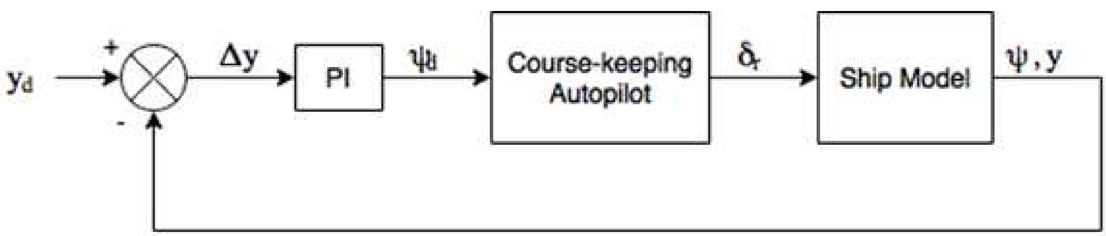


Figure 9 Sway-keeping control block diagram

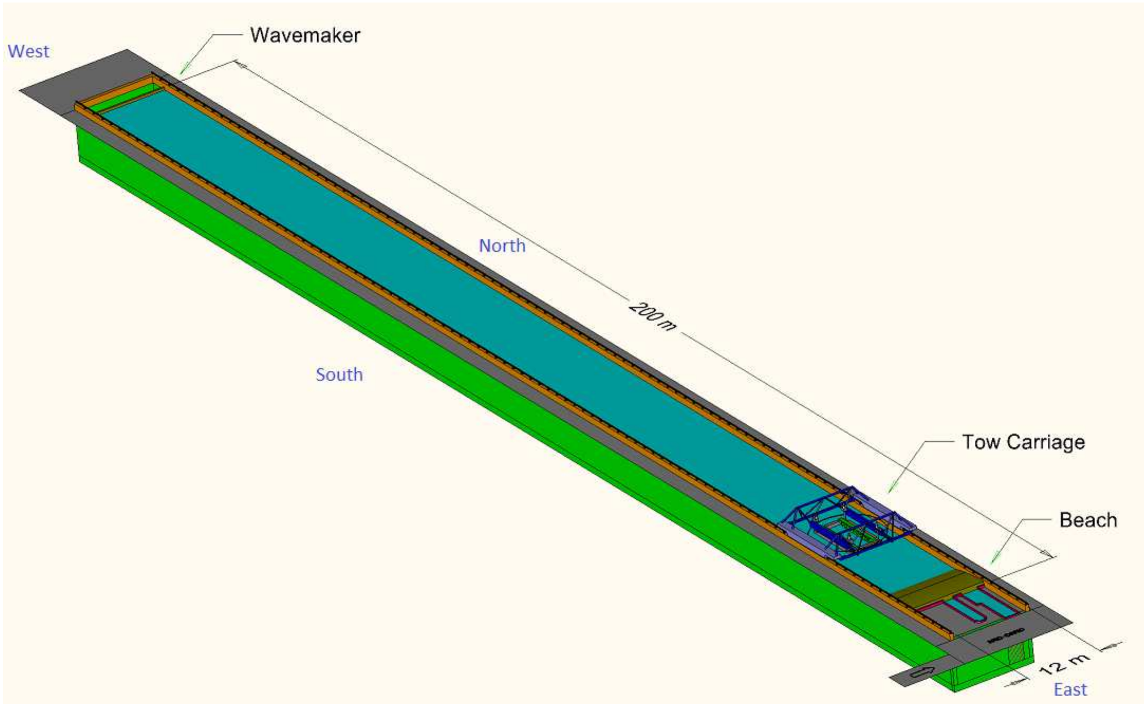


Figure 10 Tow tank

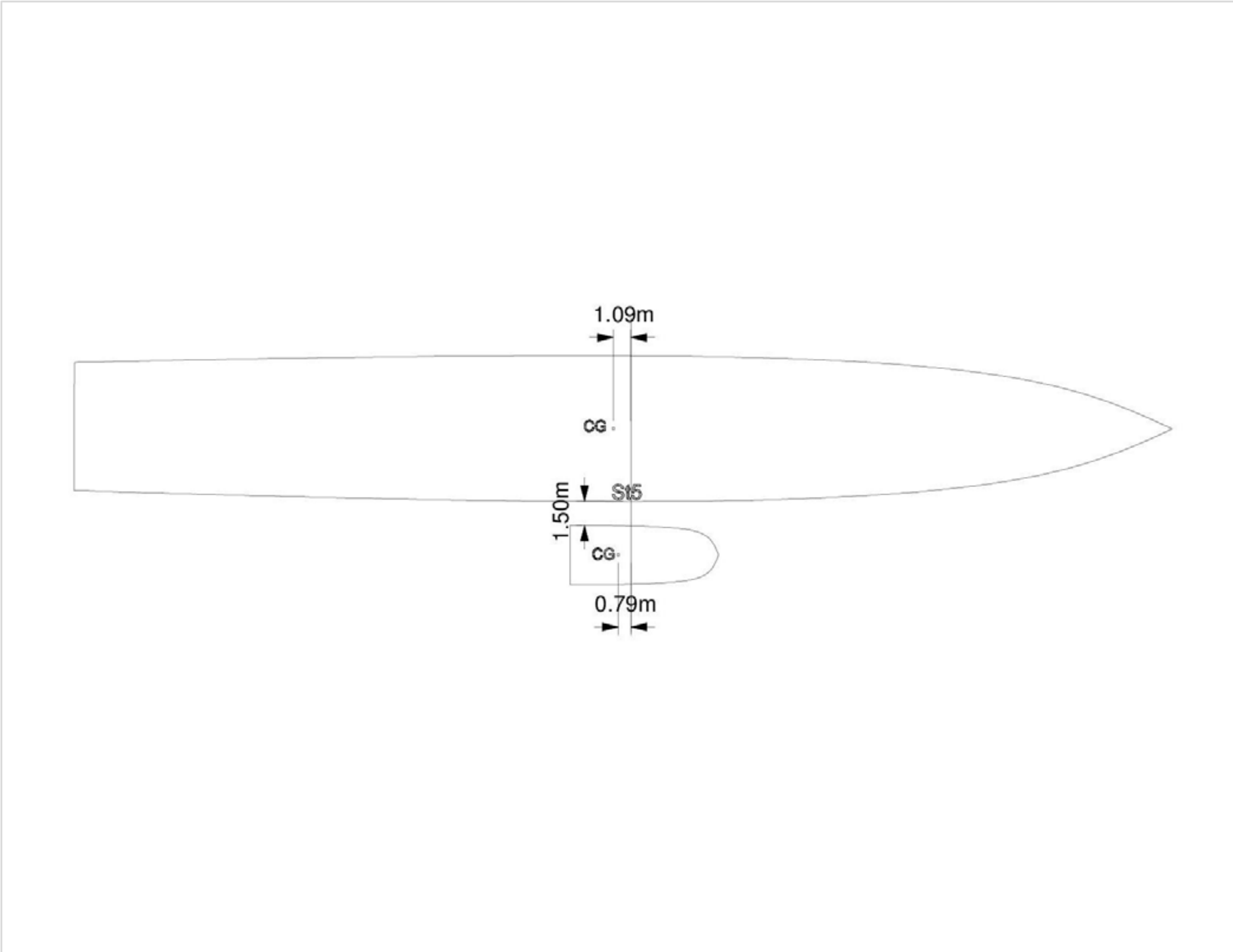


Figure 11 Relative positions of corvette and RHIB models

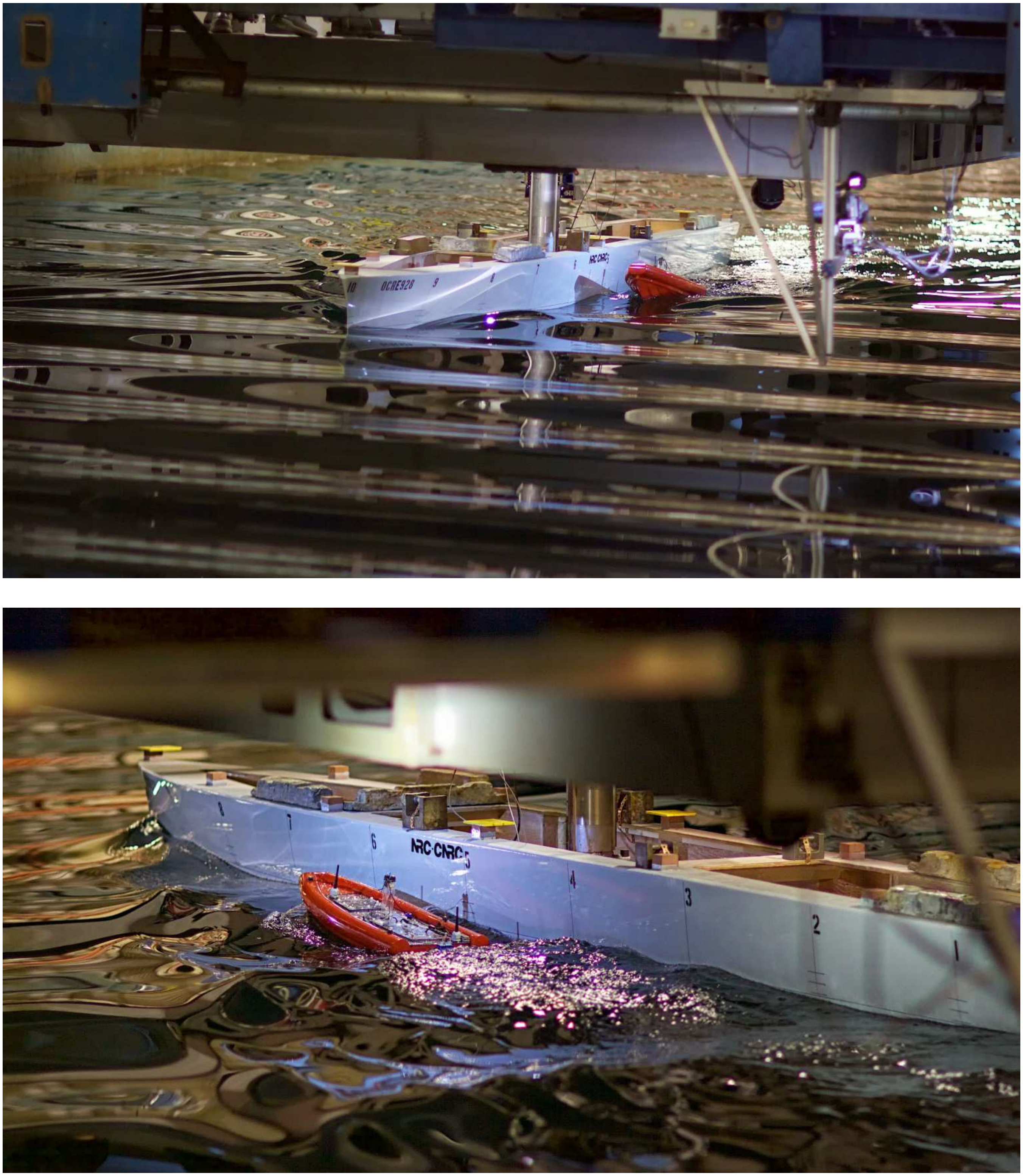


Figure 12 Photos of interactive seakeeping tests in head seas

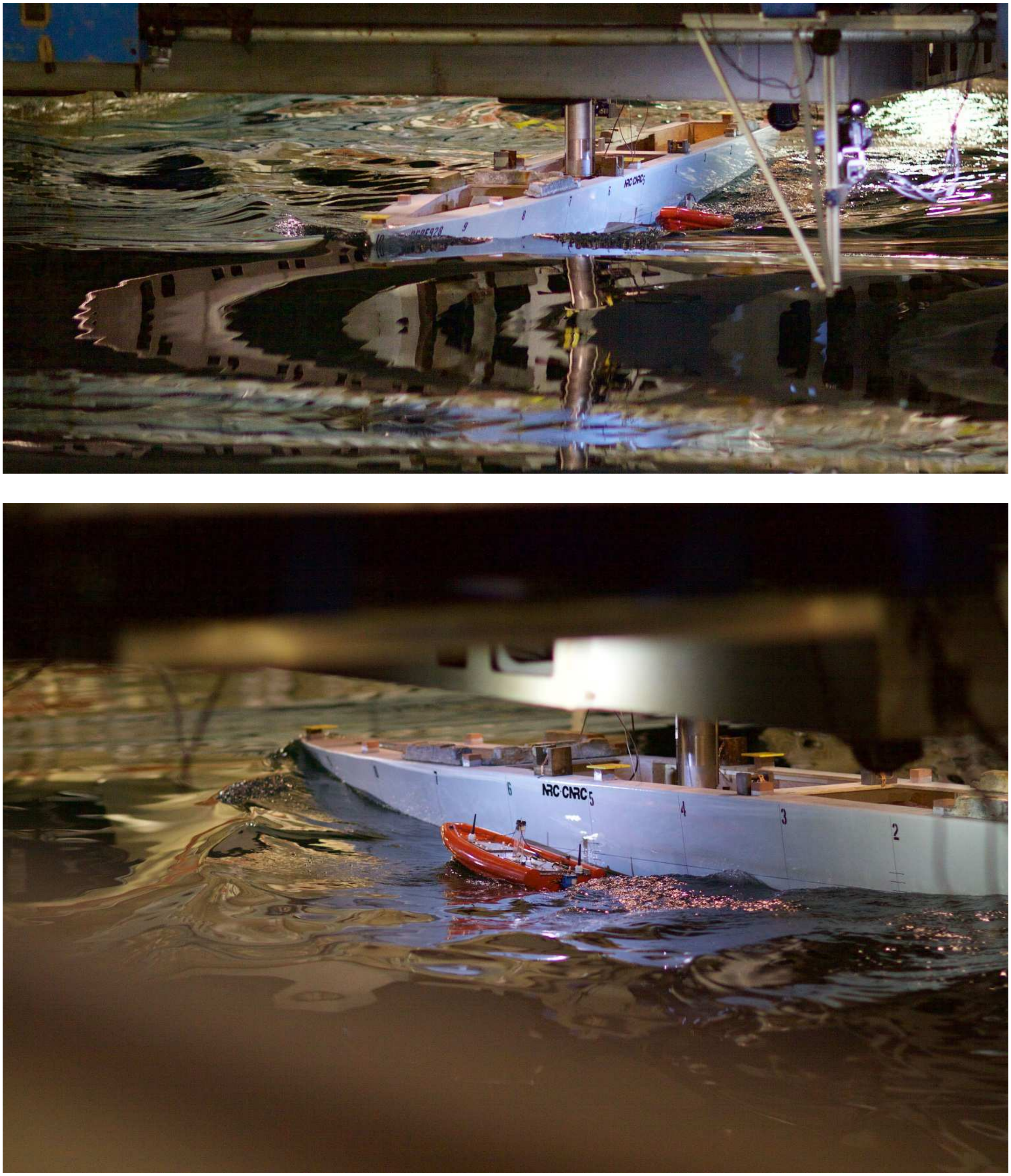


Figure 13 Photos of interactive seakeeping tests in head seas, cont.

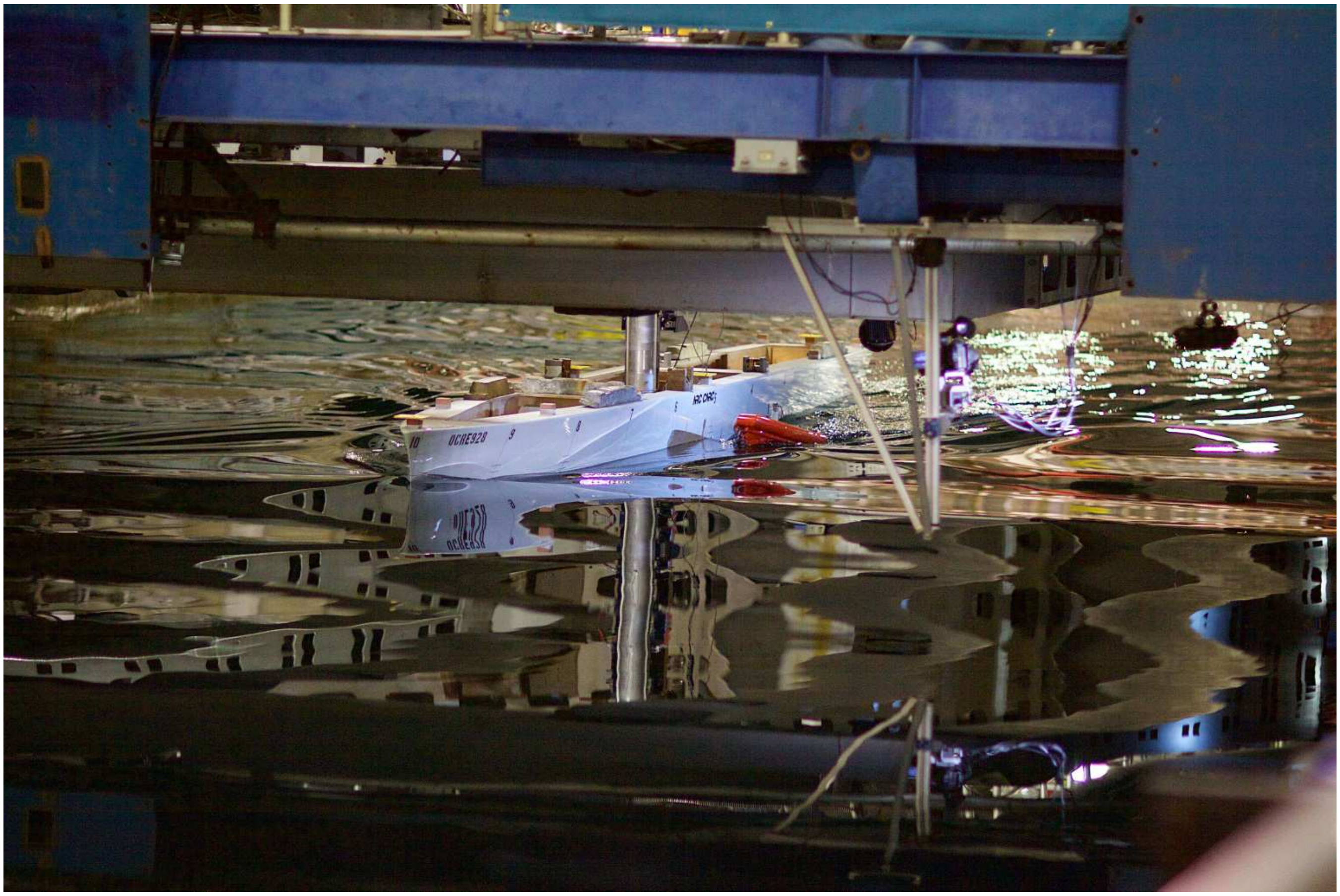


Figure 14 Photos of interactive seakeeping tests in head seas, cont.

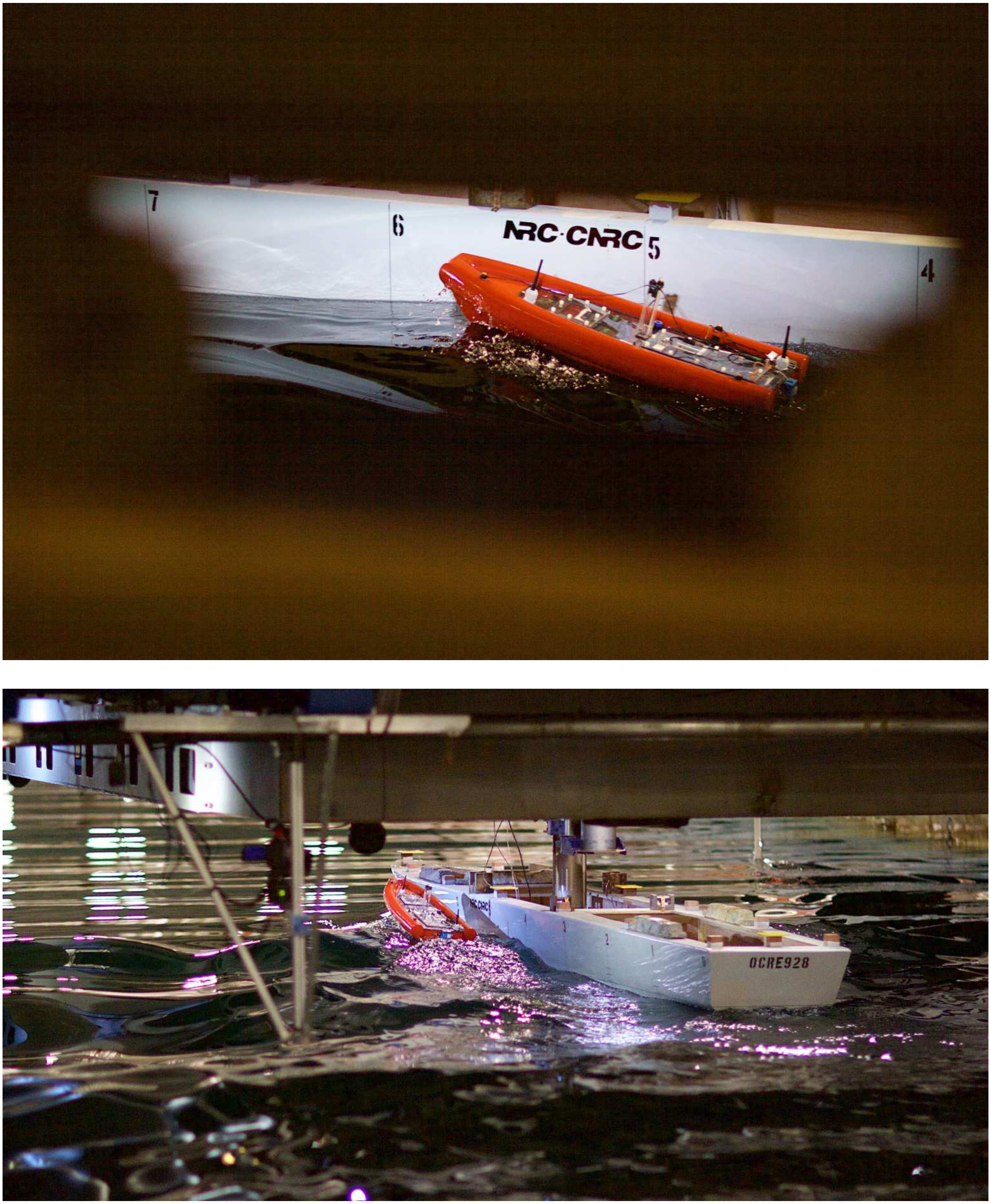


Figure 15 Photos of interactive seakeeping tests in head seas, cont.

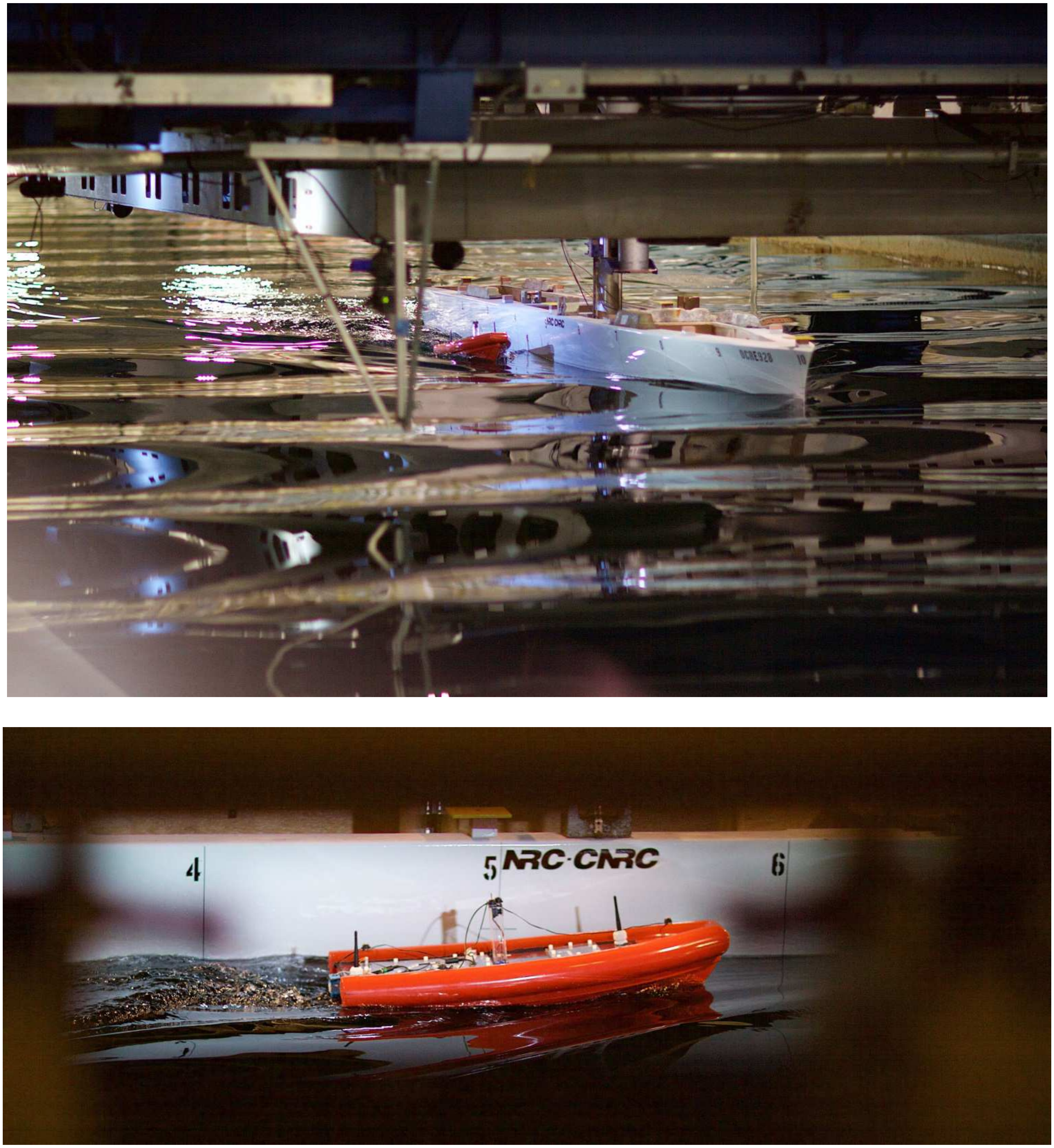


Figure 16 Photos of interactive seakeeping tests in following seas

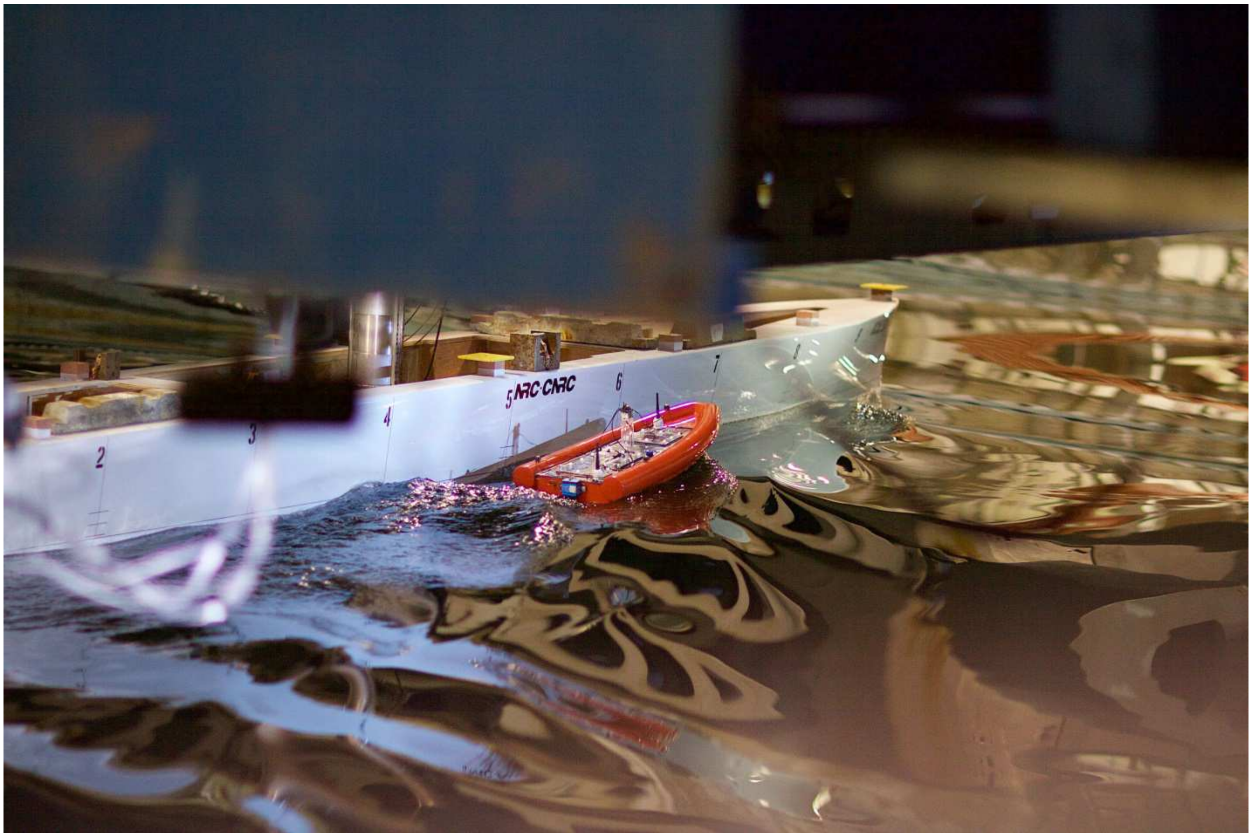


Figure 17 Photos of interactive seakeeping tests in following seas, cont.

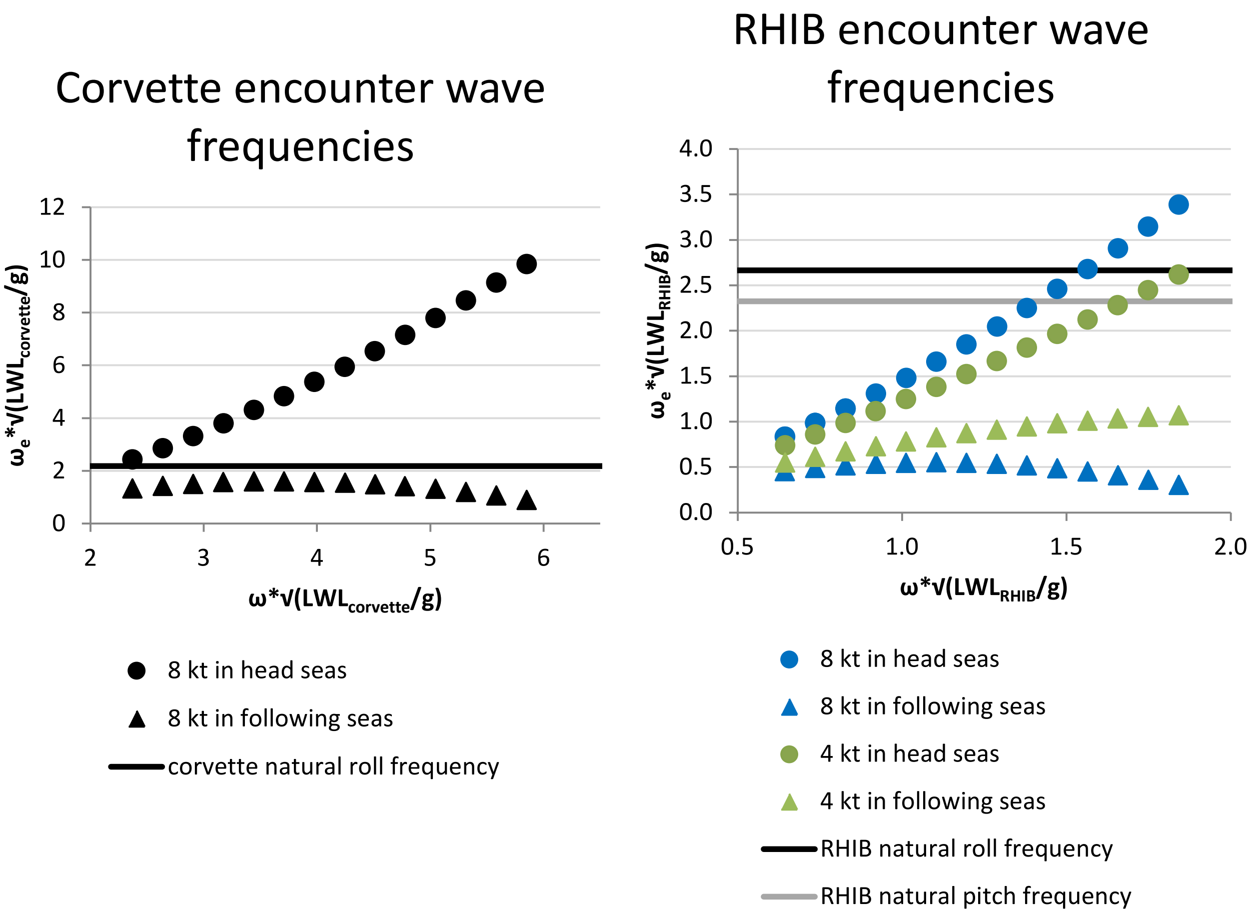


Figure 18 Wave encounter frequency as function of test wave frequency

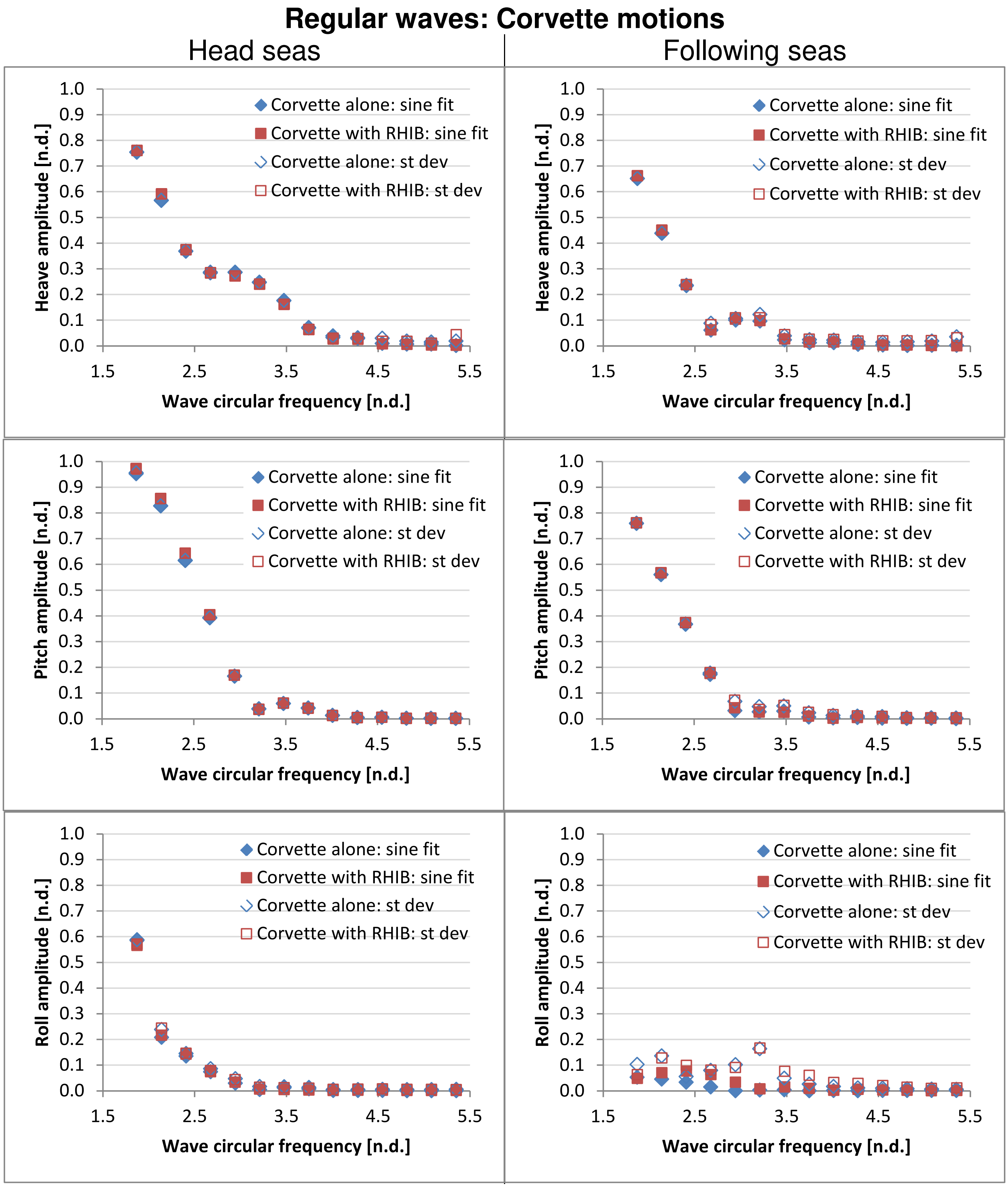


Figure 19 Corvette in regular waves: non-dimensional motion amplitudes

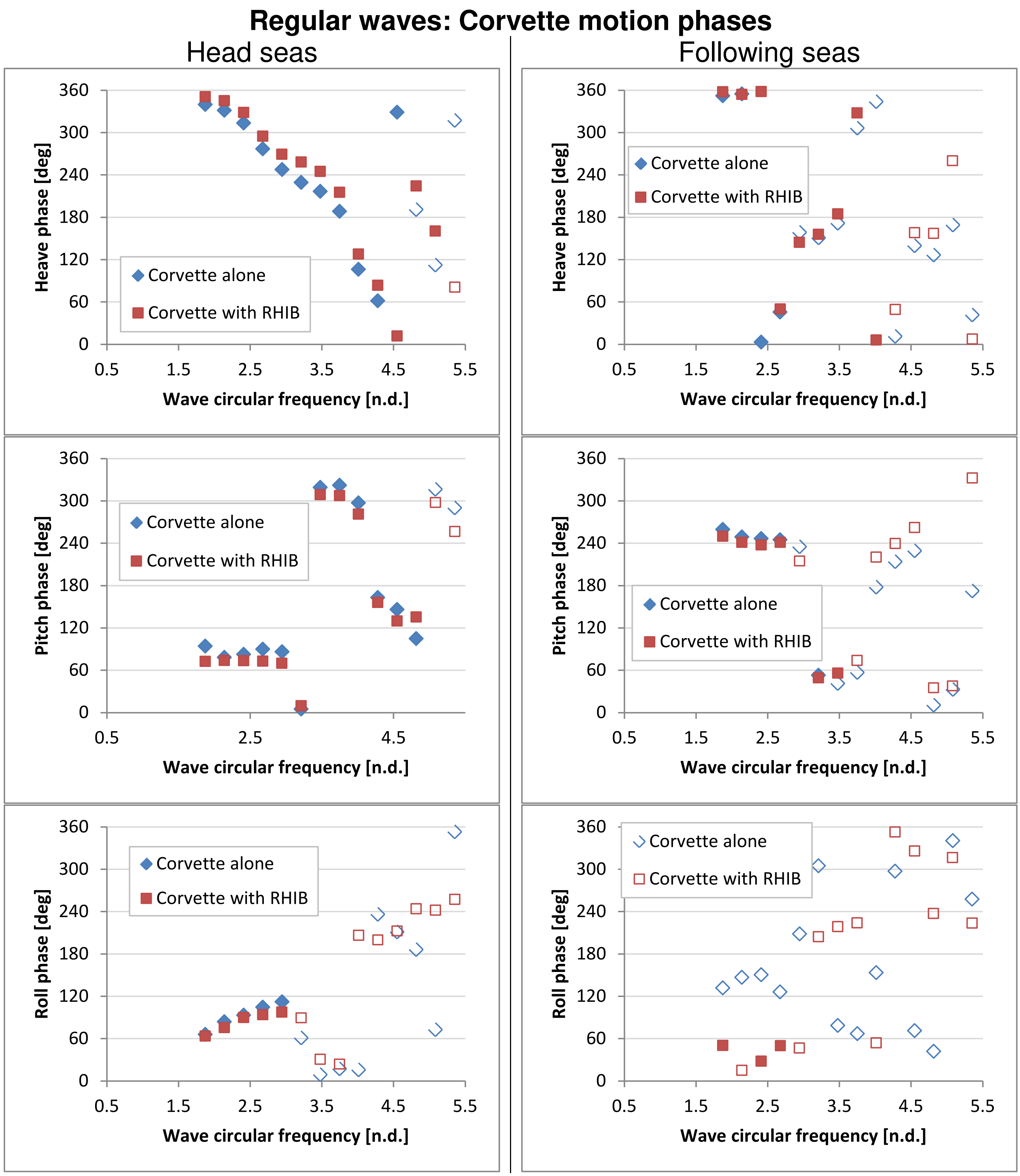


Figure 20 Corvette in regular waves: motion phases

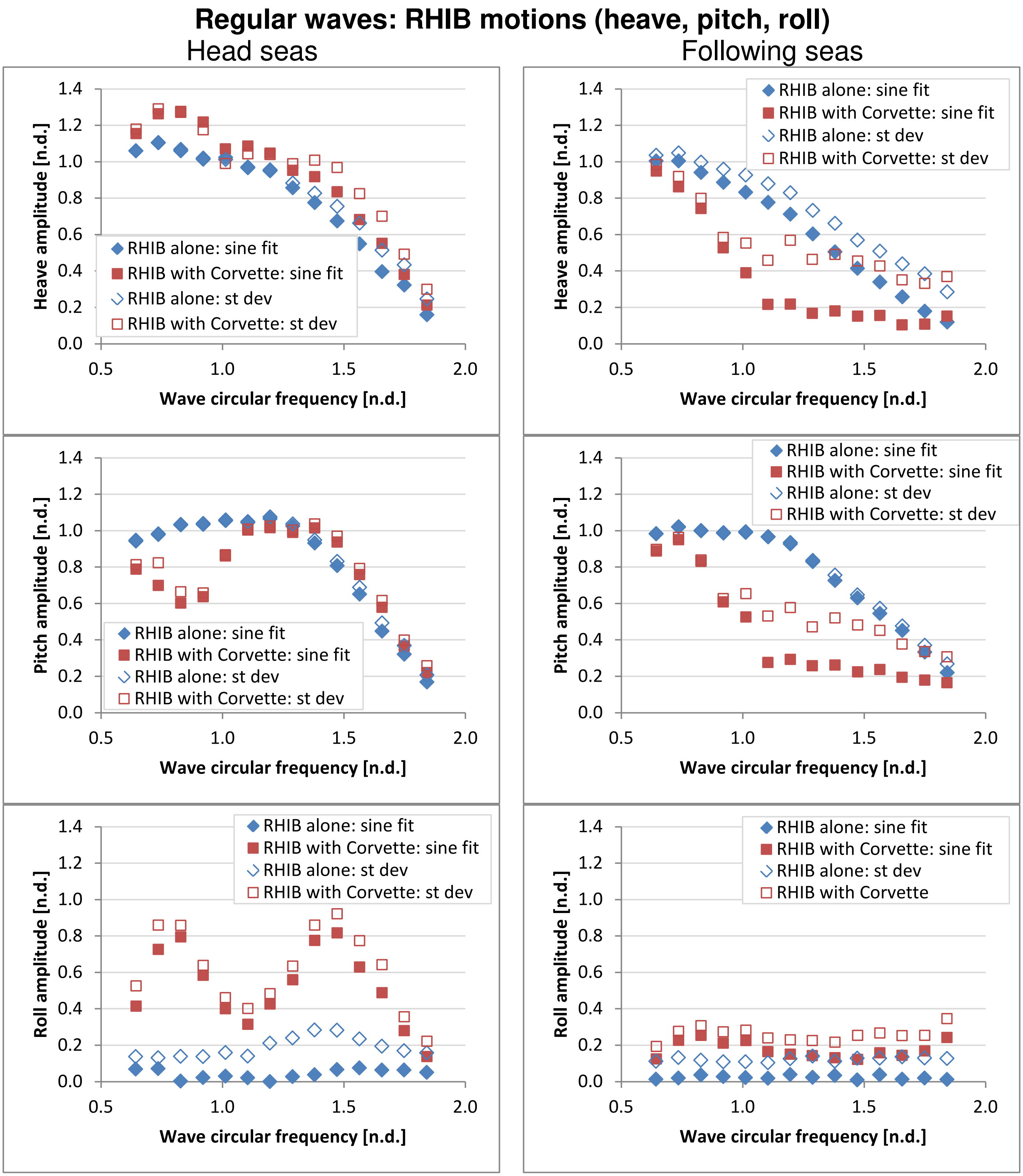


Figure 21 RHIB in regular waves at 8 knots: non-dimensional motion amplitudes - heave, pitch, roll-

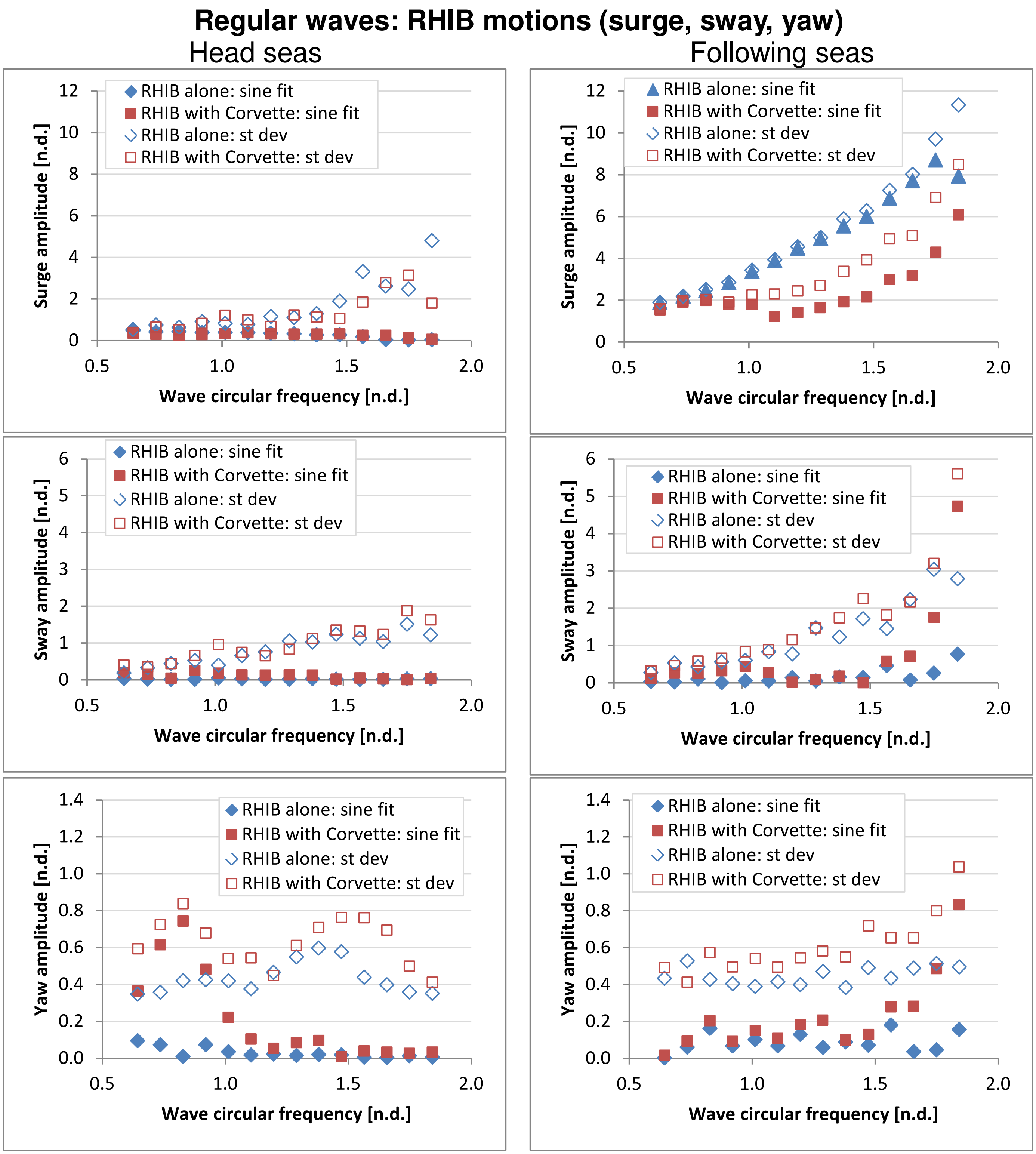


Figure 22 RHIB in regular waves at 8 knots: non-dimensional motion amplitudes - surge, sway, yaw-

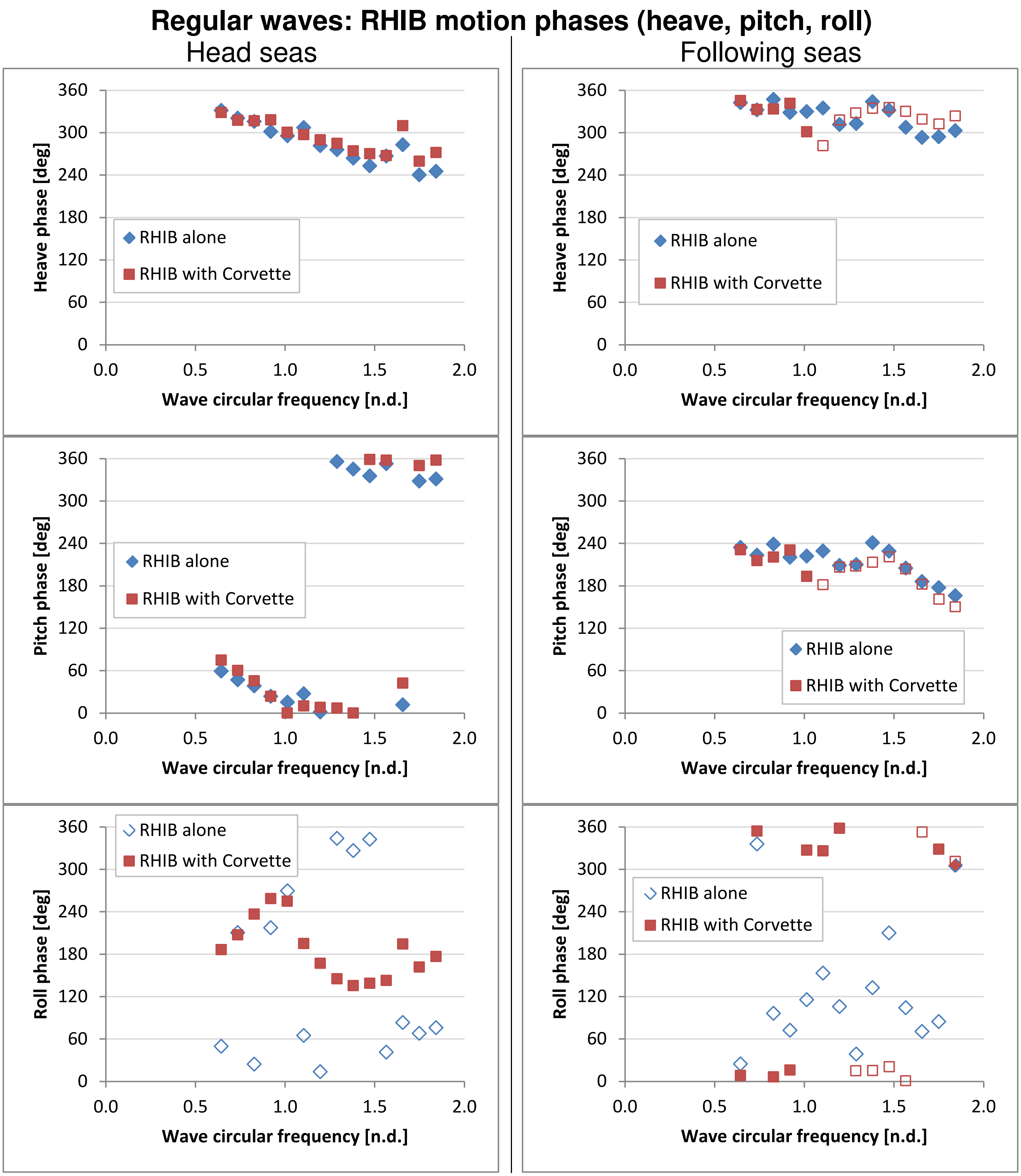


Figure 23 RHIB in regular waves at 8 knots: motion phases - heave, pitch, roll-

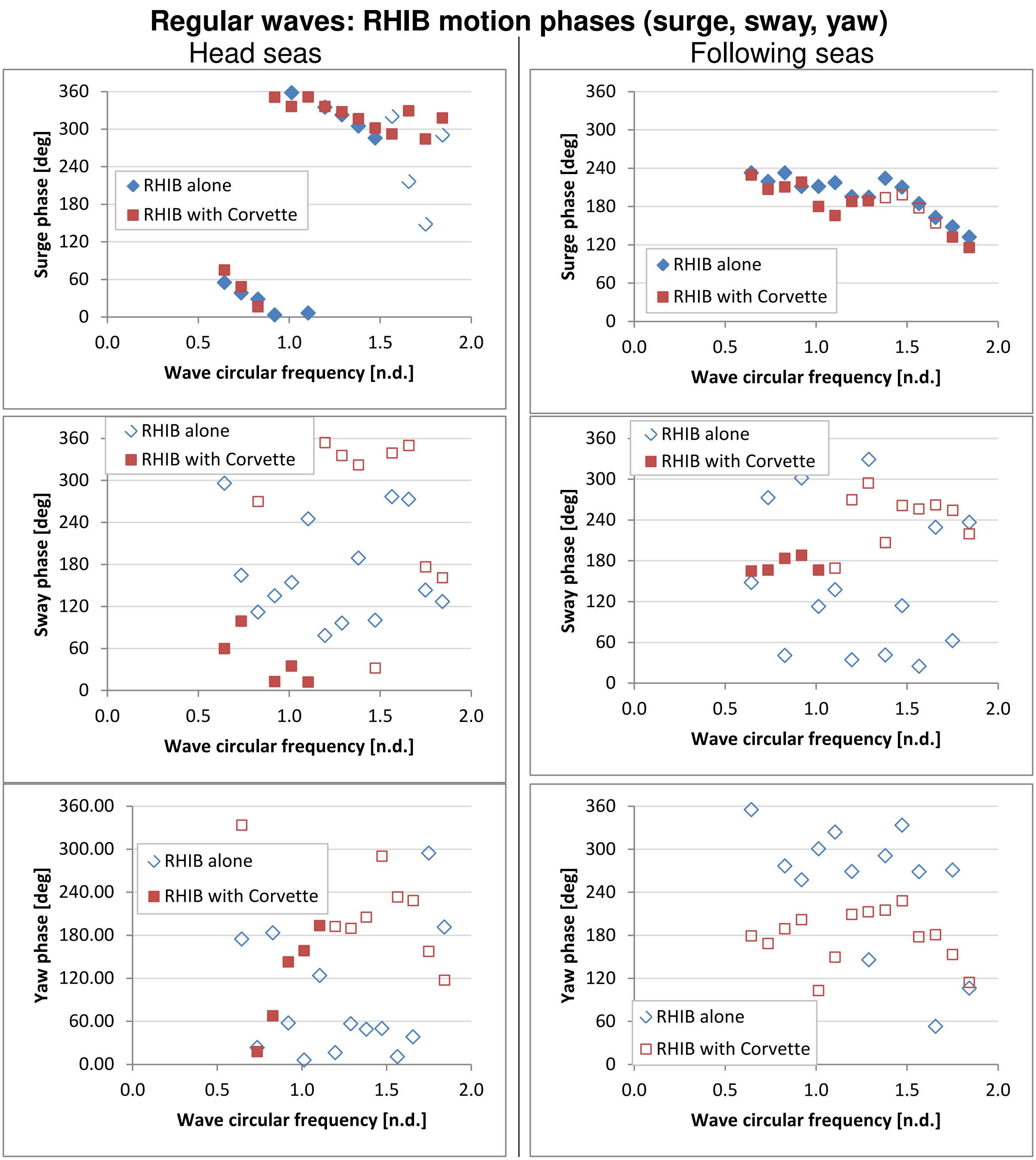


Figure 24 RHIB in regular waves at 8 knots: motion phases – surge, sway, yaw-

Regular waves: RHIB motion amplitude responses, effect of speed

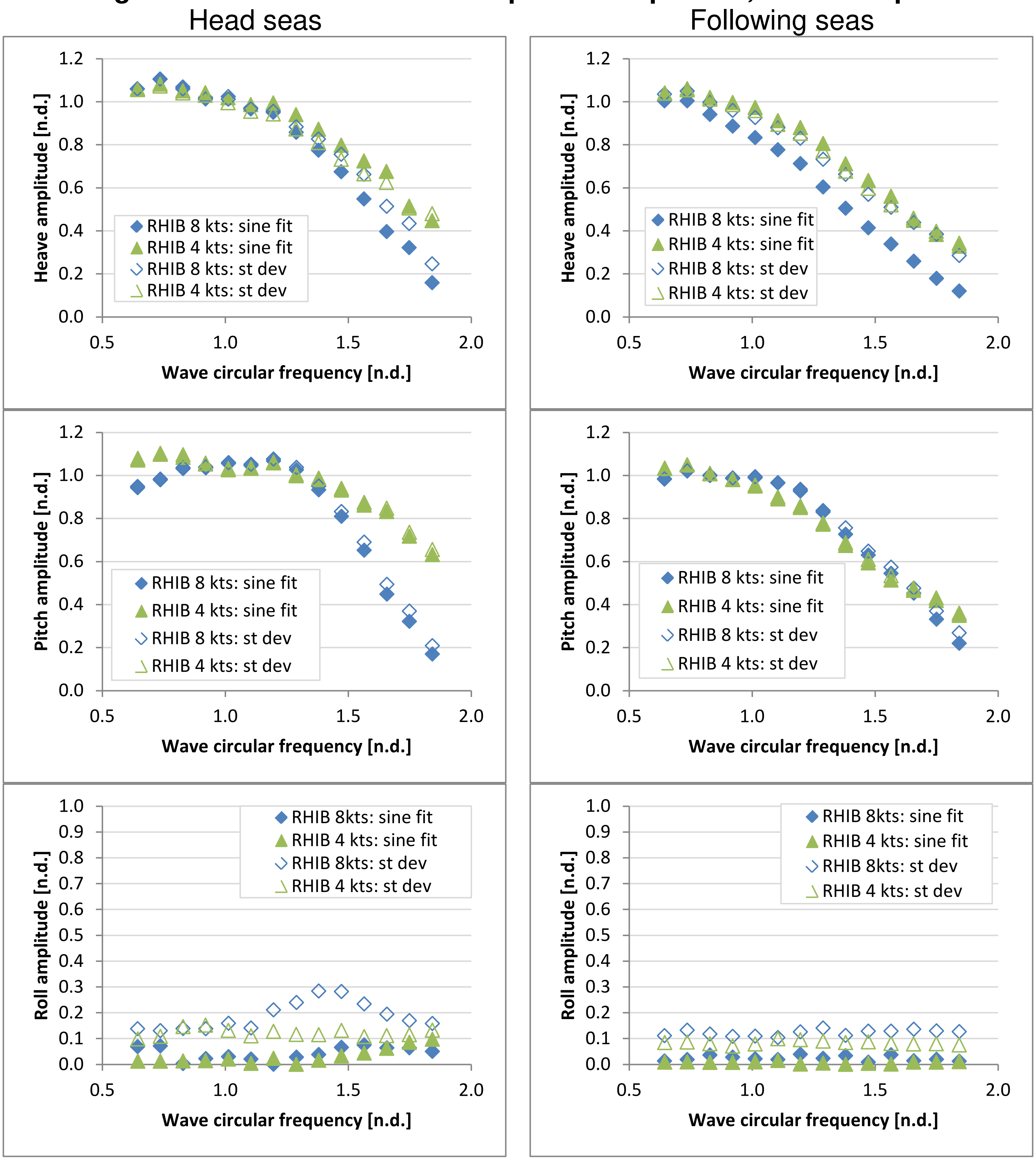


Figure 25 Effect of speed on RHIB in regular waves: non-dimensional motion amplitudes - heave, pitch, roll-

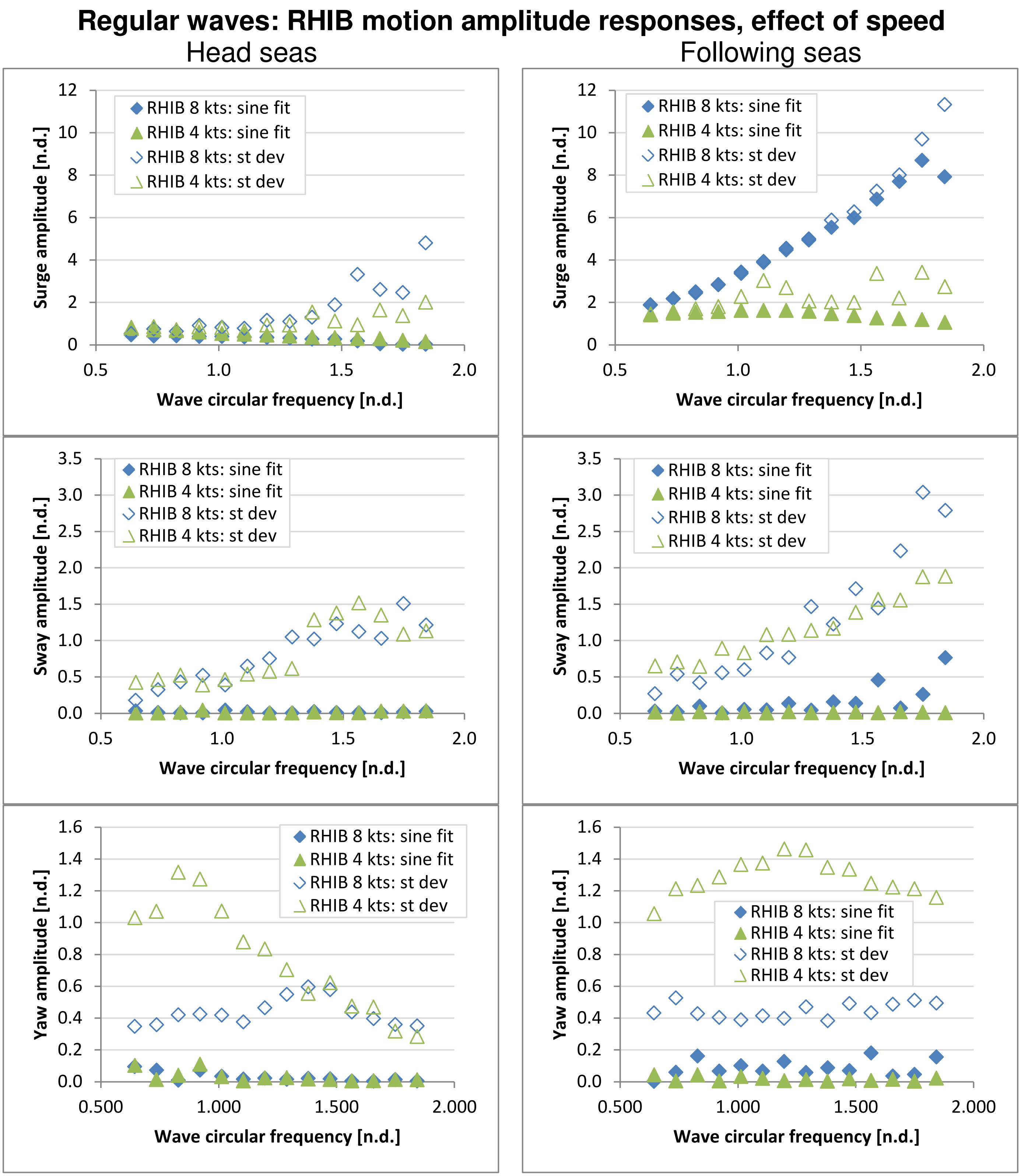


Figure 26 Effect of speed on RHIB in regular waves: non-dimensional motion amplitudes – surge, sway, yaw-

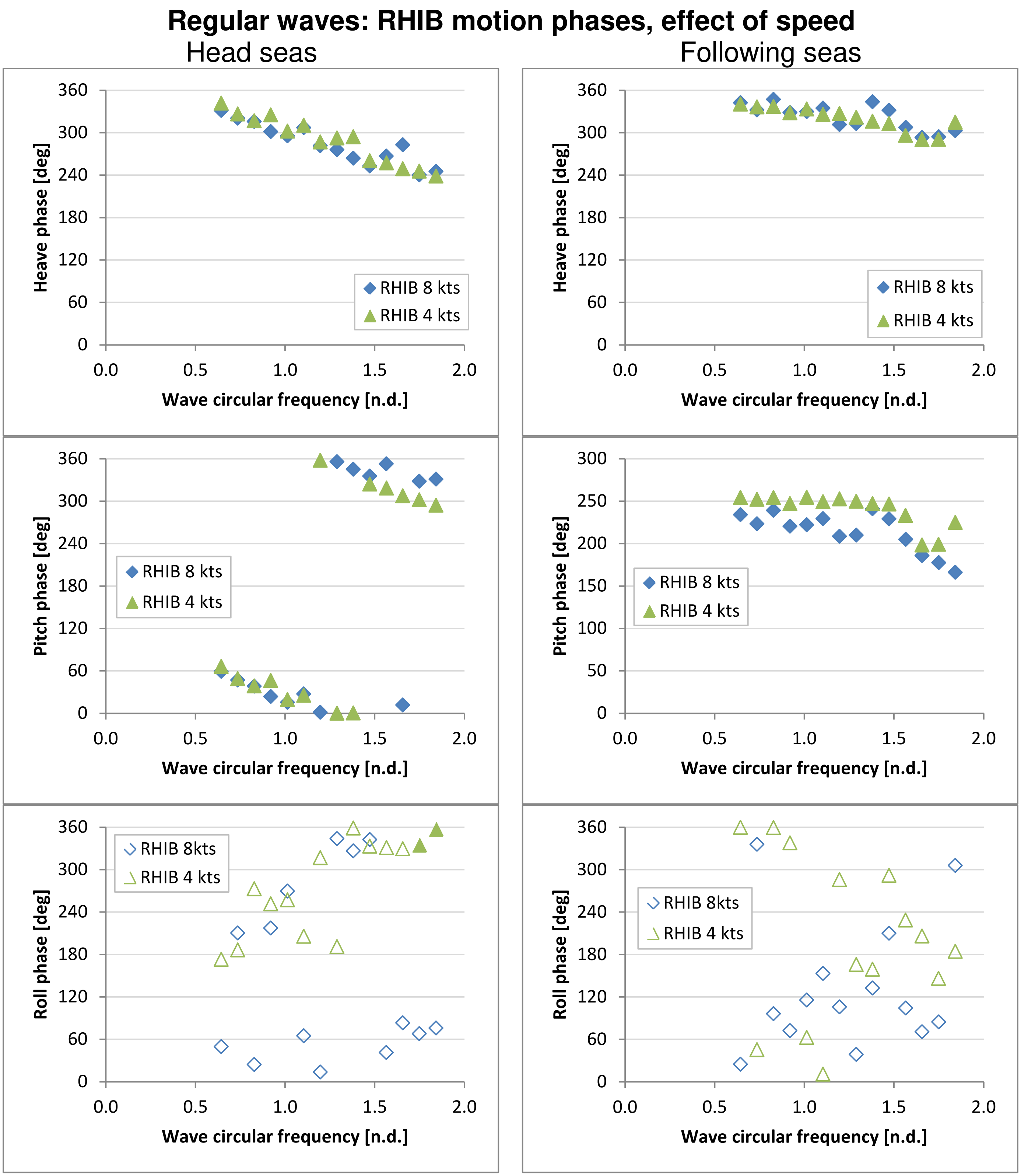


Figure 27 Effect of speed on RHIB in regular waves: motion phases – heave, pitch, roll-

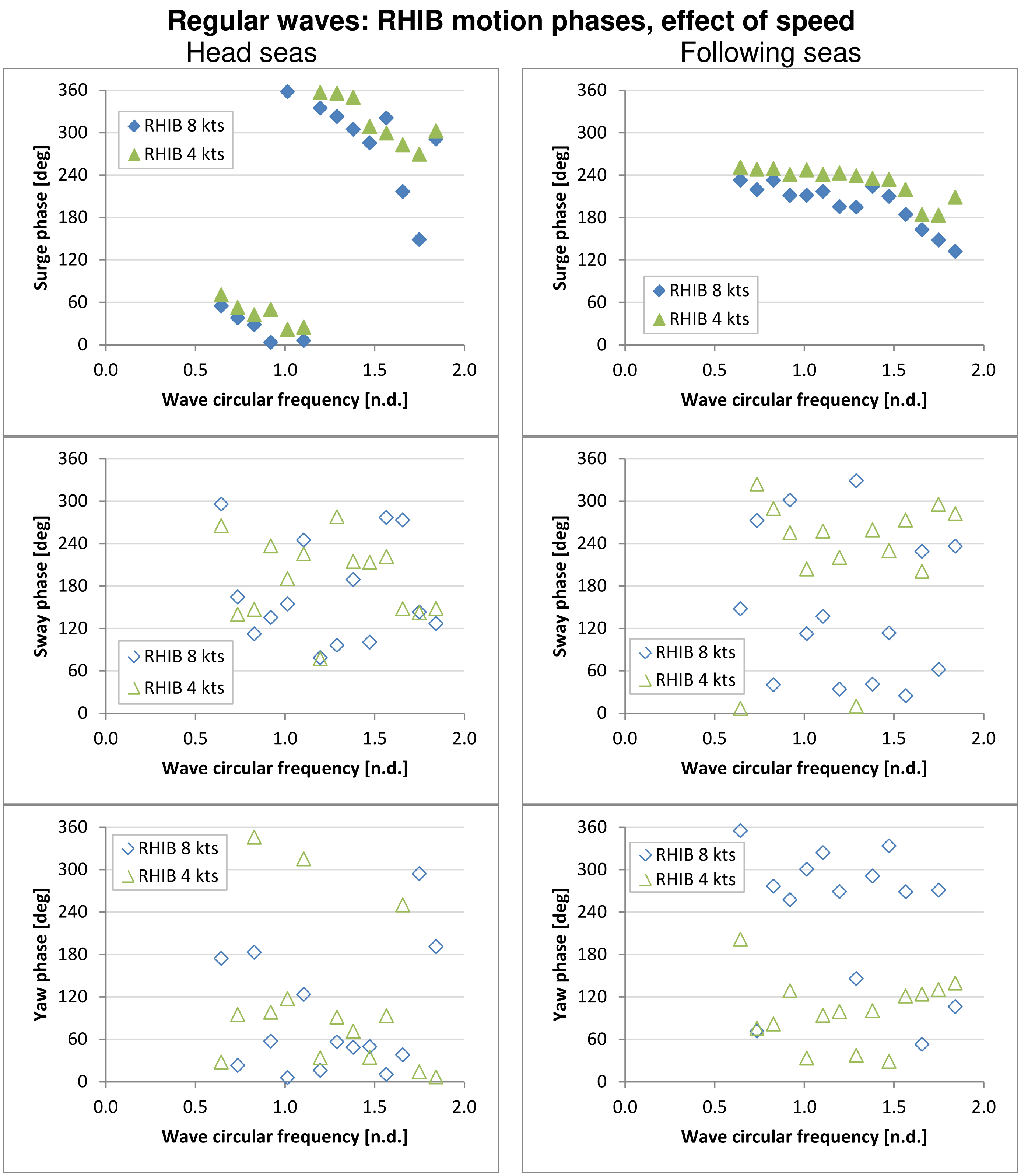


Figure 28 Effect of speed on RHIB in regular waves: motion phases – surge, sway, yaw-

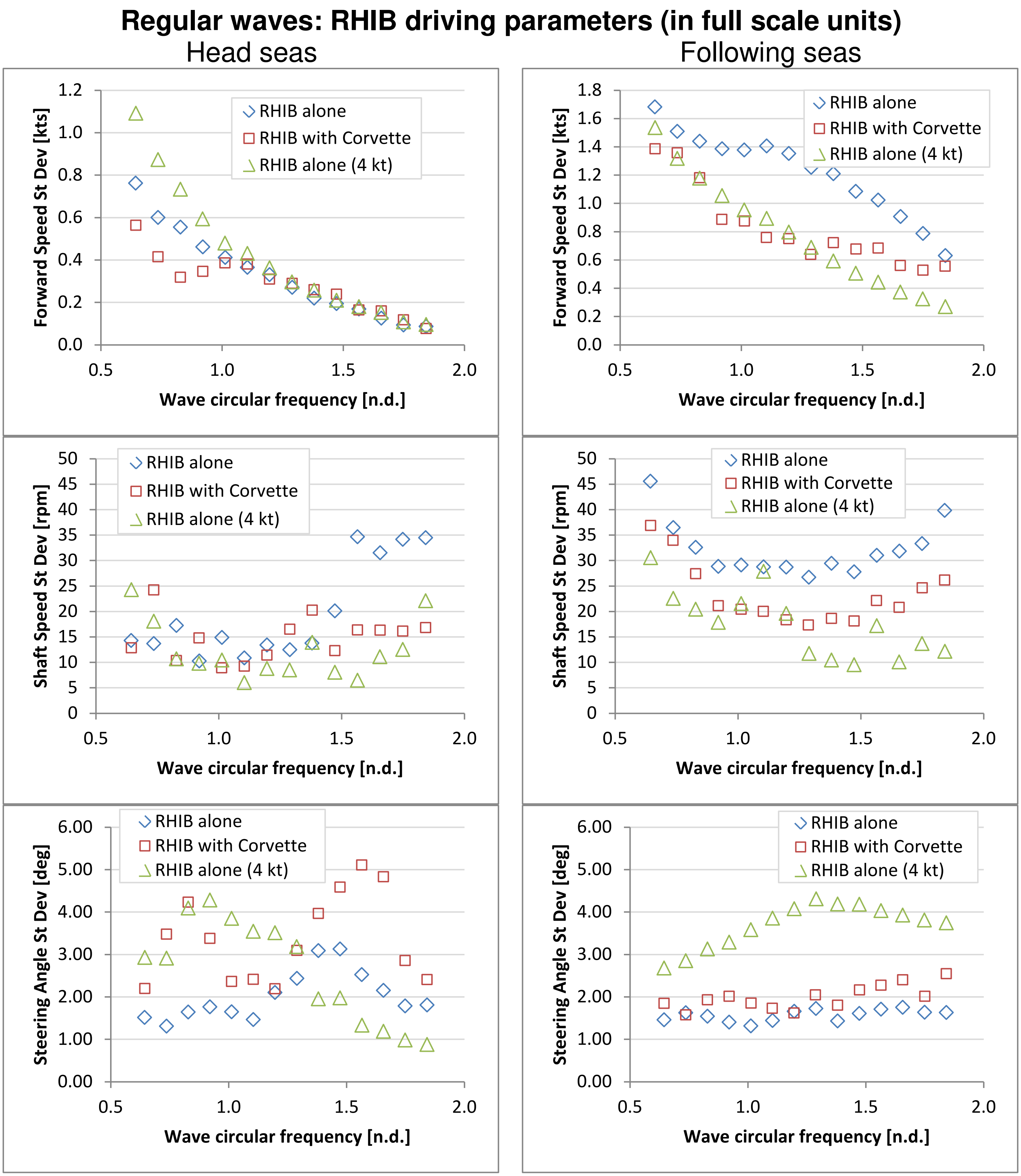


Figure 29 Effect of speed on RHIB in regular waves: standard deviation of speed, shaft speed and steering angle

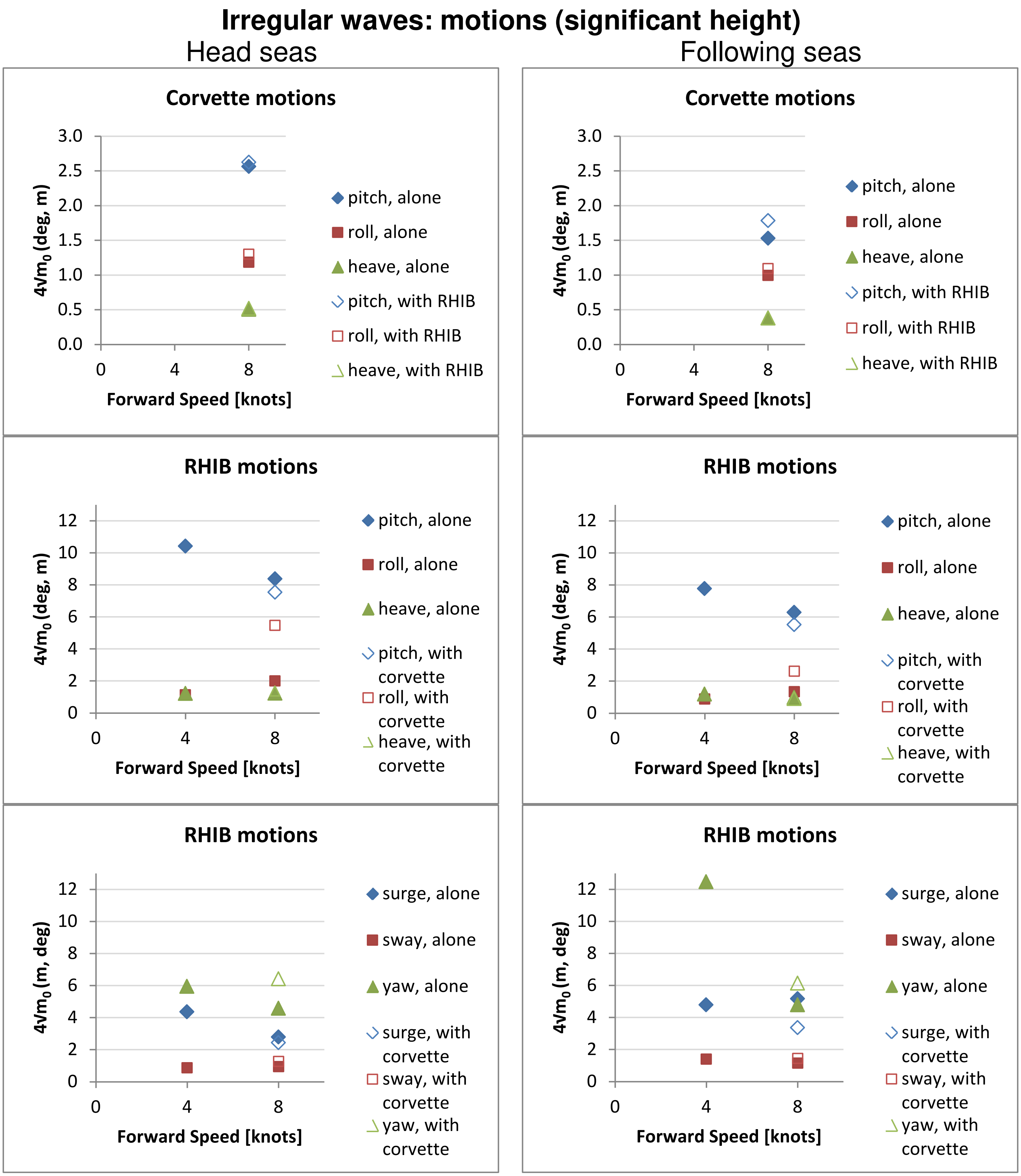


Figure 30 Corvette and RHIB motions in irregular waves: significant height

Appendix A

Corvette hydrostatics

Model Scale **Hydrostatic properties** (1: 11.625) **Hull D24 (corvette)**

Draft is from Baseline. in freshwater
No Trim, No heel Water Specific Gravity = 1.000.

LCF Draft (m)	Displ (kg)	LCB (m)	VCB (m)	LCF (m)	TPcm (MT/cm)	MTcm (MT-m /deg)	KMt m
0.2161	479.54	**2.920**	**0.132**	2.673	0.0342	0.1344	0.369

f f

Hull Data (without appendages)

Baseline draft: 0.216 m
Trim: zero
Heel: zero

DIMENSIONS

LOA	6.223	m	
LWL	6.038	m	
Beam	0.754	m	0.376972
BWL	0.709	m	0.354556
Volume	0.4795	m^3	
Displacement	479.54	kg	

COEFFICIENTS
Prismatic: 0.662 Block: 0.518 Midship: 0.783 Waterplane: 0.799

RATIOS
Length/Beam: 8.254 Displacement/length: 60.72 Beam/Depth: 3.489
kg/mm immersion: 3.419

AREAS

Waterplane:	3.419	m^2
Wetted surface	4.549	m^2
Under Water Lateral Plane:	1.174	m^2
Above Water Lateral Plane:	1.514	m^2

CENTROIDS (Meters)

Buoyancy:	LCB	2.920	m	fwd of Station 0
	VCB	0.132	m	above baseline
Flotation:	LCF	2.673	m	fwd of Station 0

Note: Coefficients calculated based on waterline length at given draft

Full Scale **Hydrostatic properties** **Hull D24 (corvette)**

Draft is from Baseline. in saltwater
No Trim, No heel Water Specific Gravity = 1.025.

LCF Draft (m)	Displ (MT)	LCB (m)	VCB (m)	LCF (m)	TPcm (MT/cm)	MTcm (MT-m /deg)	KMt m
2.5123	772.1914	**33.943**	**1.540**	31.070	4.7362	2516.0513	4.295
		f		f			

Hull Data (without appendages)

Baseline draft: 2.512 m
Trim: zero
Heel: zero

DIMENSIONS
LOA 72.344 m
LWL 70.191 m
Beam 8.765 m
BWL 8.243 m
Volume 753.35 m^3
Displacement 772.19 MT

COEFFICIENTS
Prismatic: 0.662 Block: 0.518 Midship: 0.783 Waterplane: 0.799

RATIOS
Length/Beam: 8.254 Displacement/length: 62.231 Beam/Depth: 3.489
MT/ cm immersion 4.736

AREAS
Waterplane: 462.07 m^2
Wetted surface 614.80 m^2
Under Water Lateral Plane: 158.67 m^2
Above Water Lateral Plane: 204.61 m^2

CENTROIDS (Meters)
Buoyancy: LCB 33.943 m fwd of Station 0
VCB 1.540 m above baseline
Flotation: LCF 31.070 m fwd of Station 0

Note: Coefficients calculated based on waterline length at given draft

Appendix B

Corvette model loading table and inclining experiment

Corvette model: loading table

Origin: baseline (keel) X fwd Y to port Z up
stern (CAD X0, i.e. Station 0)

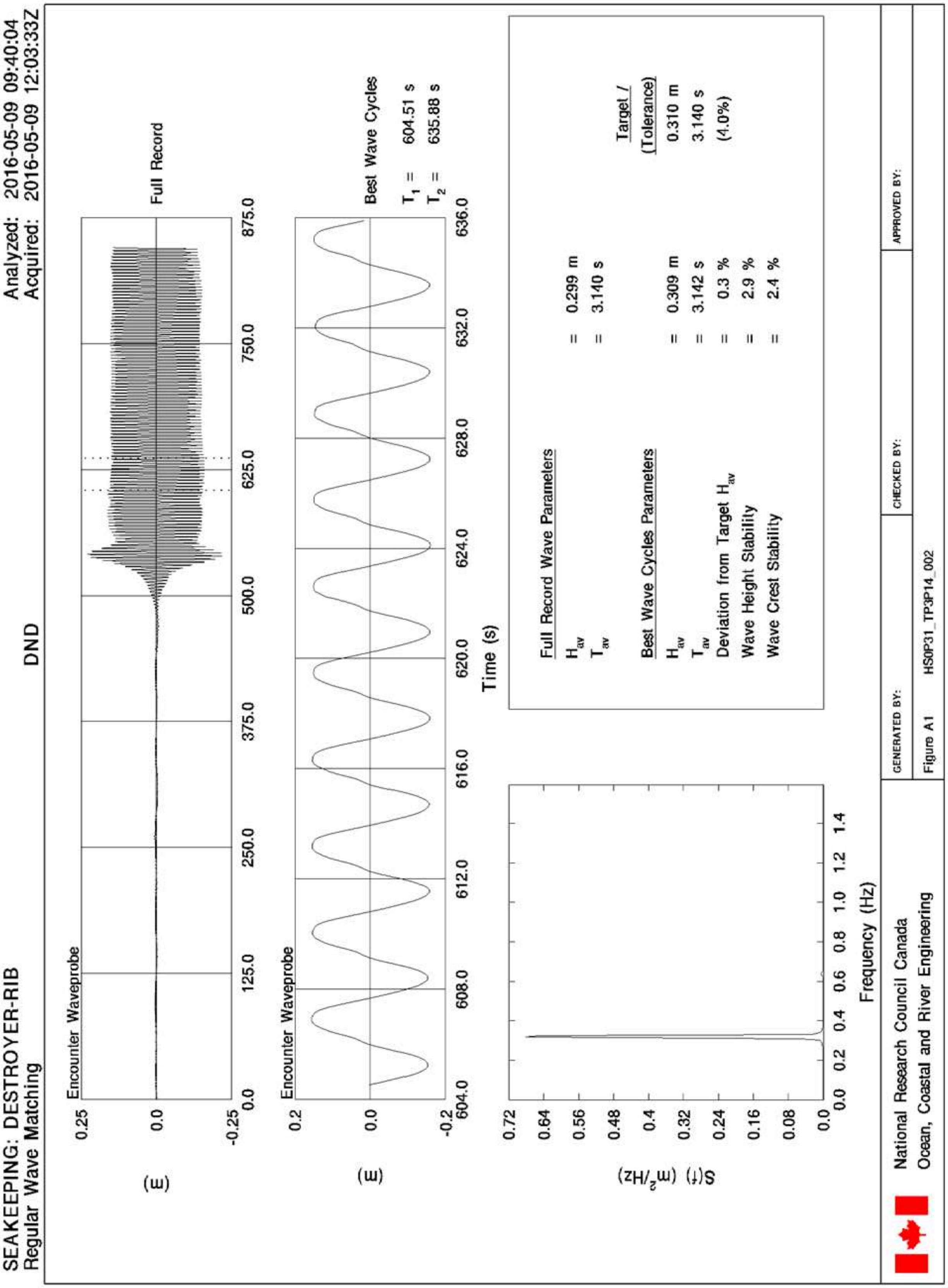
	mass	XG	YG	ZG	about own CG Ixx	about own CG Iyy	m*xG	m*yG	m*zG	about global CG_calc Ixx	about global CG_calc Iyy	about global CG_target Ixx	about global CG_target Iyy
	kg	m	m	m	kg.m^2	kg.m^2	kg.m	kg.m	kg.m	kg.m^2	kg.m^2		
Lightship	141.1	2.61706	0	0.21126	9.956	367.805	369.27	0.00	29.81	10.632	383.731	10.682	381.480
Trim hook plate 4	0.627	6.0283	0	0.508	0	0	3.78	0.00	0.32	0.032	5.990	0.032	6.090
Trim hook plate 1	0.627	0	-0.253	0.508	0	0	0.00	-0.16	0.32	0.072	5.473	0.072	5.378
	1.6	0.06	0	0.287	0	0	0.10	0.00	0.46	0.000	13.325	0.000	13.087
26 kg 2	24.15	0.6886	0.28	0.495	0	0.631	16.63	6.76	11.95	3.020	124.787	2.979	121.963
26 kg 1	24.22	1.34315	-0.266	0.495	0	0.633	32.53	-6.44	11.99	2.814	63.958	2.802	61.943
26 kg 4	25.76	1.5595	0.14	0.189	0	0.673	40.17	3.61	4.87	0.729	50.396	0.733	48.582
26 kg 3	25.44	1.5595	-0.14	0.189	0	0.665	39.67	-3.56	4.81	0.703	49.770	0.723	47.978
5kg 1	5	1.23515	0.011	0.199	0	0	6.18	0.06	1.00	0.034	14.665	0.036	14.229
2kg 1	2	2.07415	0.115	0.101	0	0	4.15	0.23	0.20	0.091	1.584	0.093	1.497
2kg 2	2	2.07415	-0.115	0.101	0	0	4.15	-0.23	0.20	0.090	1.584	0.093	1.497
2kg 3	2	2.05815	0.288	0.513	0	0	4.12	0.58	1.03	0.275	1.684	0.272	1.591
2kg 4	2	2.05815	-0.288	0.513	0	0	4.12	-0.58	1.03	0.273	1.684	0.272	1.591
Tow Post	11.6	2.92	0	0.174	0	0	33.87	0.00	2.02	0.131	0.139	0.138	0.138
Gimbal	13.4	2.92	0	0.174	0	0	39.13	0.00	2.33	0.152	0.161	0.159	0.159
Trim hook plate 2	0.627	3.014	0.322	0.508	0	0	1.89	0.20	0.32	0.098	0.035	0.097	0.037
Trim hook plate 3	0.627	3.014	-0.322	0.508	0	0	1.89	-0.20	0.32	0.097	0.035	0.097	0.037
inclinometer	0.5	3.17315	0	0.083	0	0	1.59	0.00	0.04	0.019	0.045	0.020	0.052
	5	3.21915	-0.263	0.518	0	0	16.10	-1.32	2.59	0.625	0.656	0.622	0.724
	5	3.36215	0.263	0.518	0	0	16.81	1.32	2.59	0.631	1.149	0.622	1.254
20 kg 8	19.95	3.357	-0.0775	0.114	0	0	66.97	-1.55	2.27	0.669	3.926	0.690	4.380
20 kg 9	19.97	3.357	0.0775	0.114	0	0	67.04	1.55	2.28	0.677	3.930	0.690	4.384
26 kg 5	26	3.9355	0	0.495	0.679	0	102.32	0.00	12.87	1.876	26.663	1.848	27.981
	20	4.0055	-0.03	0.114	0	0	80.11	-0.60	2.28	0.571	23.013	0.589	24.137
26 kg 6	26.55	4.276	-0.278	0.498	0	0.553	113.53	-7.38	13.22	3.291	48.786	3.279	50.598
26 kg 7	24.88	4.3	0.285	0.494	0	0.650	106.98	7.09	12.29	3.172	47.410	3.129	49.139
26 kg 10	24.9	4.89015	0.112	0.227	0	0.651	121.76	2.79	5.65	0.390	94.855	0.390	97.378
26 kg 11	24.2	4.89015	-0.112	0.227	0	0.632	118.34	-2.71	5.49	0.367	92.188	0.379	94.640
Total	479.7	2.946	-0.001	0.280			1413.2	-0.5	134.5	31.533	1061.623 kg.m^2	31.537	1061.946 kg.m^2
Targets	479.6	2.92	0	**0.283**	(using autoship M; using CAD: 0.280)					rxx	ryy	rxx	ryy
									radius	0.256	1.488 m	0.256	1.488 m
										rxx/BWL	ryy/LWL	rxx/BWL	ryy/LWL
									ratio	0.362	0.246	0.362	0.246

Corvette: roll inclining experiment

Dec-16	mass	displacement	inclinometer reading	angle change	GMt
	kg	m	deg	deg	m
	4.993	0	0.60	0	
move to Stbd	4.993	0.632	5.03	4.425	**0.085**
	4.993	0	0.61	0	
move to Port	4.898	-0.632	-3.74	-4.345	**0.085**
	4.898	0	0.60	0	
				GM target	**0.086**

Appendix C

Results of wave calibration


SEAKEEPING: DESTROYER-RIB
Regular Wave Matching
DND
Analyzed: 2016-05-09 09:40:04
Acquired: 2016-05-09 12:03:33Z
Encounter Waveprobe
Full Record
Encounter Waveprobe
Best Wave Cycles
T1 = 604.51 s
T2 = 635.88 s
Time (s)
S(f) (m²/Hz)
Frequency (Hz)
Full Record Wave Parameters
Hav = 0.299 m
Tav = 3.140 s
Best Wave Cycles Parameters
Hav = 0.309 m
Tav = 3.142 s
Deviation from Target Hav = 0.3 %
Wave Height Stability = 2.9 %
Wave Crest Stability = 2.4 %
Target / (Tolerance)
0.310 m
3.140 s
(4.0%)
National Research Council Canada
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GENERATED BY:
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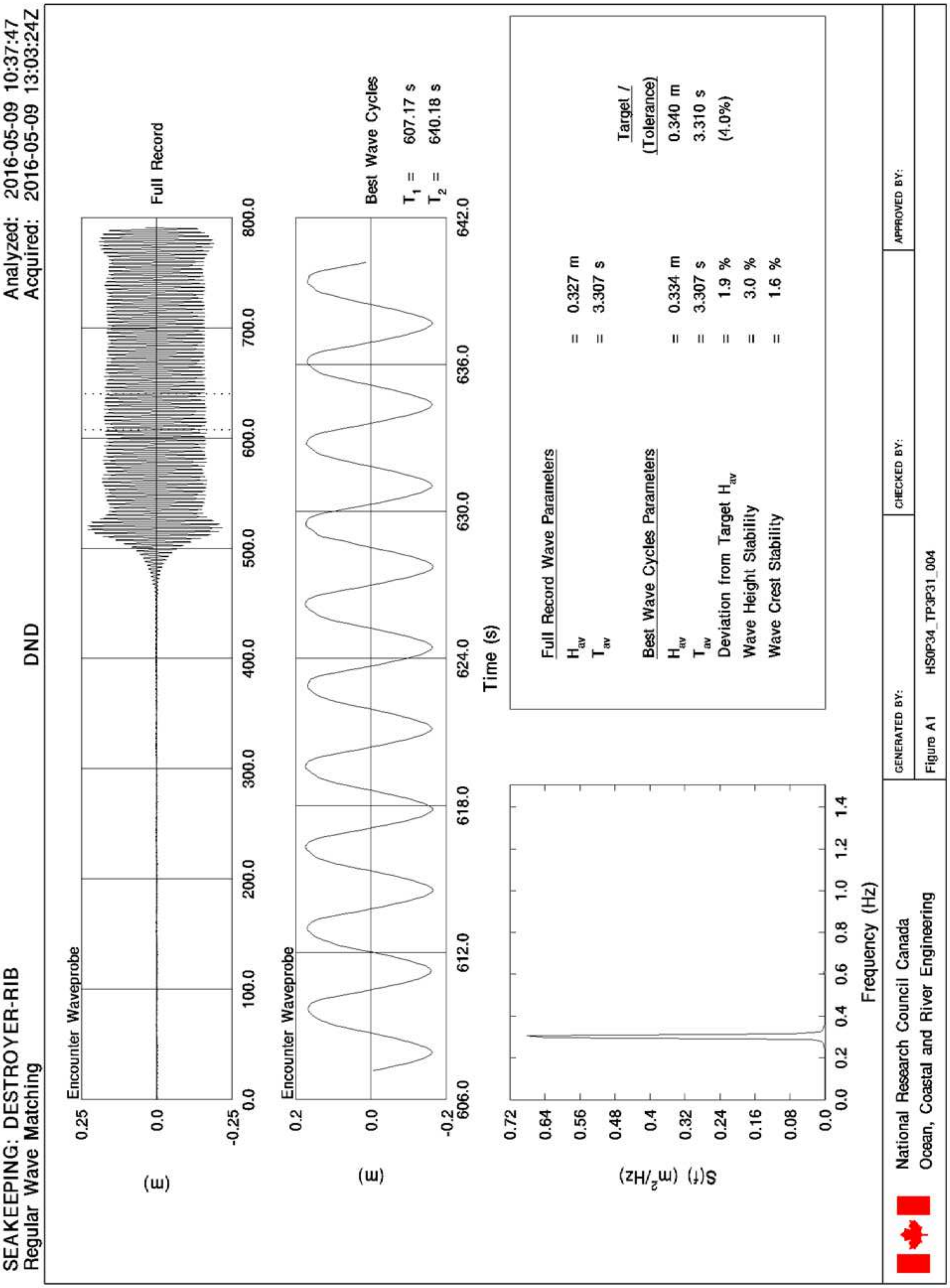
Figure A1
HS0P31_TP3P14_002


SEAKEEPING: DESTROYER-RIB
Regular Wave Matching
DND
Analyzed: 2016-05-09 10:37:47
Acquired: 2016-05-09 13:03:24Z
Encounter Waveprobe
Full Record
Best Wave Cycles
T1 = 607.17 s
T2 = 640.18 s
Time (s)
Frequency (Hz)
S(f) (m²/Hz)
(m)
Full Record Wave Parameters
Hav = 0.327 m
Tav = 3.307 s
Best Wave Cycles Parameters
Hav = 0.334 m
Tav = 3.307 s
Deviation from Target Hav = 1.9 %
Wave Height Stability = 3.0 %
Wave Crest Stability = 1.6 %
Target / (Tolerance)
0.340 m
3.310 s
(4.0%)
National Research Council Canada
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GENERATED BY:
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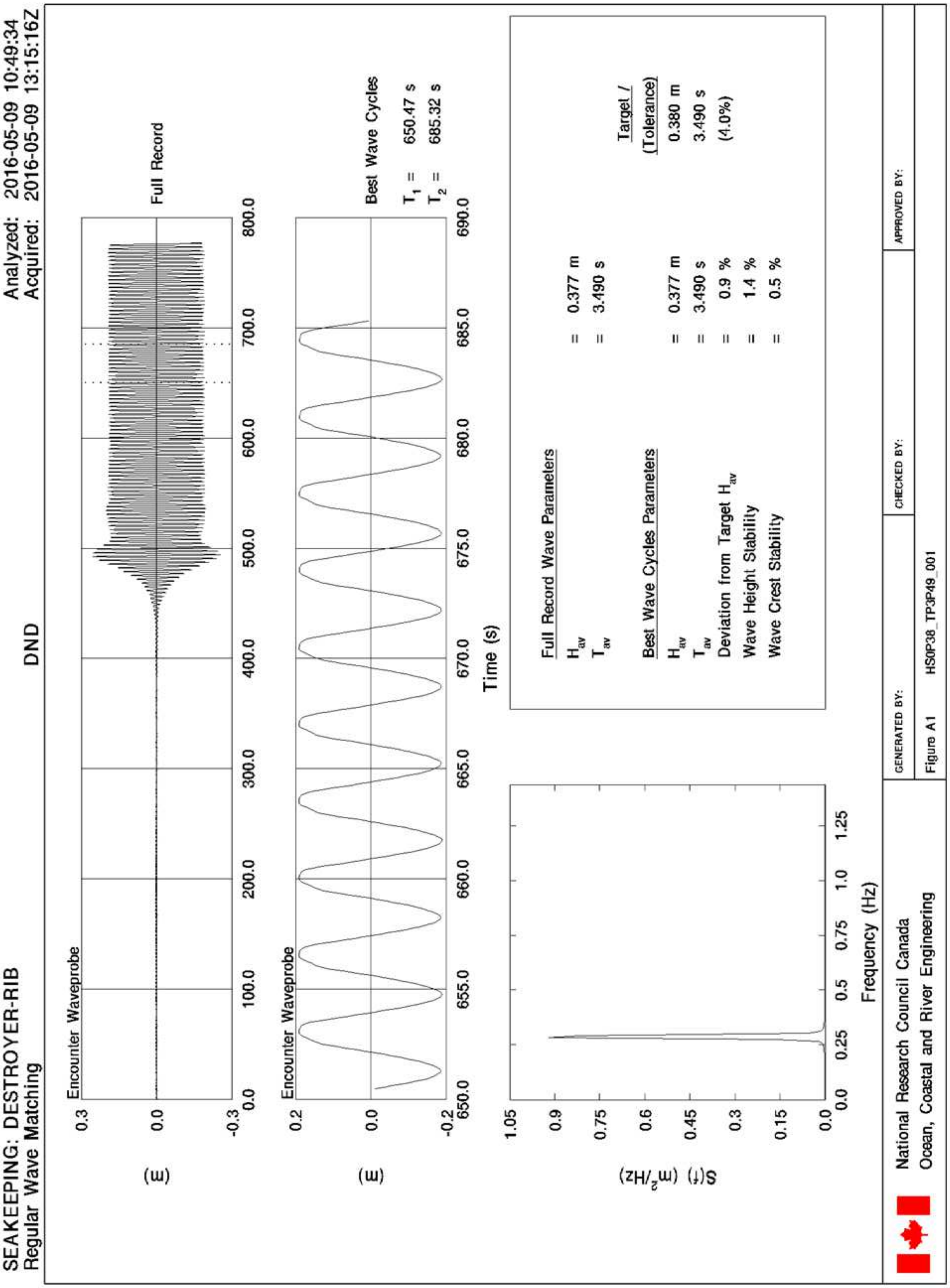
APPROVED BY:
Figure A1
HS0P34_TP3P31_004


SEAKEEPING: DESTROYER-RIB
Regular Wave Matching
DND
Analyzed: 2016-05-09 10:49:34
Acquired: 2016-05-09 13:15:16Z
Encounter Waveprobe
Full Record
(m)
0.3
0.0
-0.3
0.0
100.0
200.0
300.0
400.0
500.0
600.0
700.0
800.0
Encounter Waveprobe
Best Wave Cycles
T_1 = 650.47 s
T_2 = 685.32 s
0.2
-0.2
650.0
655.0
660.0
665.0
670.0
675.0
680.0
685.0
690.0
Time (s)
S(f) (m²/Hz)
1.05
0.9
0.75
0.6
0.45
0.3
0.15
0.25
0.5
0.75
1.0
1.25
Frequency (Hz)
Full Record Wave Parameters
H_{av} = 0.377 m
T_{av} = 3.490 s
Best Wave Cycles Parameters
H_{av} = 0.377 m
T_{av} = 3.490 s
Deviation from Target H_{av} = 0.9 %
Wave Height Stability = 1.4 %
Wave Crest Stability = 0.5 %
Target / (Tolerance)
0.380 m
3.490 s
(4.0%)
National Research Council Canada
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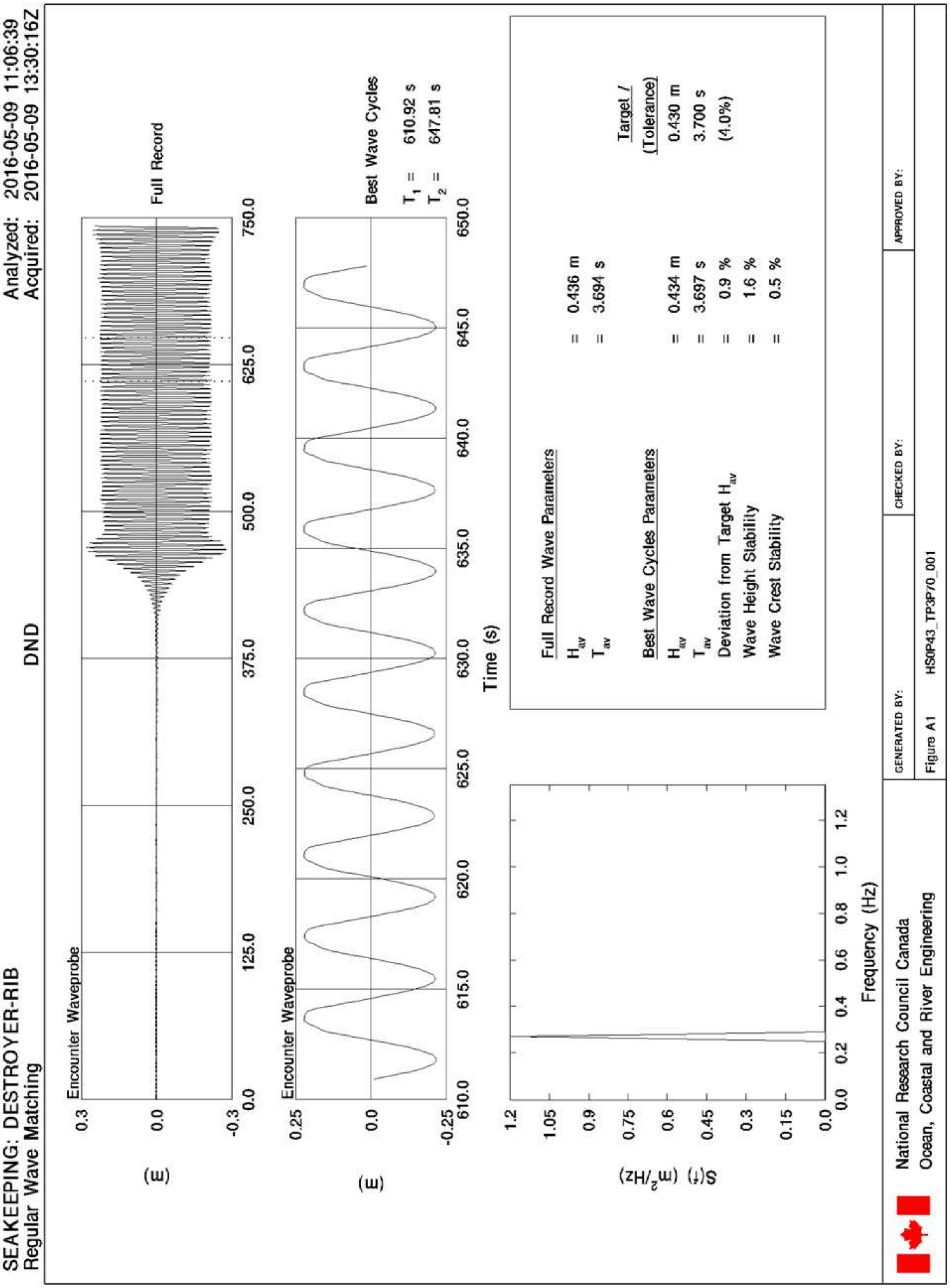
GENERATED BY:
CHECKED BY:
APPROVED BY:
Figure A1
HS0P38_TP3P49_001


SEAKEEPING: DESTROYER-RIB
Regular Wave Matching
DND
Analyzed: 2016-05-09 11:06:39
Acquired: 2016-05-09 13:30:16Z
Encounter Waveprobe
Full Record
(m)
Encounter Waveprobe
Best Wave Cycles
T1 = 610.92 s
T2 = 647.81 s
Time (s)
S(f) (m²/Hz)
Frequency (Hz)
Full Record Wave Parameters
Hav = 0.436 m
Tav = 3.694 s
Best Wave Cycles Parameters
Hav = 0.434 m
Tav = 3.697 s
Deviation from Target Hav = 0.9 %
Wave Height Stability = 1.6 %
Wave Crest Stability = 0.5 %
Target / (Tolerance)
0.430 m
3.700 s
(4.0%)
National Research Council Canada
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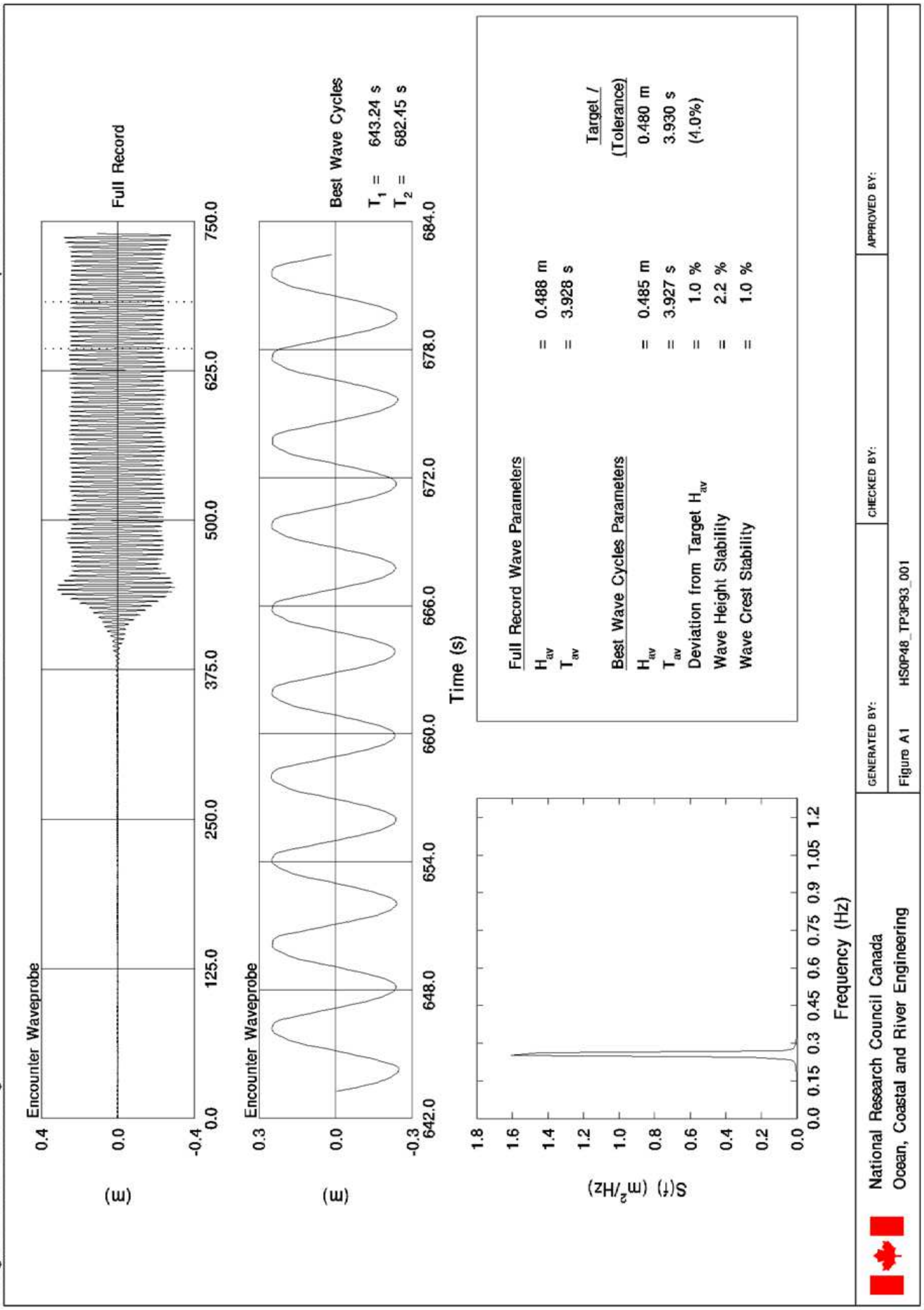
CHECKED BY:
APPROVED BY:
Figure A1
HS0P43_TP3P70_001


SEAKEEPING: DESTROYER-RIB
Regular Wave Matching
DND
Analyzed: 2016-05-09 11:18:16
Acquired: 2016-05-09 13:44:04Z
Encounter Waveprobe
Full Record
(m)
0.4
0.0
-0.4
0.0
125.0
250.0
375.0
500.0
625.0
750.0
Encounter Waveprobe
Best Wave Cycles
T_1 = 643.24 s
T_2 = 682.45 s
0.3
0.0
-0.3
642.0
648.0
654.0
660.0
666.0
672.0
678.0
684.0
Time (s)
$S(f)$ (m^2/Hz)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0 0.15 0.3 0.45 0.6 0.75 0.9 1.05 1.2
Frequency (Hz)
Full Record Wave Parameters
H_{av} = 0.488 m
T_{av} = 3.928 s
Best Wave Cycles Parameters
H_{av} = 0.485 m
T_{av} = 3.927 s
Deviation from Target H_{av} = 1.0 %
Wave Height Stability = 2.2 %
Wave Crest Stability = 1.0 %
Target / (Tolerance)
0.480 m
3.930 s
(4.0%)
National Research Council Canada
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GENERATED BY:
CHECKED BY:
APPROVED BY:
Figure A1
HS0P48_TP3P93_001

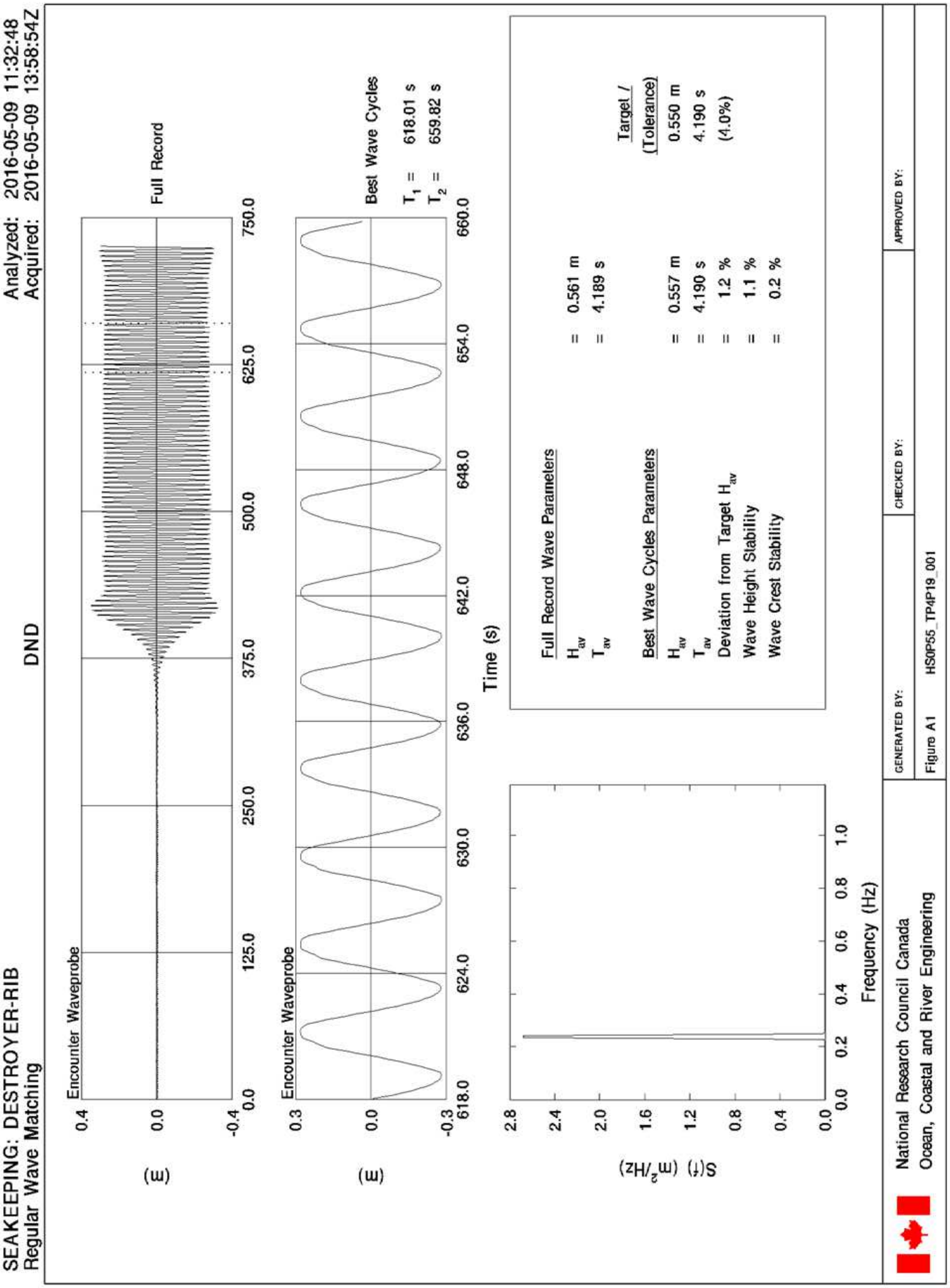
SEAKEEPING: DESTROYER-RIB
Regular Wave Matching
DND
Analyzed: 2016-05-09 11:32:48
Acquired: 2016-05-09 13:58:54Z
Encounter Waveprobe
Full Record
(m)
0.4
0.0
-0.4
0.0
125.0
250.0
375.0
500.0
625.0
750.0
Encounter Waveprobe
Best Wave Cycles
T1 = 618.01 s
T2 = 659.82 s
0.3
0.0
-0.3
618.0
624.0
630.0
636.0
642.0
648.0
654.0
660.0
Time (s)
S(f) (m²/Hz)
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
0.2
0.4
0.6
0.8
1.0
Frequency (Hz)
Full Record Wave Parameters
Hav = 0.561 m
Tav = 4.189 s
Best Wave Cycles Parameters
Hav = 0.557 m
Tav = 4.190 s
Deviation from Target Hav = 1.2 %
Wave Height Stability = 1.1 %
Wave Crest Stability = 0.2 %
Target / (Tolerance)
0.550 m
4.190 s
(4.0%)
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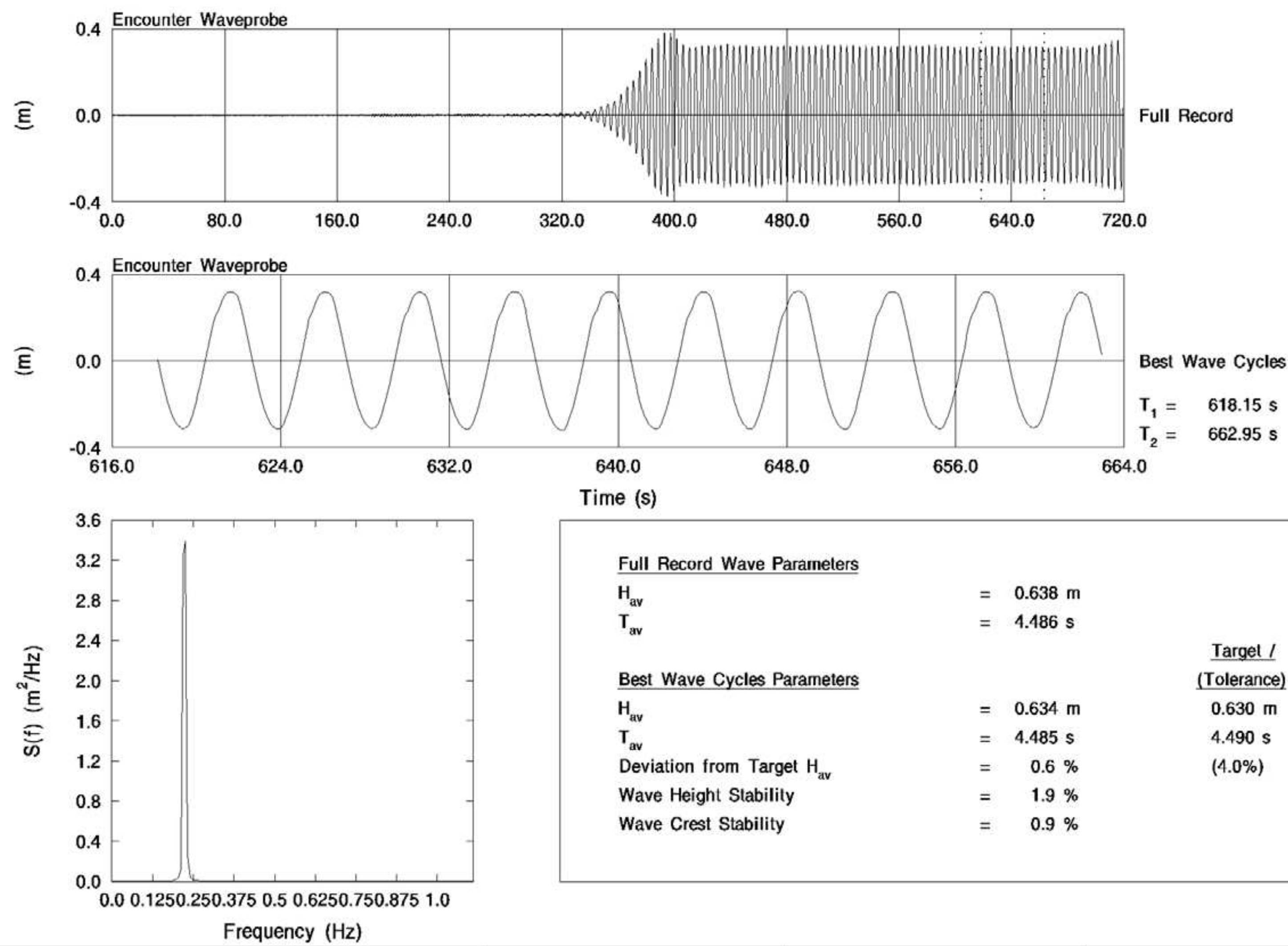
Figure A1
HS0P55_TP4P19_001

SEAKEEPING: DESTROYER-RIB
Regular Wave Matching

DND

Analyzed: 2016-05-09 11:45:49
Acquired: 2016-05-09 14:11:48Z



Full Record Wave Parameters			
H_{av}	=	0.638 m	
T_{av}	=	4.486 s	
			Target /
Best Wave Cycles Parameters			(Tolerance)
H_{av}	=	0.634 m	0.630 m
T_{av}	=	4.485 s	4.490 s
Deviation from Target H_{av}	=	0.6 %	(4.0%)
Wave Height Stability	=	1.9 %	
Wave Crest Stability	=	0.9 %	

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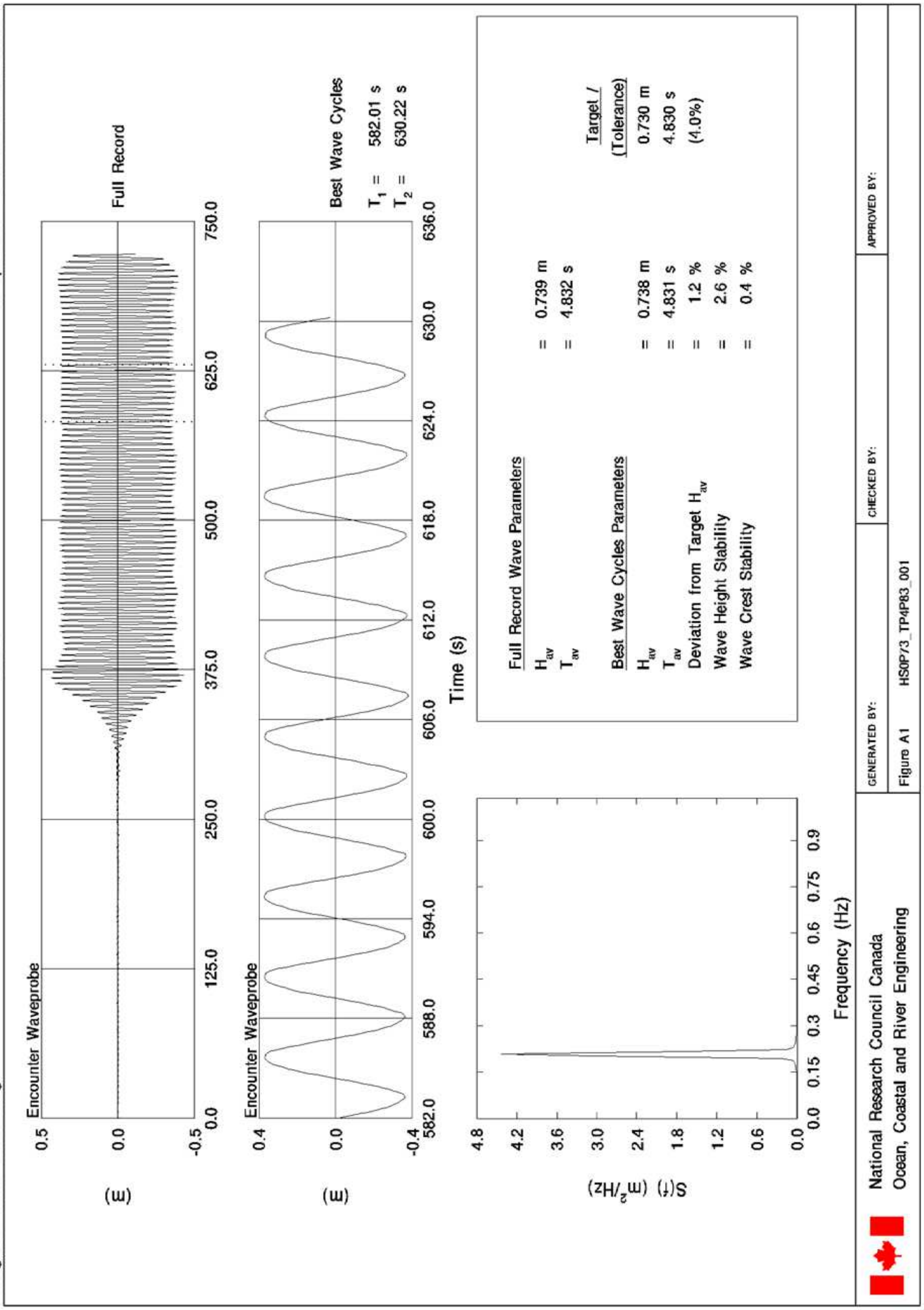
Figure A1 HS0P63_TP4P49_001


SEAKEEPING: DESTROYER-RIB
Regular Wave Matching
DND
Analyzed: 2016-05-09 11:57:53
Acquired: 2016-05-09 14:23:50Z
Encounter Waveprobe
Full Record
(m)
0.5
0.0
-0.5
0.0
125.0
250.0
375.0
500.0
625.0
750.0
Encounter Waveprobe
Best Wave Cycles
T1 = 582.01 s
T2 = 630.22 s
0.4
0.0
-0.4
582.0
588.0
594.0
600.0
606.0
612.0
618.0
624.0
630.0
636.0
Time (s)
S(f) (m²/Hz)
4.8
4.2
3.6
3.0
2.4
1.8
1.2
0.6
0.0
0.15
0.3
0.45
0.6
0.75
0.9
Frequency (Hz)
Full Record Wave Parameters
Hav = 0.739 m
Tav = 4.832 s
Best Wave Cycles Parameters
Target / (Tolerance)
Hav = 0.738 m 0.730 m
Tav = 4.831 s 4.830 s
Deviation from Target Hav = 1.2 % (4.0%)
Wave Height Stability = 2.6 %
Wave Crest Stability = 0.4 %
National Research Council Canada
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GENERATED BY:
CHECKED BY:
APPROVED BY:
Figure A1
HS0P73_TP4P83_001

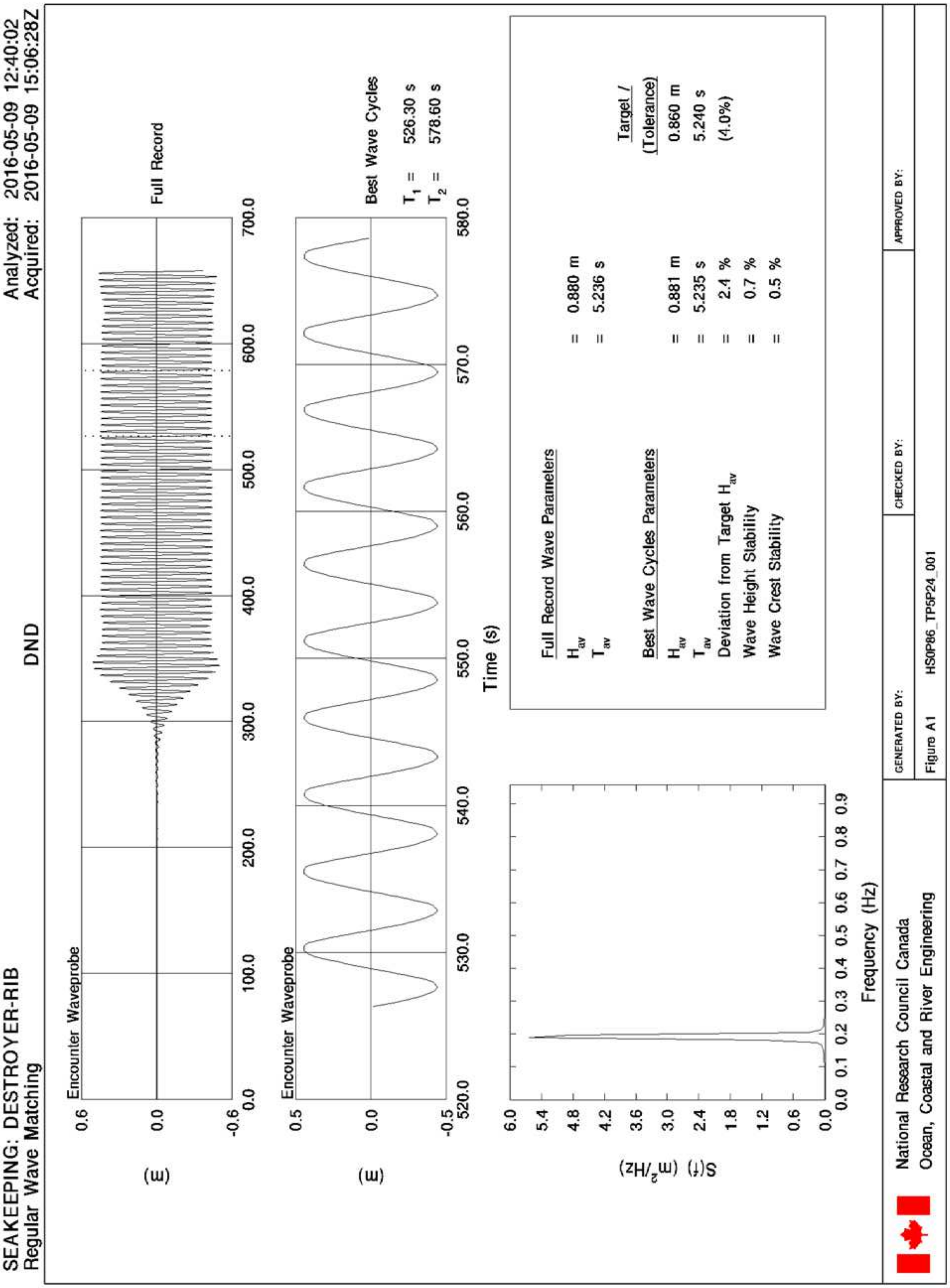
SEAKEEPING: DESTROYER-RIB
Regular Wave Matching
DND
Analyzed: 2016-05-09 12:40:02
Acquired: 2016-05-09 15:06:28Z
Encounter Waveprobe
Full Record
(m)
0.6
0.0
-0.6
0.0
100.0
200.0
300.0
400.0
500.0
600.0
700.0
Encounter Waveprobe
Best Wave Cycles
T_1 = 526.30 s
T_2 = 578.60 s
0.5
-0.5
520.0
530.0
540.0
550.0
560.0
570.0
580.0
Time (s)
S(f) (m^2/Hz)
6.0
5.4
4.8
4.2
3.6
3.0
2.4
1.8
1.2
0.6
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9
Frequency (Hz)
Full Record Wave Parameters
H_{av} = 0.880 m
T_{av} = 5.236 s
Best Wave Cycles Parameters
H_{av} = 0.881 m
T_{av} = 5.235 s
Deviation from Target H_{av} = 2.4 %
Wave Height Stability = 0.7 %
Wave Crest Stability = 0.5 %
Target / (Tolerance)
0.860 m
5.240 s
(4.0%)
National Research Council Canada
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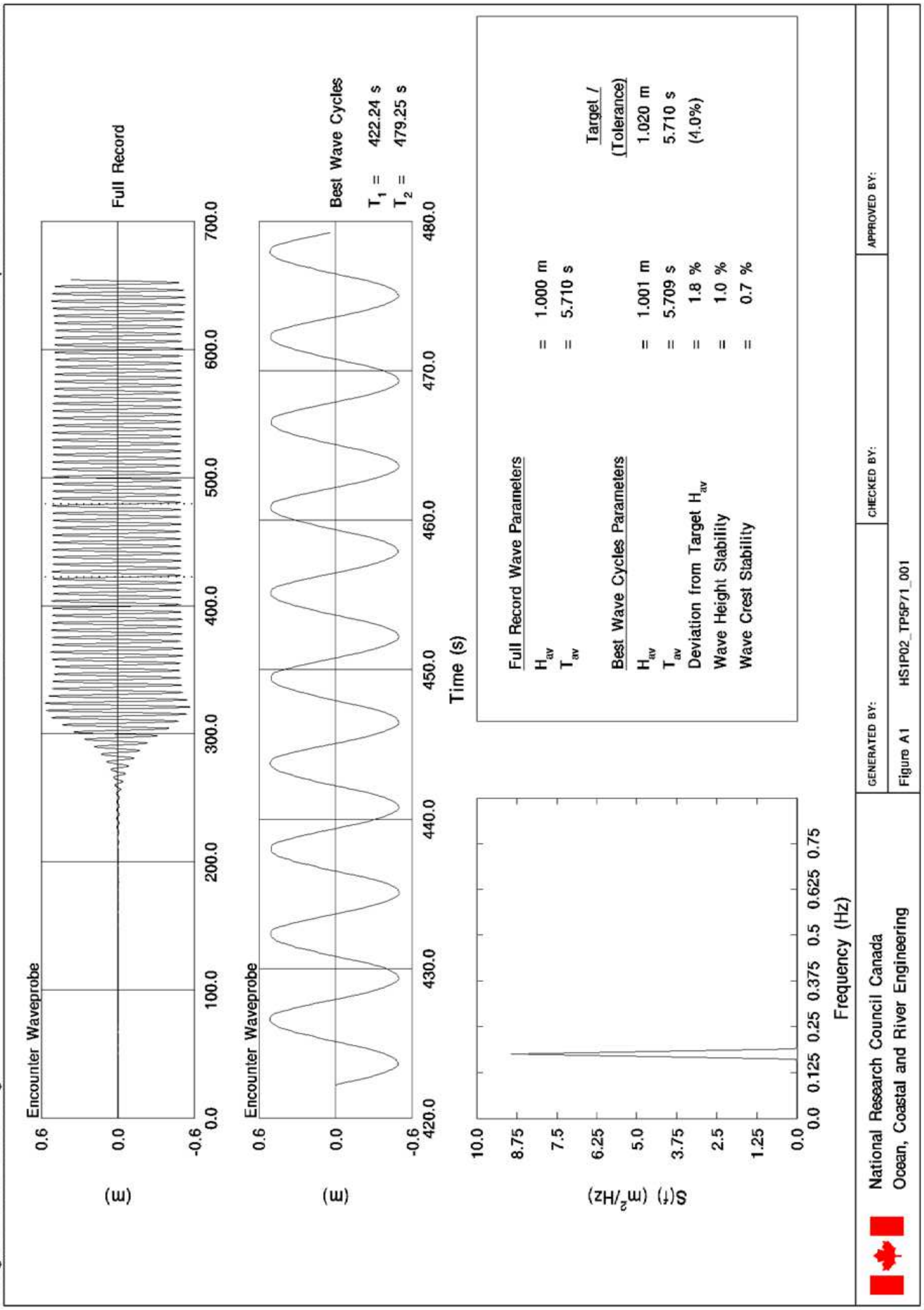
Figure A1
CHECKED BY:
HS0P86_TP5P24_001
APPROVED BY:



SEAKEEPING: DESTROYER-RIB
Regular Wave Matching
DND
Analyzed: 2016-05-09 12:54:33
Acquired: 2016-05-09 15:20:59Z
Encounter Waveprobe
Full Record
(m)
0.6
0.0
-0.6
0.0
100.0
200.0
300.0
400.0
500.0
600.0
700.0
Encounter Waveprobe
Best Wave Cycles
T1 = 422.24 s
T2 = 479.25 s
420.0
430.0
440.0
450.0
460.0
470.0
480.0
Time (s)
S(f) (m²/Hz)
10.0
8.75
7.5
6.25
5.0
3.75
2.5
1.25
0.0
0.0 0.125 0.25 0.375 0.5 0.625 0.75
Frequency (Hz)
Full Record Wave Parameters
Hav = 1.000 m
Tav = 5.710 s
Best Wave Cycles Parameters
Target / (Tolerance)
Hav = 1.001 m 1.020 m
Tav = 5.709 s 5.710 s
Deviation from Target Hav = 1.8 % (4.0%)
Wave Height Stability = 1.0 %
Wave Crest Stability = 0.7 %
National Research Council Canada
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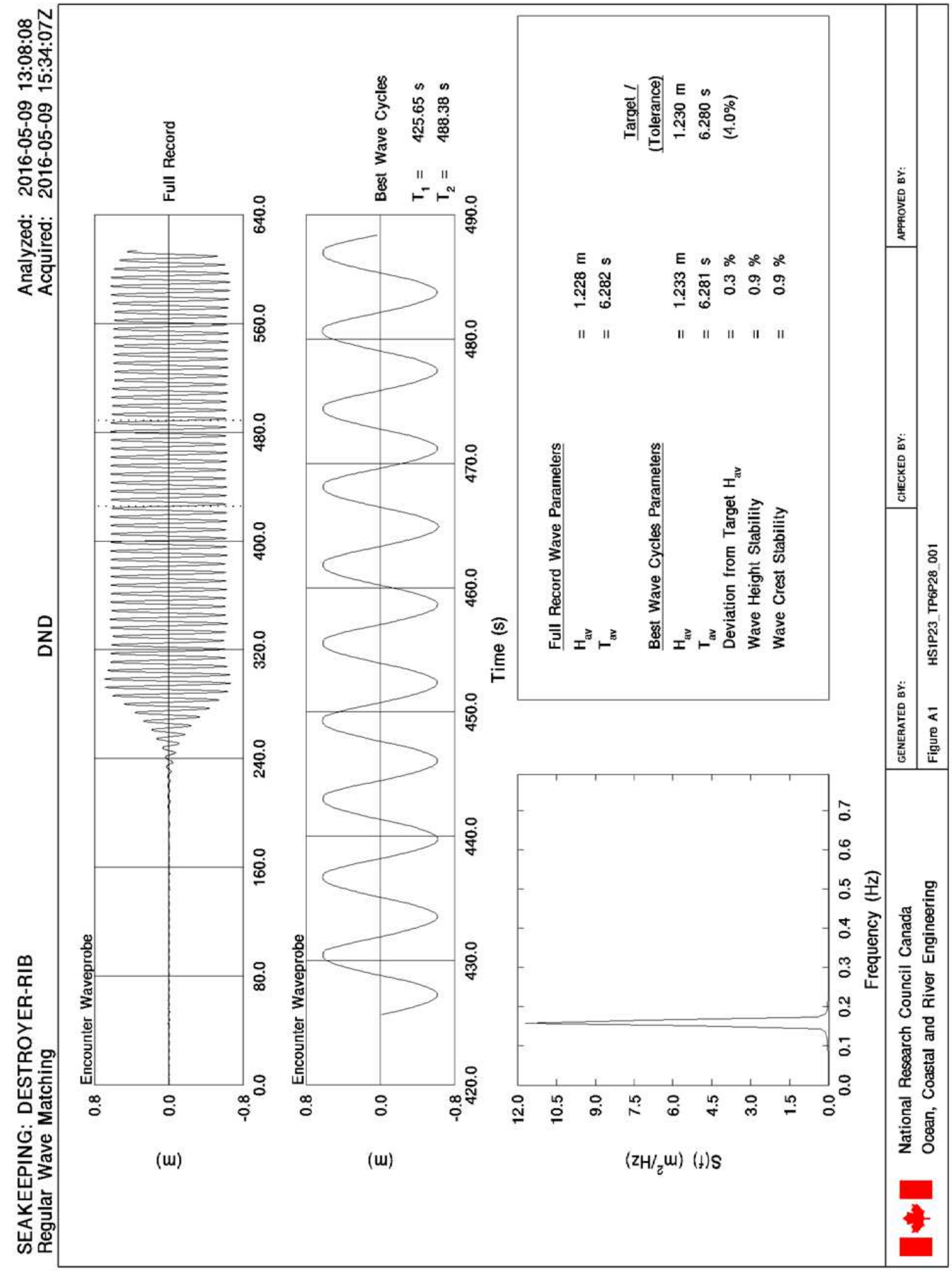
GENERATED BY:
CHECKED BY:
APPROVED BY:
Figure A1
HS1P02_TP5P71_001


SEAKEEPING: DESTROYER-RIB
Regular Wave Matching
DND
Analyzed: 2016-05-09 13:08:08
Acquired: 2016-05-09 15:34:07Z
Encounter Waveprobe
Full Record
(m)
Best Wave Cycles
T1 = 425.65 s
T2 = 488.38 s
Time (s)
S(f) (m²/Hz)
Frequency (Hz)
Full Record Wave Parameters
Hav = 1.228 m
Tav = 6.282 s
Best Wave Cycles Parameters
Hav = 1.233 m
Tav = 6.281 s
Deviation from Target Hav = 0.3 %
Wave Height Stability = 0.9 %
Wave Crest Stability = 0.9 %
Target / (Tolerance)
1.230 m
6.280 s
(4.0%)
National Research Council Canada
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GENERATED BY:
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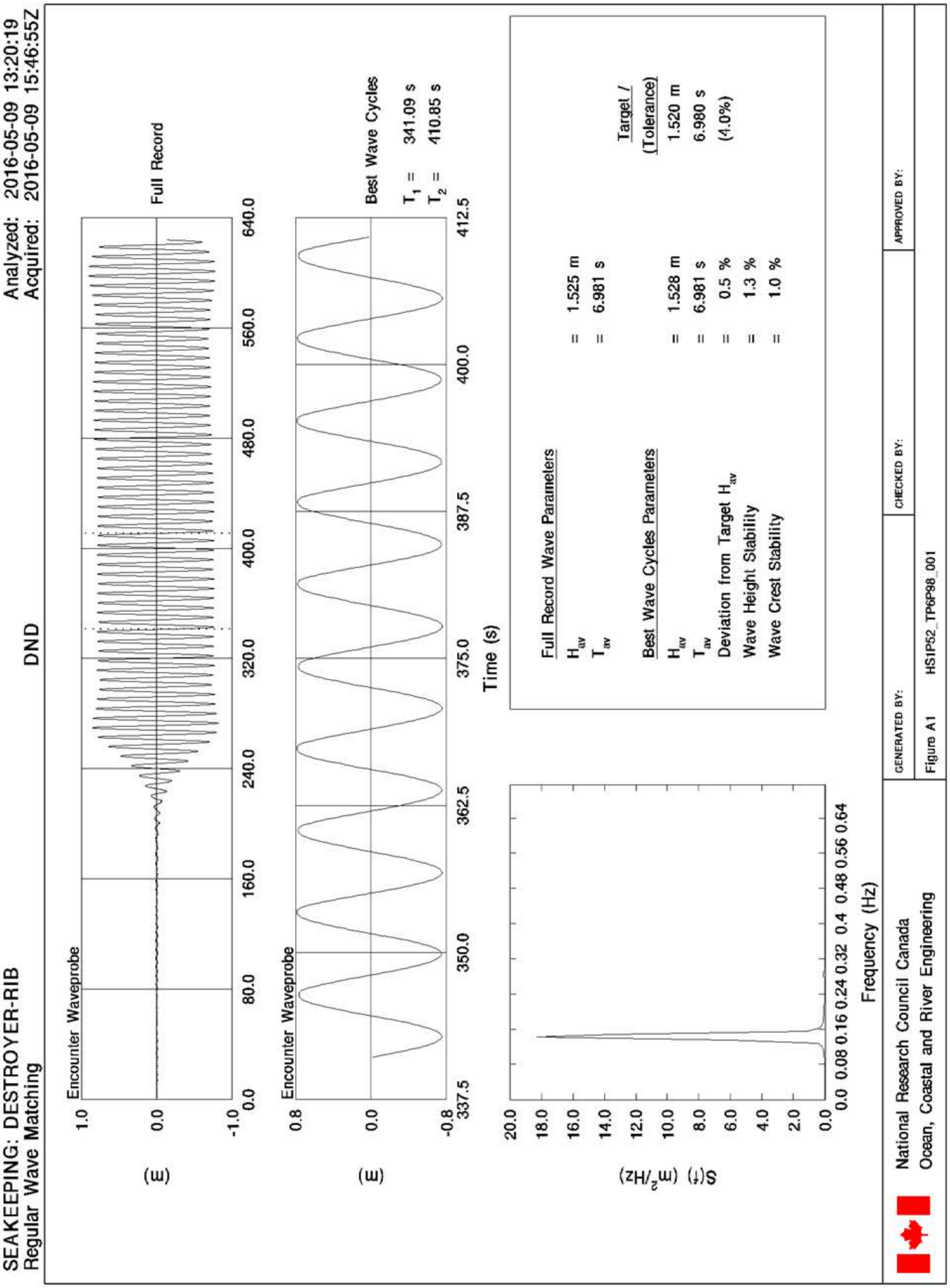
APPROVED BY:
Figure A1
HS1P23_TP6P28_001


SEAKEEPING: DESTROYER-RIB
Regular Wave Matching
DND
Analyzed: 2016-05-09 13:20:19
Acquired: 2016-05-09 15:46:55Z
Encounter Waveprobe
Full Record
(m)
1.0
0.0
-1.0
0.0
80.0
160.0
240.0
320.0
400.0
480.0
560.0
640.0
Encounter Waveprobe
Best Wave Cycles
T1 = 341.09 s
T2 = 410.85 s
0.8
0.0
-0.8
337.5
350.0
362.5
375.0
387.5
400.0
412.5
Time (s)
S(f) (m²/Hz)
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0.0 0.08 0.16 0.24 0.32 0.4 0.48 0.56 0.64
Frequency (Hz)
Full Record Wave Parameters
Hav = 1.525 m
Tav = 6.981 s
Best Wave Cycles Parameters
Target / (Tolerance)
Hav = 1.528 m 1.520 m
Tav = 6.981 s 6.980 s
Deviation from Target Hav = 0.5 % (4.0%)
Wave Height Stability = 1.3 %
Wave Crest Stability = 1.0 %
National Research Council Canada
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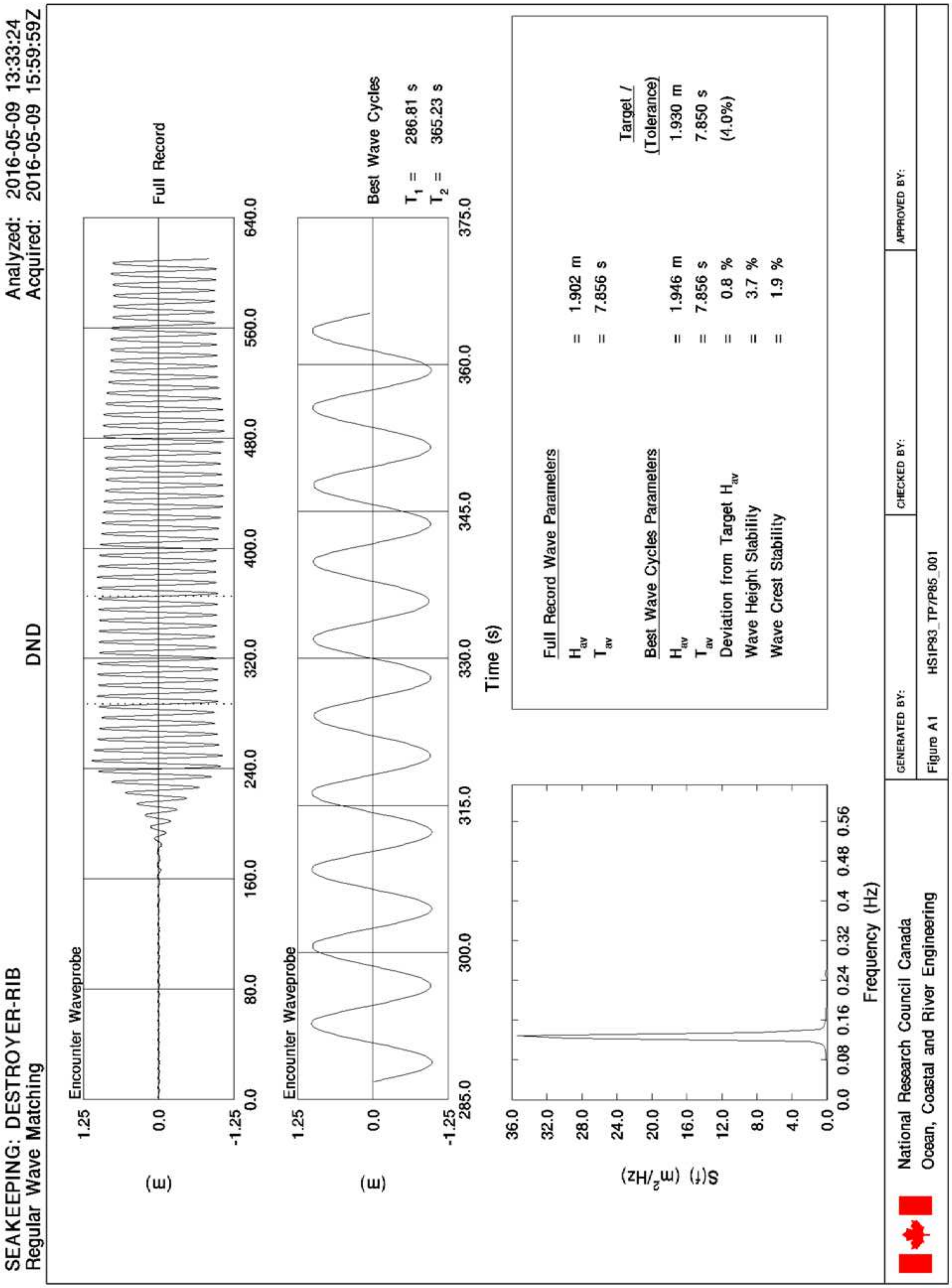
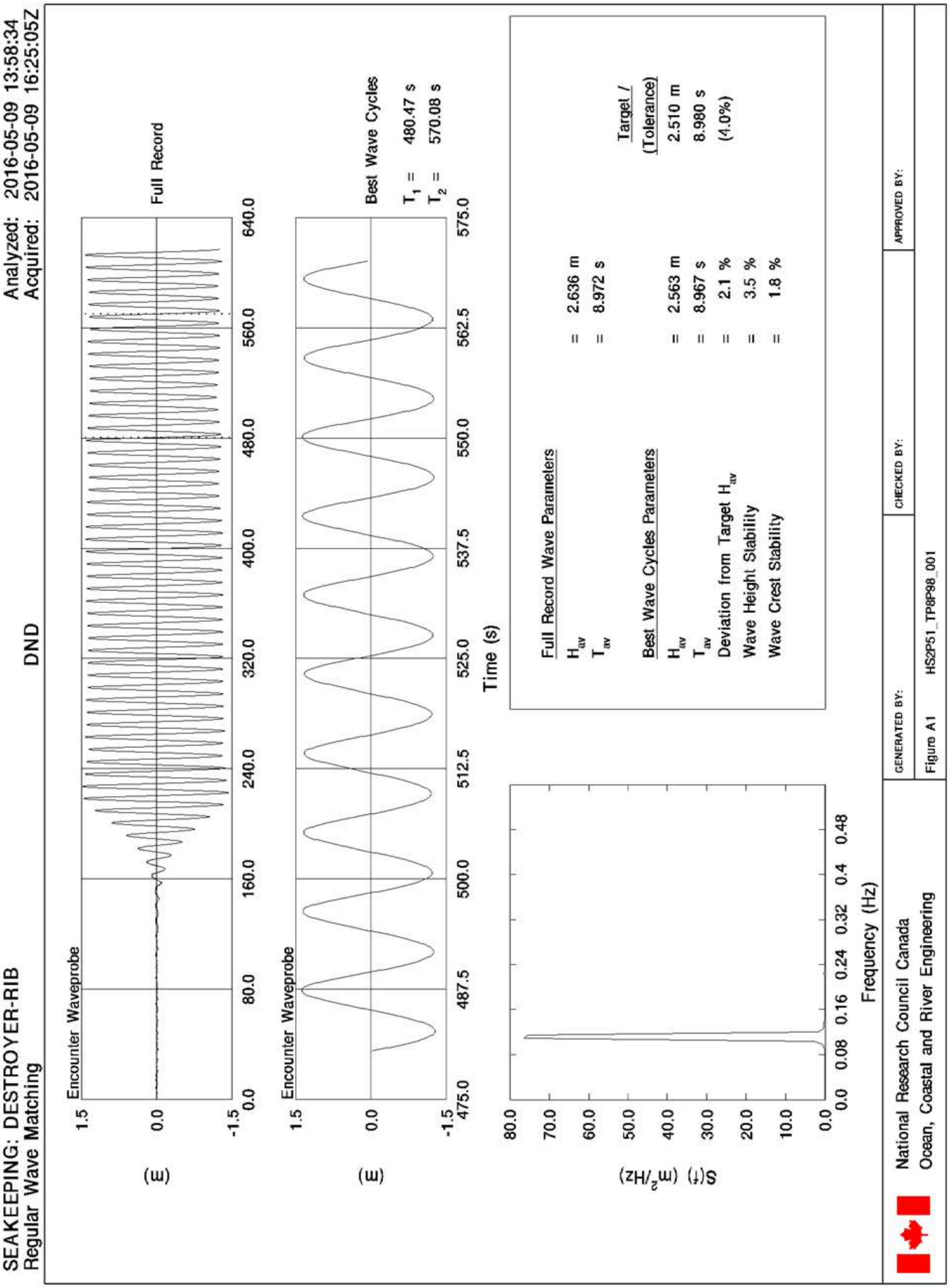
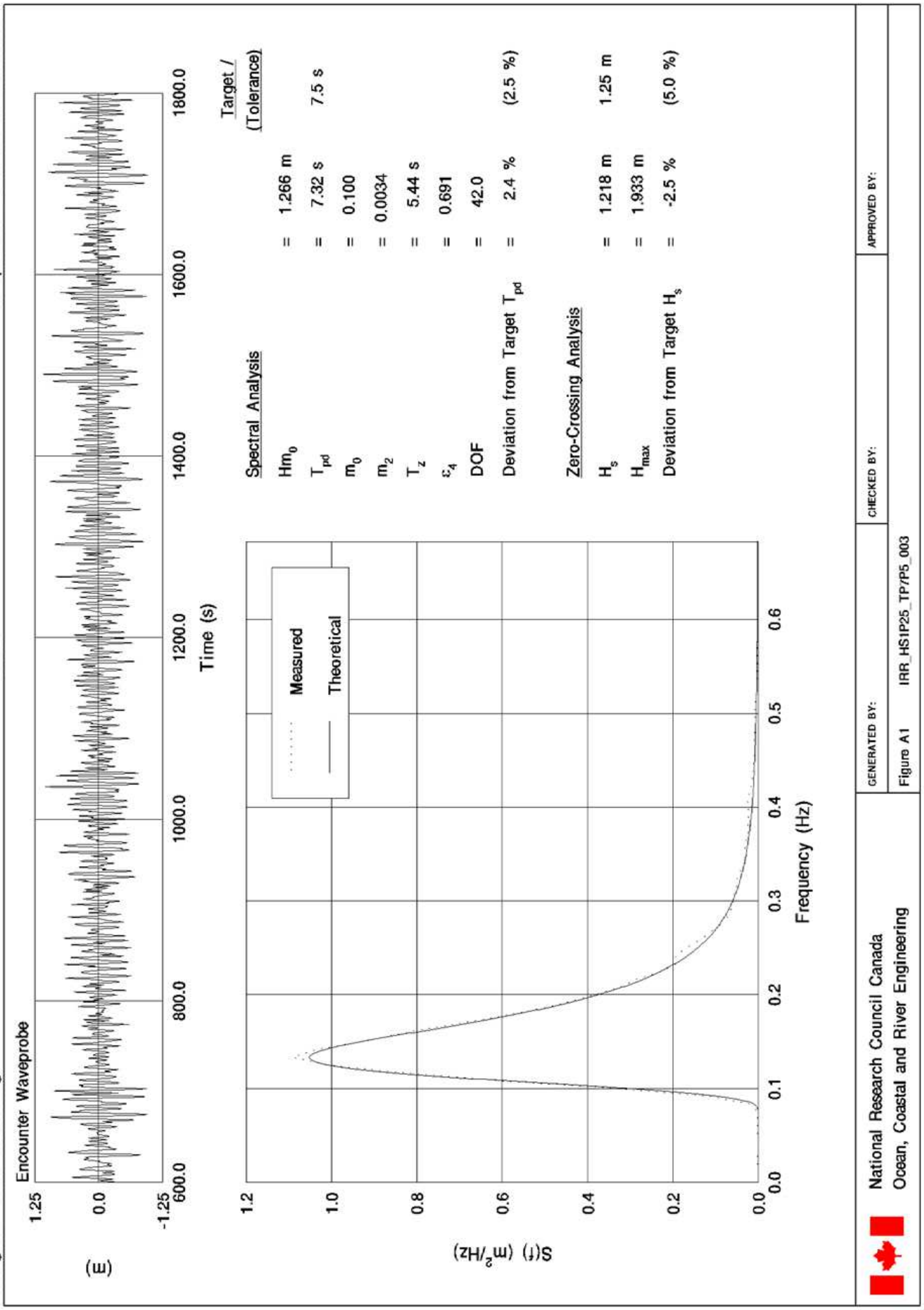
GENERATED BY:
CHECKED BY:
APPROVED BY:
Figure A1
HS1P52_TP6P98_001


SEAKEEPING: DESTROYER-RIB
Regular Wave Matching
DND
Analyzed: 2016-05-09 13:33:24
Acquired: 2016-05-09 15:59:59Z
Encounter Waveprobe
Full Record
Encounter Waveprobe
Best Wave Cycles
T1 = 286.81 s
T2 = 365.23 s
(m)
Time (s)
S(f) (m²/Hz)
Frequency (Hz)
Full Record Wave Parameters
Hav = 1.902 m
Tav = 7.856 s
Best Wave Cycles Parameters
Hav = 1.946 m
Tav = 7.856 s
Deviation from Target Hav = 0.8 %
Wave Height Stability = 3.7 %
Wave Crest Stability = 1.9 %
Target / (Tolerance)
1.930 m
7.850 s
(4.0%)
National Research Council Canada
Ocean, Coastal and River Engineering
GENERATED BY:
CHECKED BY:
APPROVED BY:
Figure A1
HS1P93_TP7P85_001


SEAKEEPING: DESTROYER-RIB
Regular Wave Matching
DND
Analyzed: 2016-05-09 13:58:34
Acquired: 2016-05-09 16:25:05Z
Encounter Waveprobe
Full Record
(m)
1.5
0.0
-1.5
0.0
80.0
160.0
240.0
320.0
400.0
480.0
560.0
640.0
Encounter Waveprobe
Best Wave Cycles
T_1 = 480.47 s
T_2 = 570.08 s
475.0
487.5
500.0
512.5
525.0
537.5
550.0
562.5
575.0
Time (s)
S(f) (m^2/Hz)
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.0 0.08 0.16 0.24 0.32 0.4 0.48
Frequency (Hz)
Full Record Wave Parameters
H_{av} = 2.636 m
T_{av} = 8.972 s
Best Wave Cycles Parameters
H_{av} = 2.563 m
T_{av} = 8.967 s
Deviation from Target H_{av} = 2.1 %
Wave Height Stability = 3.5 %
Wave Crest Stability = 1.8 %
Target / (Tolerance)
2.510 m
8.980 s
(4.0%)
National Research Council Canada
Ocean, Coastal and River Engineering
GENERATED BY:
Figure A1
HS2P51_TP8P98_001
CHECKED BY:
APPROVED BY:


SEAKEEPING: DESTROYER-RIB
Irregular Wave Matching
DND
Analyzed: 2016-05-09 15:16:57
Acquired: 2016-05-09 17:35:35Z
Encounter Waveprobe
(m)
1.25
0.0
-1.25
600.0
800.0
1000.0
1200.0
1400.0
1600.0
1800.0
Time (s)
S(f) (m²/Hz)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.1
0.2
0.3
0.4
0.5
0.6
Frequency (Hz)
Measured
Theoretical
Spectral Analysis
Hm0 = 1.266 m
Tpd = 7.32 s
m0 = 0.100
m2 = 0.0034
Tz = 5.44 s
ε4 = 0.691
DOF = 42.0
Deviation from Target Tpd = 2.4 %
Target / (Tolerance)
7.5 s
(2.5 %)
Zero-Crossing Analysis
Hs = 1.218 m
Hmax = 1.933 m
Deviation from Target Hs = -2.5 %
1.25 m
(5.0 %)
National Research Council Canada
Ocean, Coastal and River Engineering
GENERATED BY:
CHECKED BY:
APPROVED BY:
Figure A1
IRR_HS1P25_TP7P5_003

Appendix D

Analysis of decay experiments

Logarithmic decrement method of analysis

The decay analysis algorithm is based on the theory of vibration and computes viscous damping parameters using the logarithmic decrement method. Peaks and troughs data are input, and log decrements are computed as the natural logarithm of the ratio of two successive amplitudes. Both crest and trough roll amplitudes (φ_n, φ_{n+1}) are used in calculating log decrements (δ) to increase the computational accuracy - especially in cases where only a few decay cycles can be measured.

$$\delta = ln\frac{\varphi_n}{\varphi_{n+1}}$$

From log decrements, damping ratios (ζ) are calculated for all measured amplitudes.

$$\zeta = \frac{\delta}{\sqrt{4\pi^2 + \delta^2}} \approx \frac{\delta}{2\pi}$$

The damping envelope curve is expressed as $\varphi_1 \exp(-\zeta\omega t)$.

In viscous linear damping, the damping ratio is estimated as the average of damping ratios obtained from all consecutive log decrements in the time series. In non-linear viscous damping, the equivalent damping is found by equating the energy dissipated by the viscous damping to that of the non-viscous damping force. The damping ratio is modeled as

$$\zeta = B_1 + B_2 * \varphi$$

where B_1 = equivalent damping linear term
B_2 = equivalent damping quadratic term

The equivalent damping terms B_1 and B_2 are estimated as the intercept and the slope respectively of a linear regression line through the damping ratio versus roll amplitude values. The program uses the equivalent damping terms to compute and plot the equivalent damping envelope for the decay series.

Summary of results

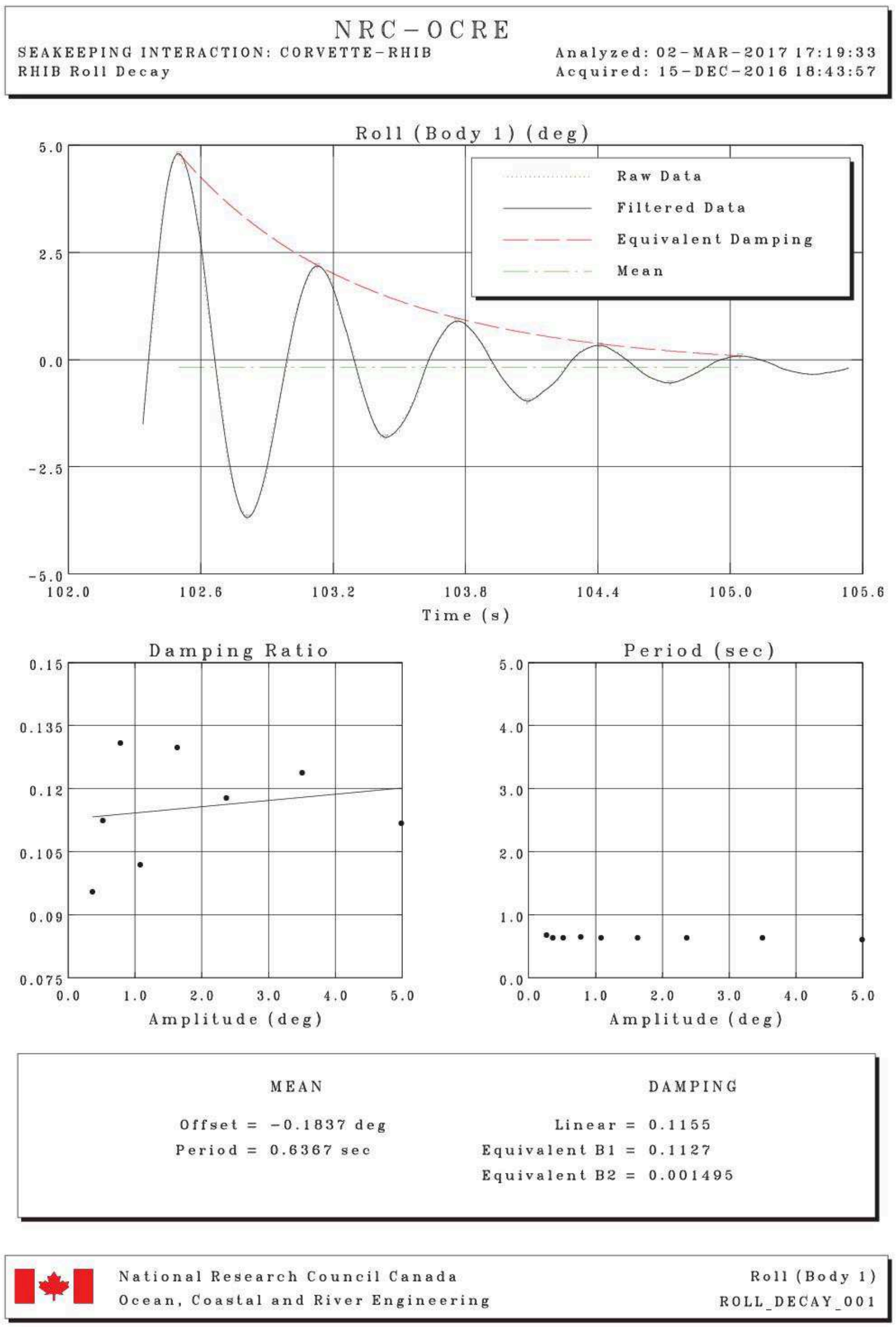
RHIB decay test results **(model scale)**

Test	Speed	Data Segment	Offset [deg]	Average Period [sec]	Linear Damping Coefficient	Equivalent Damping Slope B2	Equivalent Damping Offset B1
Roll_Decay_001	0 kt	1	-0.18	0.637	0.116	0.0015	0.113
		2	-0.19	0.641	0.118	0.0013	0.116
		3	-0.21	0.635	0.132	-0.0036	0.144
		4	-0.21	0.630	0.123	-0.0017	0.128
Pitch_Decay_001	0 kt	1	-0.18	0.754	0.212	0.0061	0.202
		2	-0.17	0.724	0.236	-0.0043	0.246
		3	-0.16	0.719	0.225	-0.0004	0.226
		4	-0.18	0.727	0.223	-0.0396	0.262

Corvette roll decay test results **(model scale)**

Test	Speed	Data Segment	Offset [deg]	Average Period [sec]	Linear Damping Coefficient	Equivalent Damping Slope B2	Equivalent Damping Offset B1
C_Roll_decay_001	0 kts	1	0.0573	2.293	0.04643	-0.02401	0.13313
		2	0.05668	2.230	0.04789	-0.00915	0.07497
		3	0.05	2.272	0.02433	-0.02223	0.11442

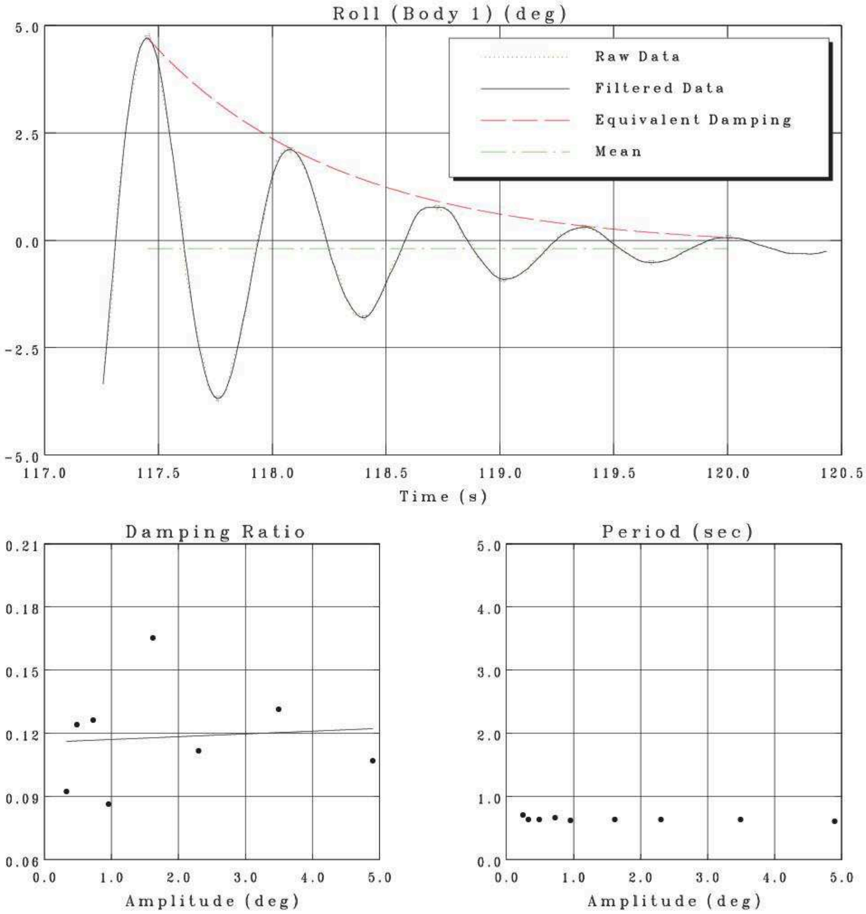
Decay experiments plots



NRC – OCRE

SEAKEEPING INTERACTION: CORVETTE–RHIB
RHIB Roll Decay

Analyzed: 02–MAR–2017 17:20:23
Acquired: 15–DEC–2016 18:43:57



MEAN	DAMPING
Offset = –0.1881 deg	Linear = 0.1181
Period = 0.6408 sec	Equivalent B1 = 0.1156
	Equivalent B2 = 0.001318

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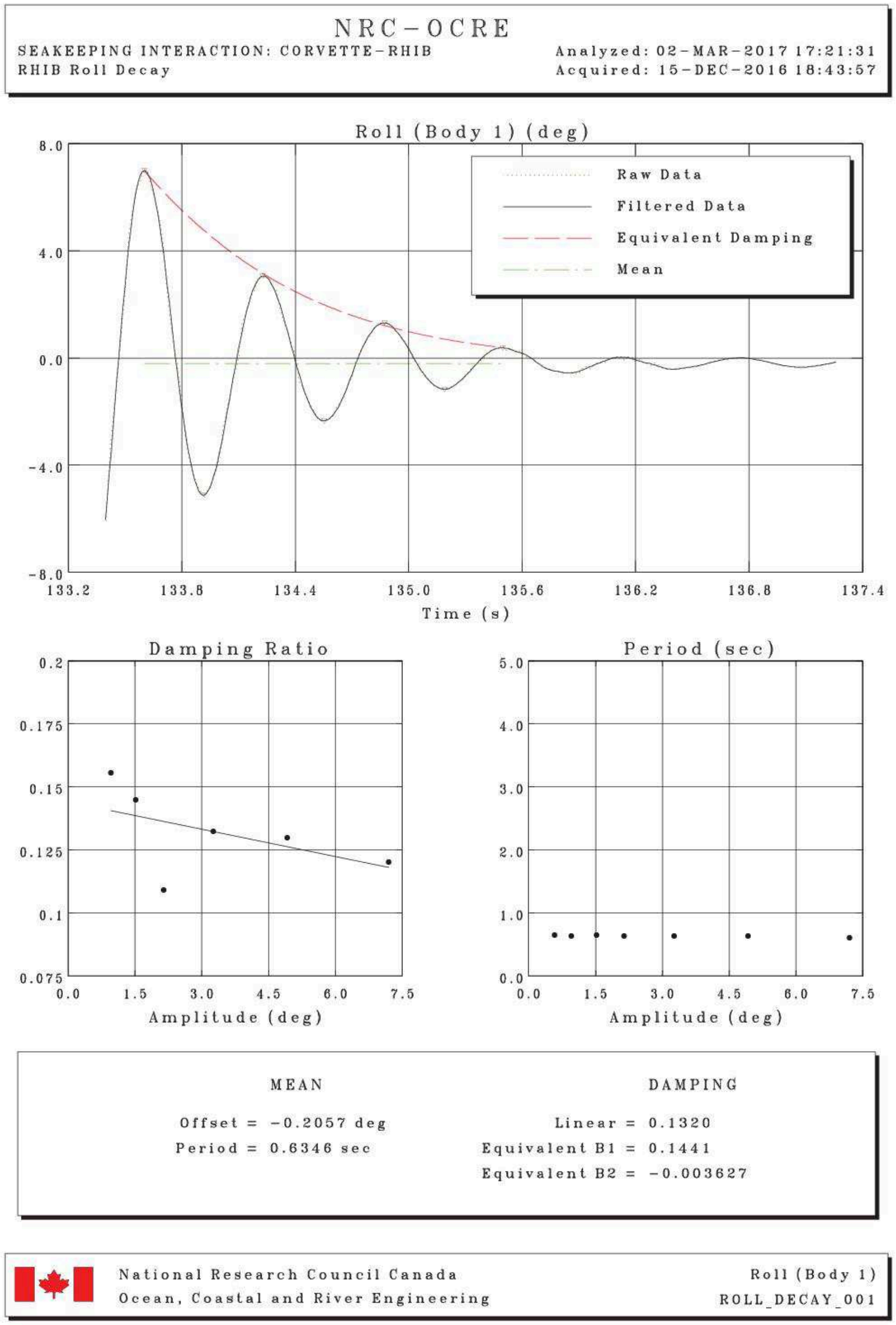
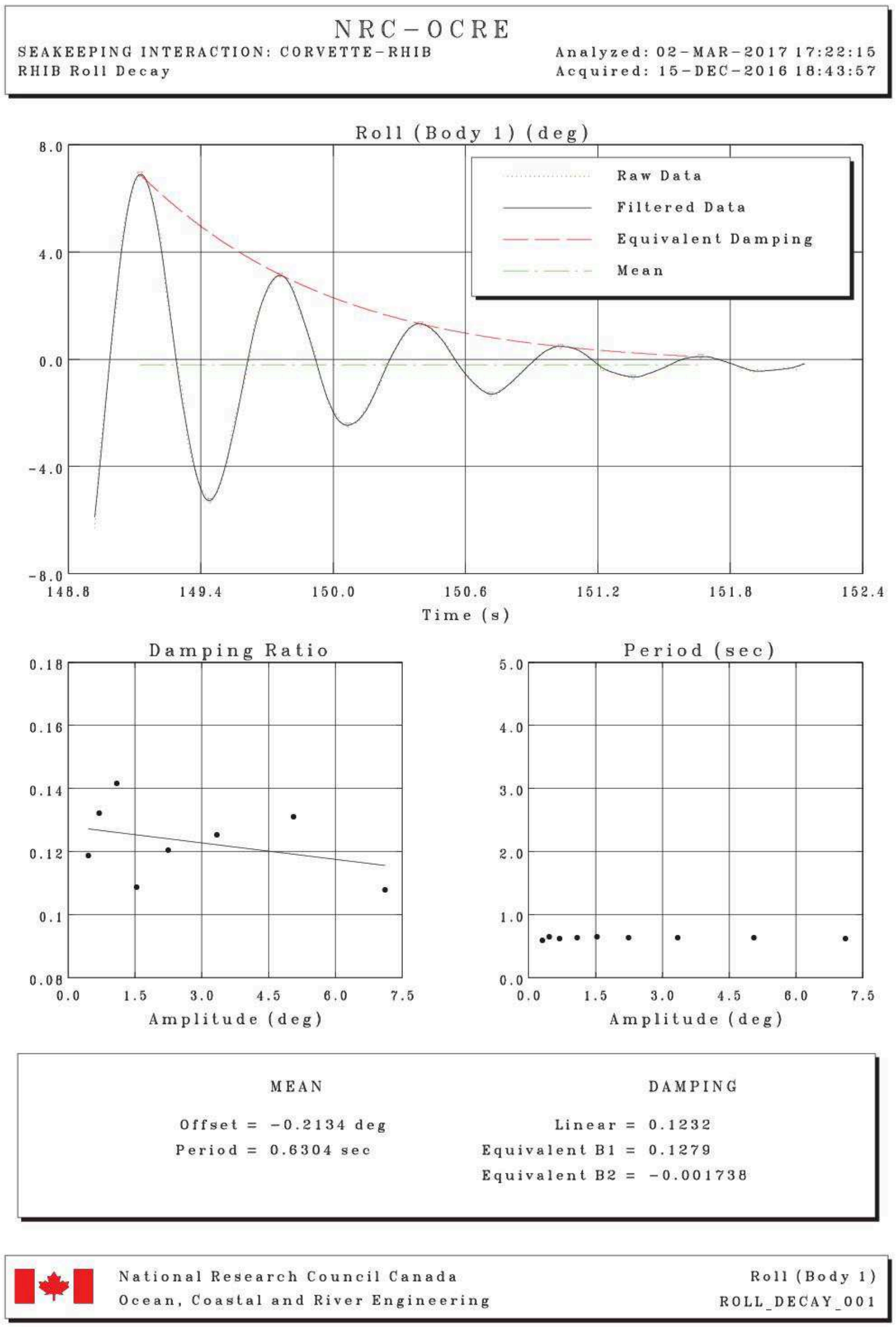
Roll (Body 1)
ROLL_DECAY_001

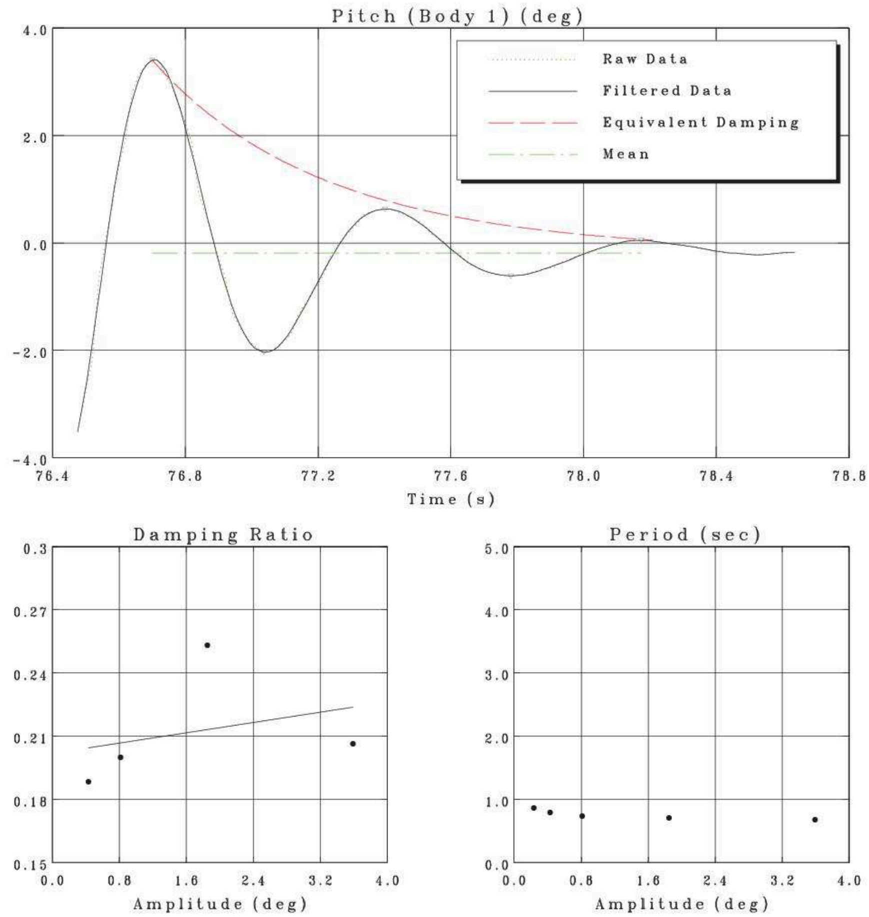

NRC – OCRE
SEAKEEPING INTERACTION: CORVETTE–RHIB
RHIB Roll Decay
Analyzed: 02–MAR–2017 17:21:31
Acquired: 15–DEC–2016 18:43:57
Roll (Body 1) (deg)
Raw Data
Filtered Data
Equivalent Damping
Mean
8.0
4.0
0.0
-4.0
-8.0
133.2
133.8
134.4
135.0
135.6
136.2
136.8
137.4
Time (s)
Damping Ratio
0.2
0.175
0.15
0.125
0.1
0.075
0.0
1.5
3.0
4.5
6.0
7.5
Amplitude (deg)
Period (sec)
5.0
4.0
3.0
2.0
1.0
0.0
0.0
1.5
3.0
4.5
6.0
7.5
Amplitude (deg)
MEAN
Offset = -0.2057 deg
Period = 0.6346 sec
DAMPING
Linear = 0.1320
Equivalent B1 = 0.1441
Equivalent B2 = -0.003627
National Research Council Canada
Ocean, Coastal and River Engineering
Roll (Body 1)
ROLL_DECAY_001


NRC-OCRE
SEAKEEPING INTERACTION: CORVETTE-RHIB
RHIB Roll Decay
Analyzed: 02-MAR-2017 17:22:15
Acquired: 15-DEC-2016 18:43:57
Roll (Body 1) (deg)
Raw Data
Filtered Data
Equivalent Damping
Mean
8.0
4.0
0.0
-4.0
-8.0
148.8
149.4
150.0
150.6
151.2
151.8
152.4
Time (s)
Damping Ratio
0.18
0.16
0.14
0.12
0.1
0.08
0.0
1.5
3.0
4.5
6.0
7.5
Amplitude (deg)
Period (sec)
5.0
4.0
3.0
2.0
1.0
0.0
0.0
1.5
3.0
4.5
6.0
7.5
Amplitude (deg)
MEAN
Offset = -0.2134 deg
Period = 0.6304 sec
DAMPING
Linear = 0.1232
Equivalent B1 = 0.1279
Equivalent B2 = -0.001738
National Research Council Canada
Ocean, Coastal and River Engineering
Roll (Body 1)
ROLL_DECAY_001

NRC – OCRE

SEAKEEPING INTERACTION: CORVETTE–RHIB
RHIB Pitch Decay

Analyzed: 02–MAR–2017 16:49:36
Acquired: 15–DEC–2016 18:46:25



MEAN		DAMPING	
Offset =	−0.1847 deg	Linear =	0.2120
Period =	0.7536 sec	Equivalent B1 =	0.2018
		Equivalent B2 =	0.006066

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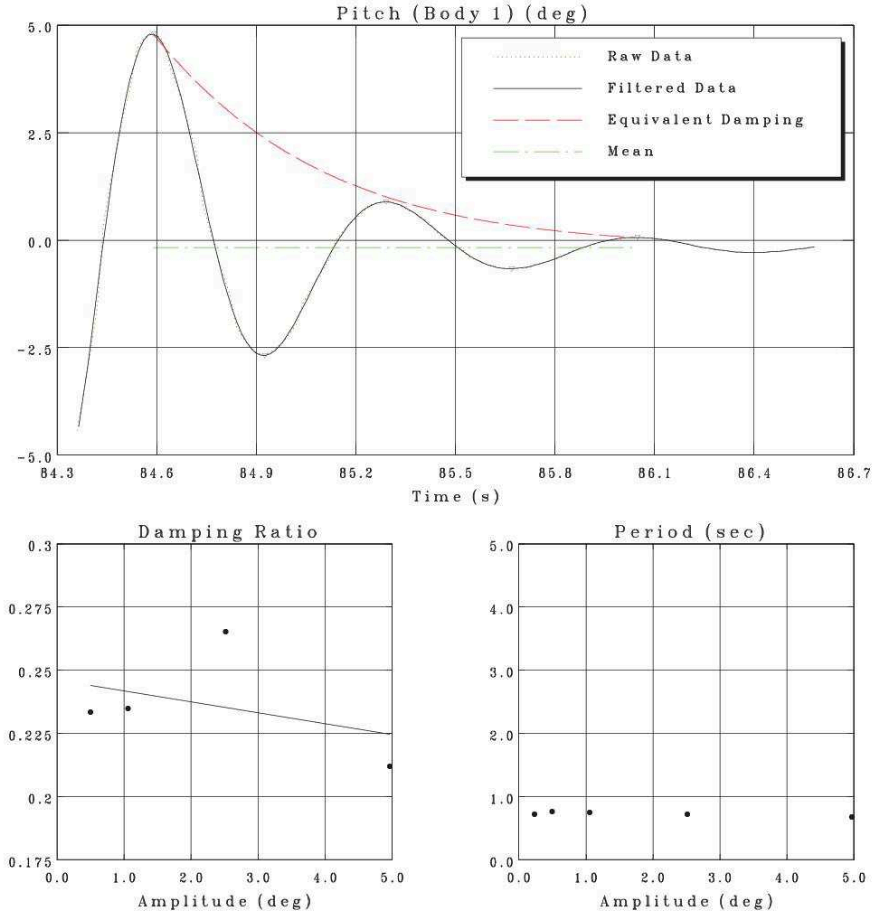
Ocean, Coastal and River Engineering

Pitch (Body 1)
PITCH_DECAY_001

NRC−OCRE

SEAKEEPING INTERACTION: CORVETTE−RHIB
RHIB Pitch Decay

Analyzed: 02−MAR−2017 17:15:17
Acquired: 15−DEC−2016 18:46:25



MEAN	DAMPING
Offset = −0.1711 deg	Linear = 0.2363
Period = 0.7243 sec	Equivalent B1 = 0.2461
	Equivalent B2 = −0.004325

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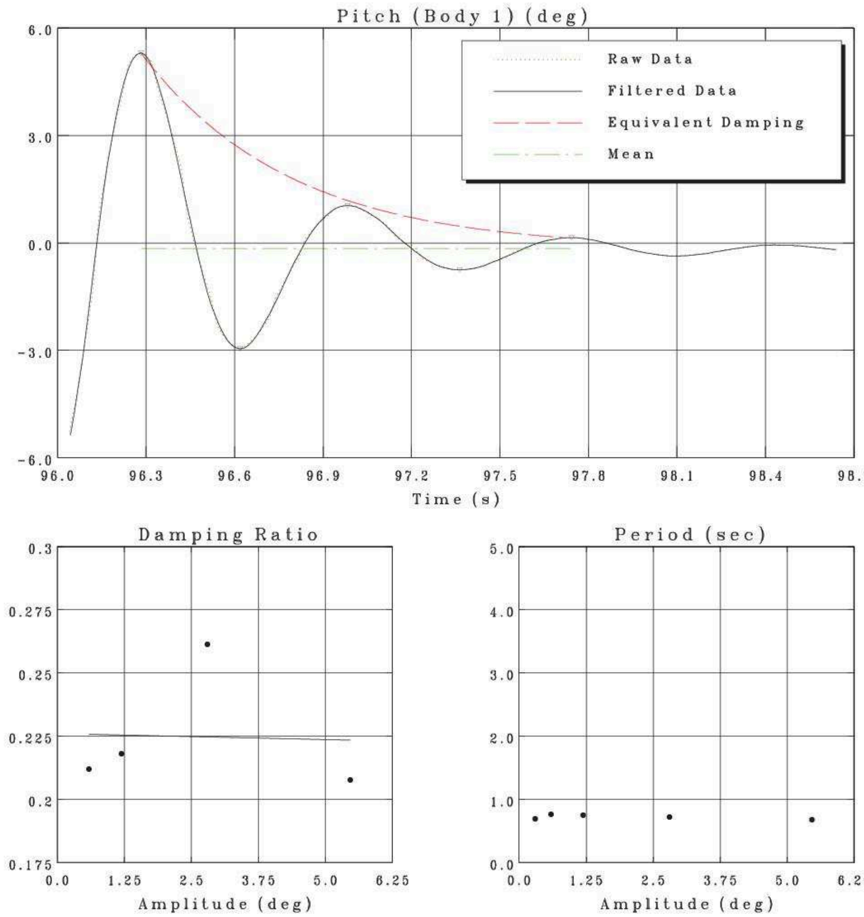
Pitch (Body 1)
PITCH_DECAY_001

NRC–OCRE

SEAKEEPING INTERACTION: CORVETTE–RHIB
RHIB Pitch Decay

Analyzed: 02–MAR–2017 17:16:04
Acquired: 15–DEC–2016 18:46:25



MEAN	DAMPING
Offset = –0.1562 deg	Linear = 0.2247
Period = 0.7188 sec	Equivalent B1 = 0.2259
	Equivalent B2 = –0.0004441

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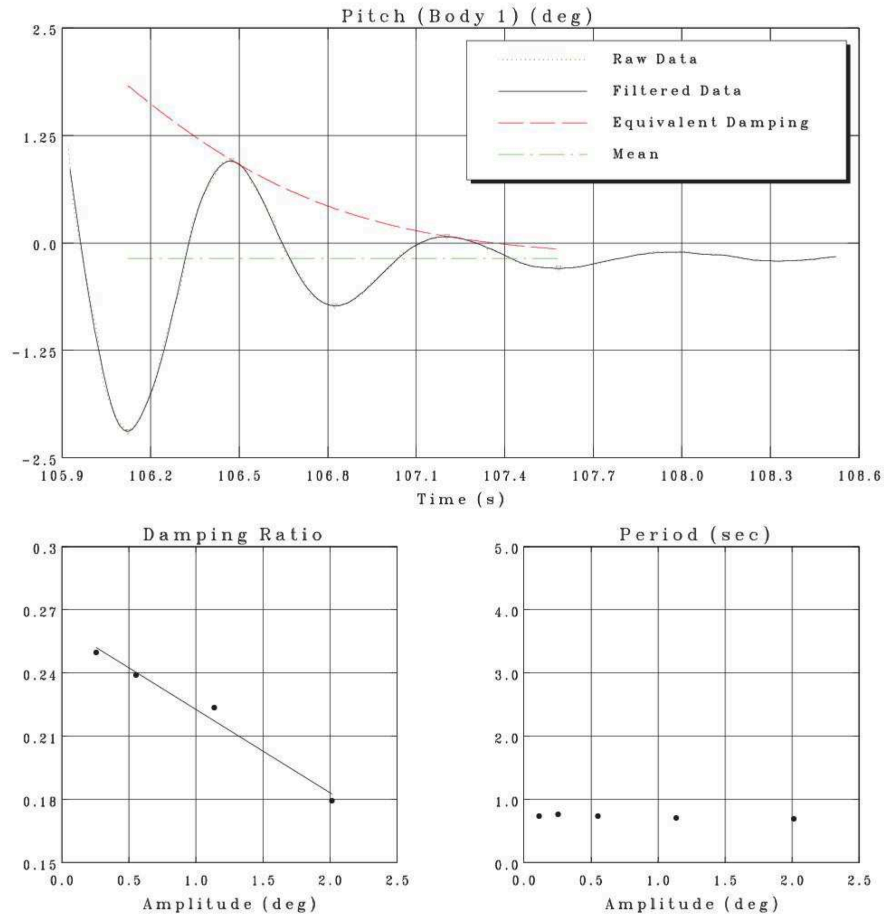
Ocean, Coastal and River Engineering

Pitch (Body 1)
PITCH_DECAY_001

NRC−OCRE

SEAKEEPING INTERACTION: CORVETTE−RHIB
RHIB Pitch Decay

Analyzed: 02−MAR−2017 17:17:01
Acquired: 15−DEC−2016 18:46:25



MEAN	DAMPING
Offset = −0.1824 deg	Linear = 0.2230
Period = 0.7269 sec	Equivalent B1 = 0.2622
	Equivalent B2 = −0.03964

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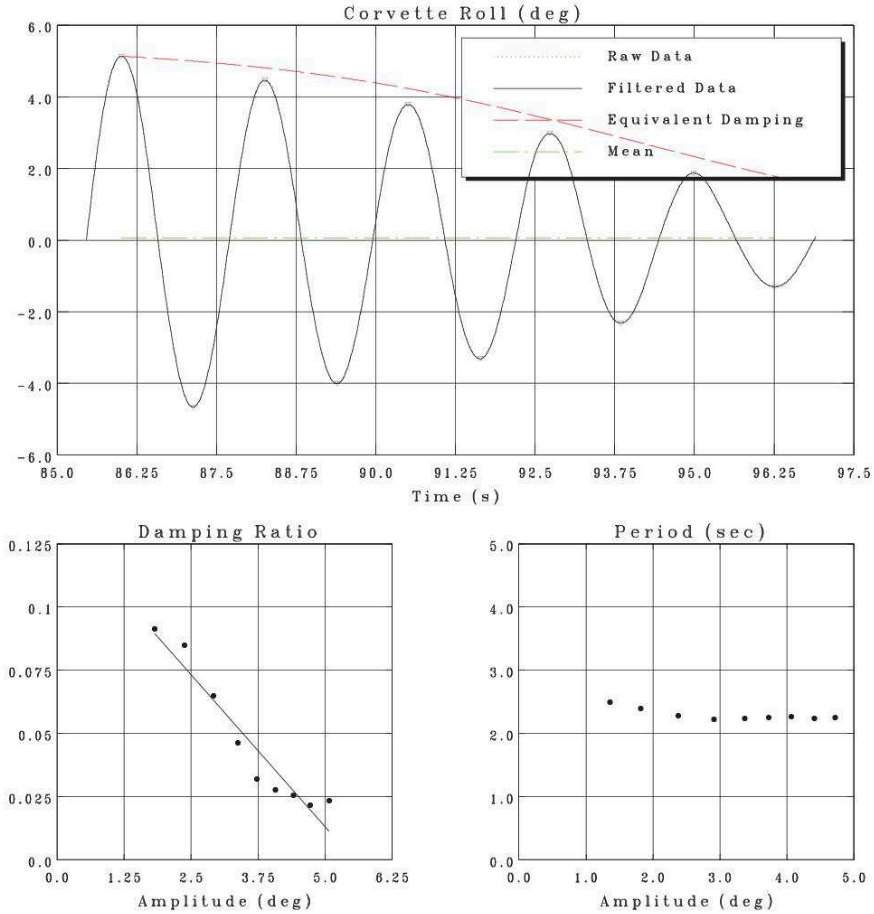
Pitch (Body 1)
PITCH_DECAY_001

NRC – OCRE

SEAKEEPING INTERACTION: CORVETTE-RHIB
Corvette Roll Decay

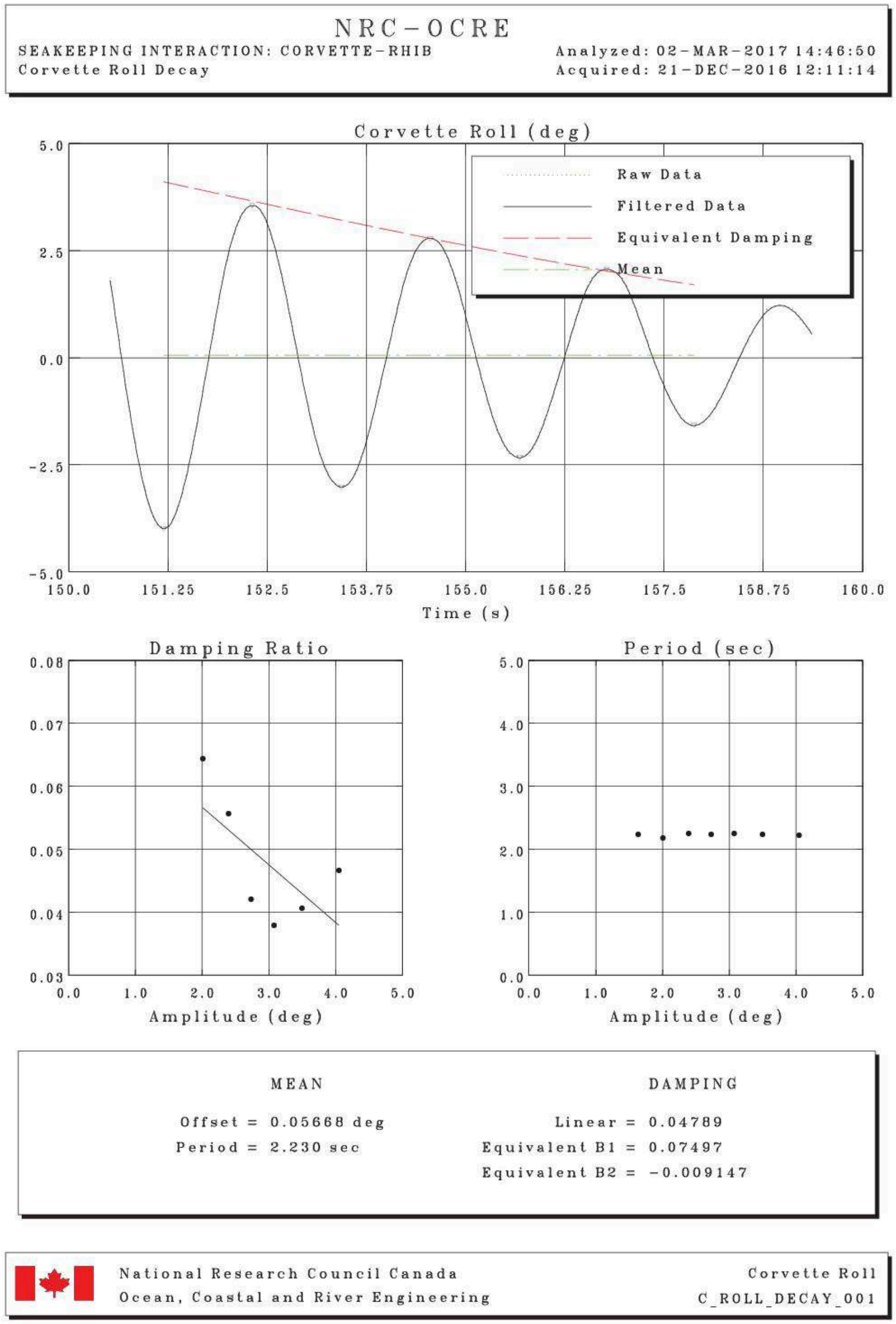
Analyzed: 02-MAR-2017 14:42:40
Acquired: 21-DEC-2016 12:11:14

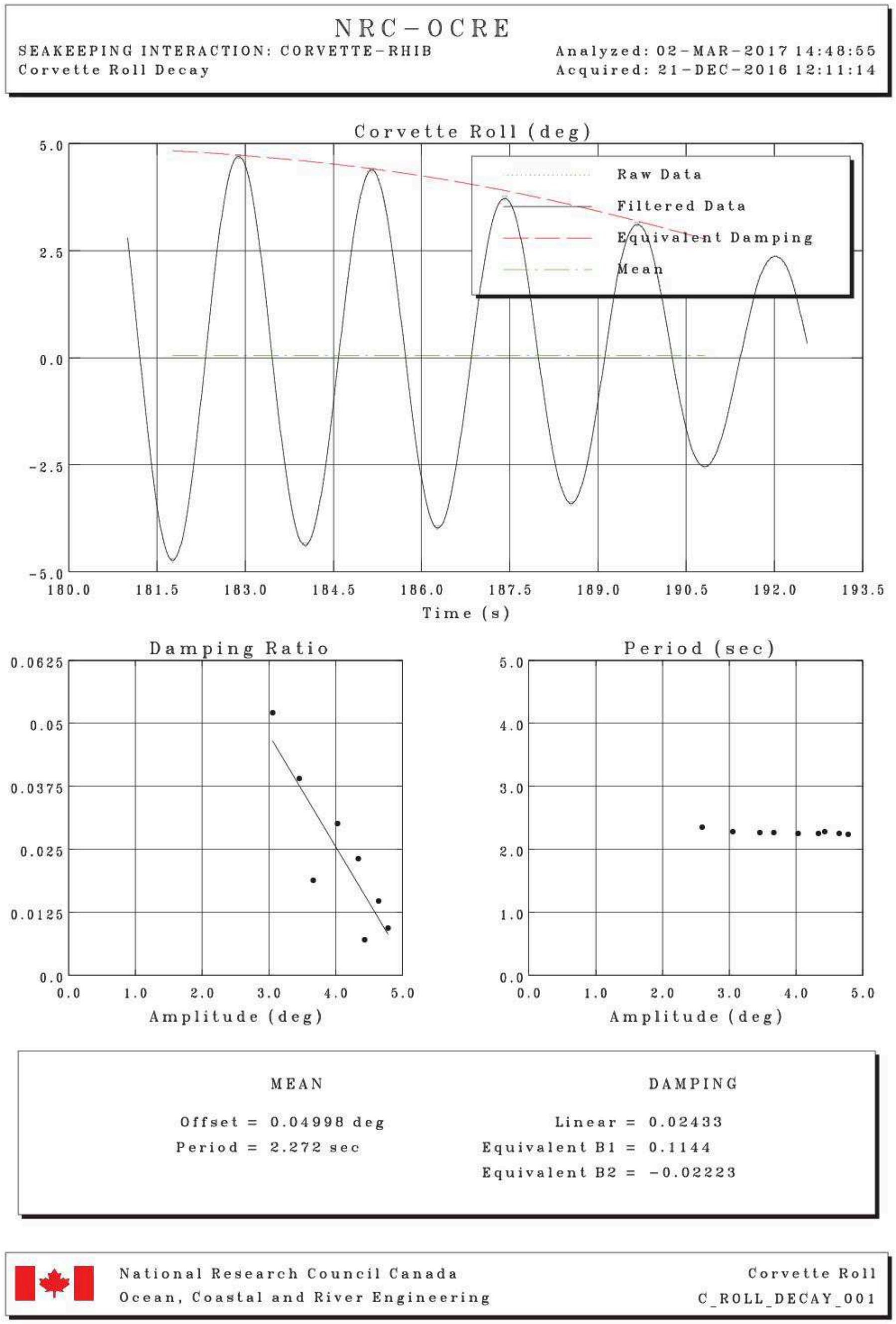


MEAN	DAMPING
Offset = 0.05728 deg	Linear = 0.04643
Period = 2.293 sec	Equivalent B1 = 0.1331
	Equivalent B2 = -0.02401

National Research Council Canada
Ocean, Coastal and River Engineering

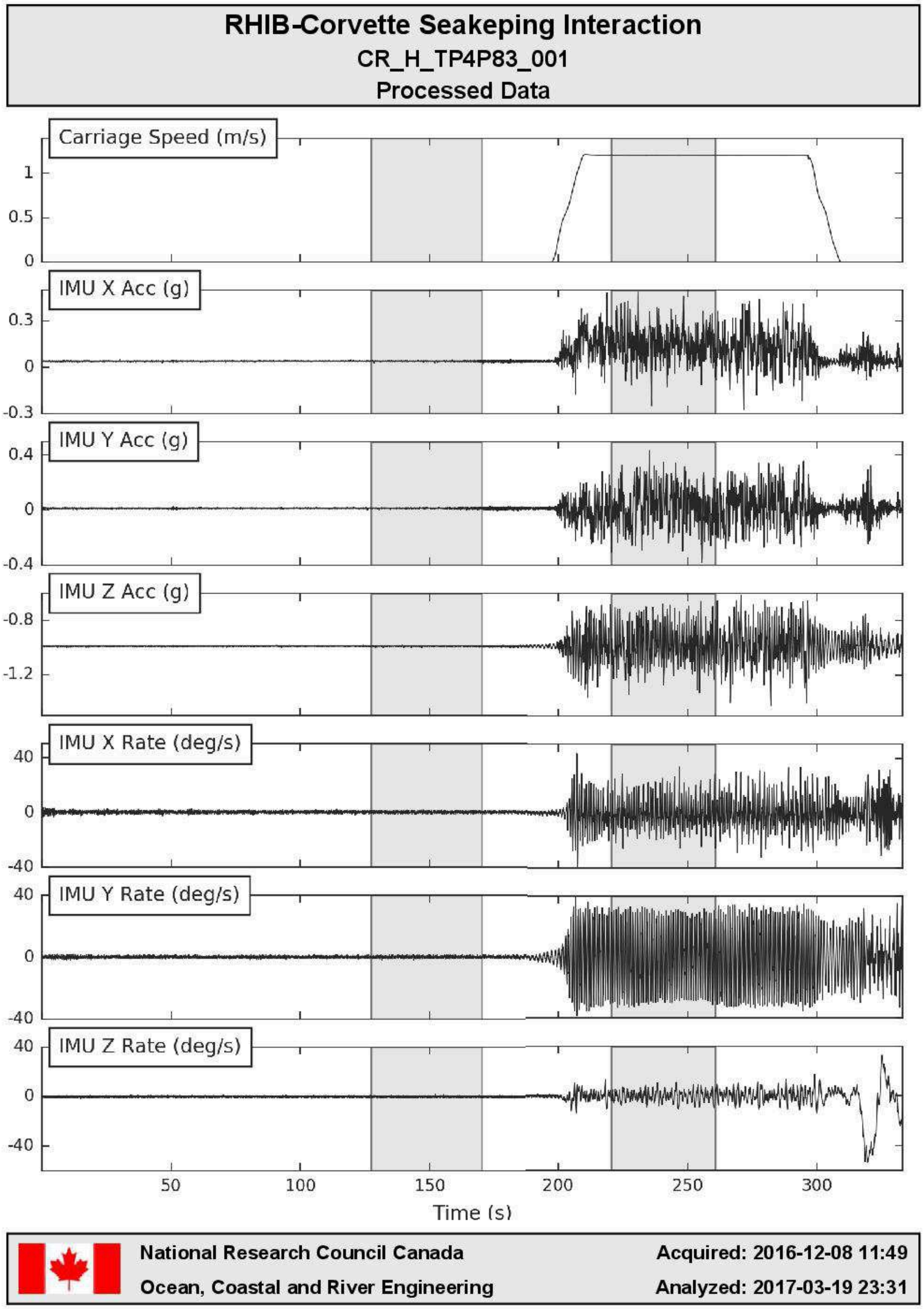
Corvette Roll
C_ROLL_DECAY_001


NRC – OCRE
SEAKEEPING INTERACTION: CORVETTE–RHIB
Corvette Roll Decay
Analyzed: 02–MAR–2017 14:46:50
Acquired: 21–DEC–2016 12:11:14
Corvette Roll (deg)
Raw Data
Filtered Data
Equivalent Damping
Mean
5.0
2.5
0.0
-2.5
-5.0
150.0
151.25
152.5
153.75
155.0
156.25
157.5
158.75
160.0
Time (s)
Damping Ratio
0.08
0.07
0.06
0.05
0.04
0.03
0.0
1.0
2.0
3.0
4.0
5.0
Amplitude (deg)
Period (sec)
5.0
4.0
3.0
2.0
1.0
0.0
0.0
1.0
2.0
3.0
4.0
5.0
Amplitude (deg)
MEAN
Offset = 0.05668 deg
Period = 2.230 sec
DAMPING
Linear = 0.04789
Equivalent B1 = 0.07497
Equivalent B2 = –0.009147
National Research Council Canada
Ocean, Coastal and River Engineering
Corvette Roll
C_ROLL_DECAY_001

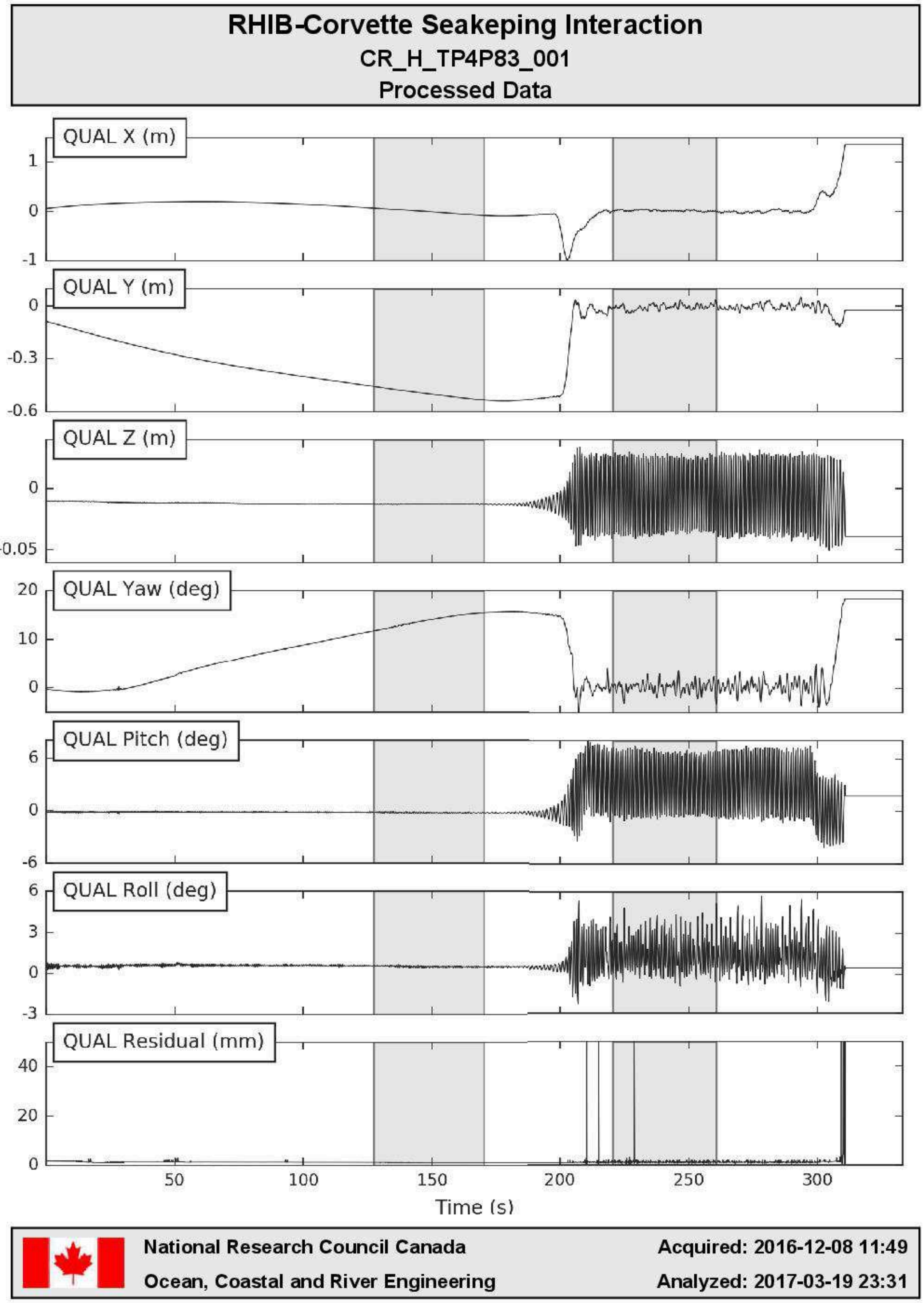

NRC−OCRE
SEAKEEPING INTERACTION: CORVETTE−RHIB
Corvette Roll Decay
Analyzed: 02−MAR−2017 14:48:55
Acquired: 21−DEC−2016 12:11:14
Corvette Roll (deg)
Raw Data
Filtered Data
Equivalent Damping
Mean
Time (s)
Damping Ratio
Period (sec)
Amplitude (deg)
Amplitude (deg)
MEAN
Offset = 0.04998 deg
Period = 2.272 sec
DAMPING
Linear = 0.02433
Equivalent B1 = 0.1144
Equivalent B2 = −0.02223
National Research Council Canada
Ocean, Coastal and River Engineering
Corvette Roll
C_ROLL_DECAY_001

Appendix E

Examples of time series plots

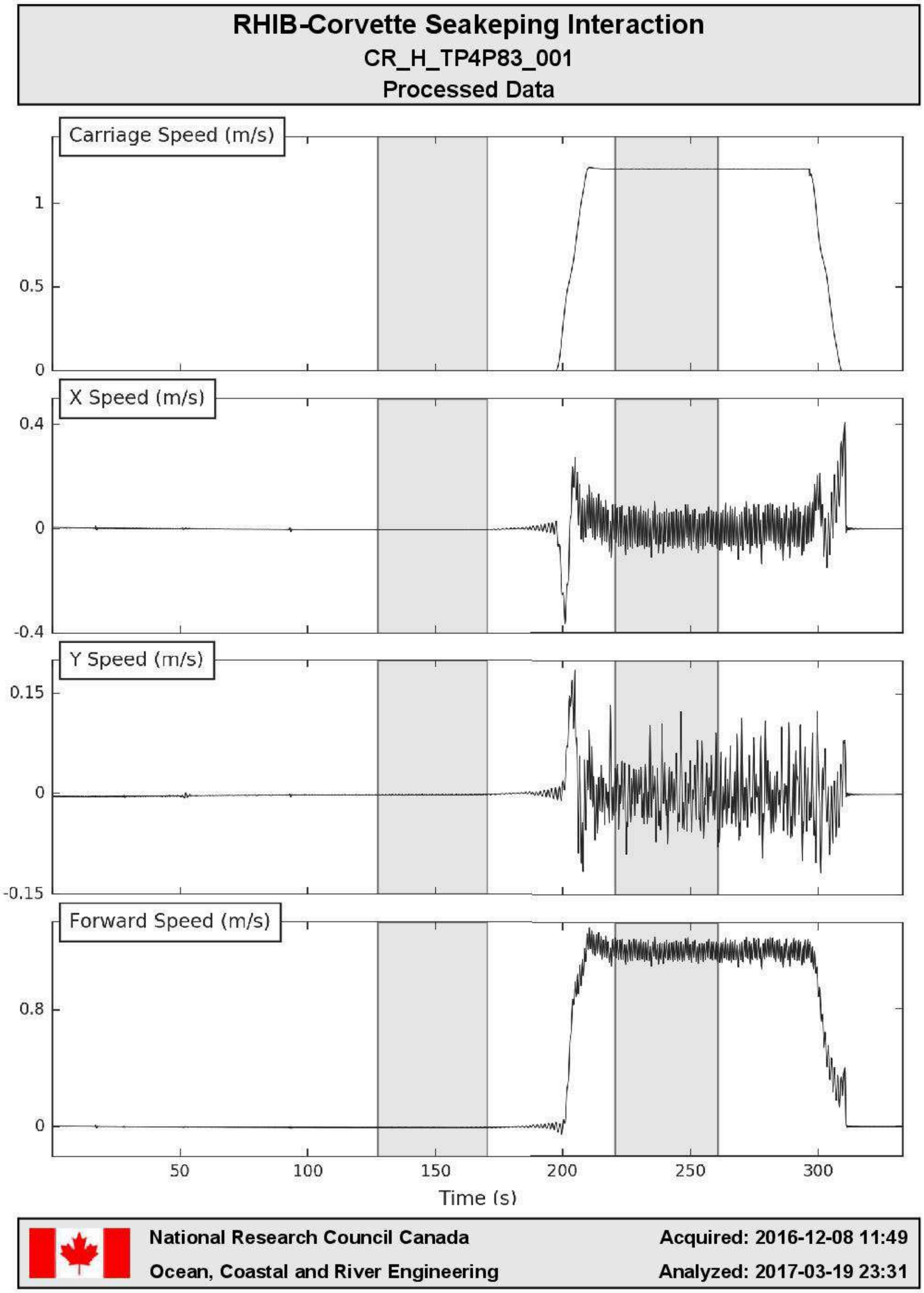

RHIB-Corvette Seakeping Interaction
CR_H_TP4P83_001
Processed Data
Carriage Speed (m/s)
IMU X Acc (g)
IMU Y Acc (g)
IMU Z Acc (g)
IMU X Rate (deg/s)
IMU Y Rate (deg/s)
IMU Z Rate (deg/s)
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-08 11:49
Analyzed: 2017-03-19 23:31

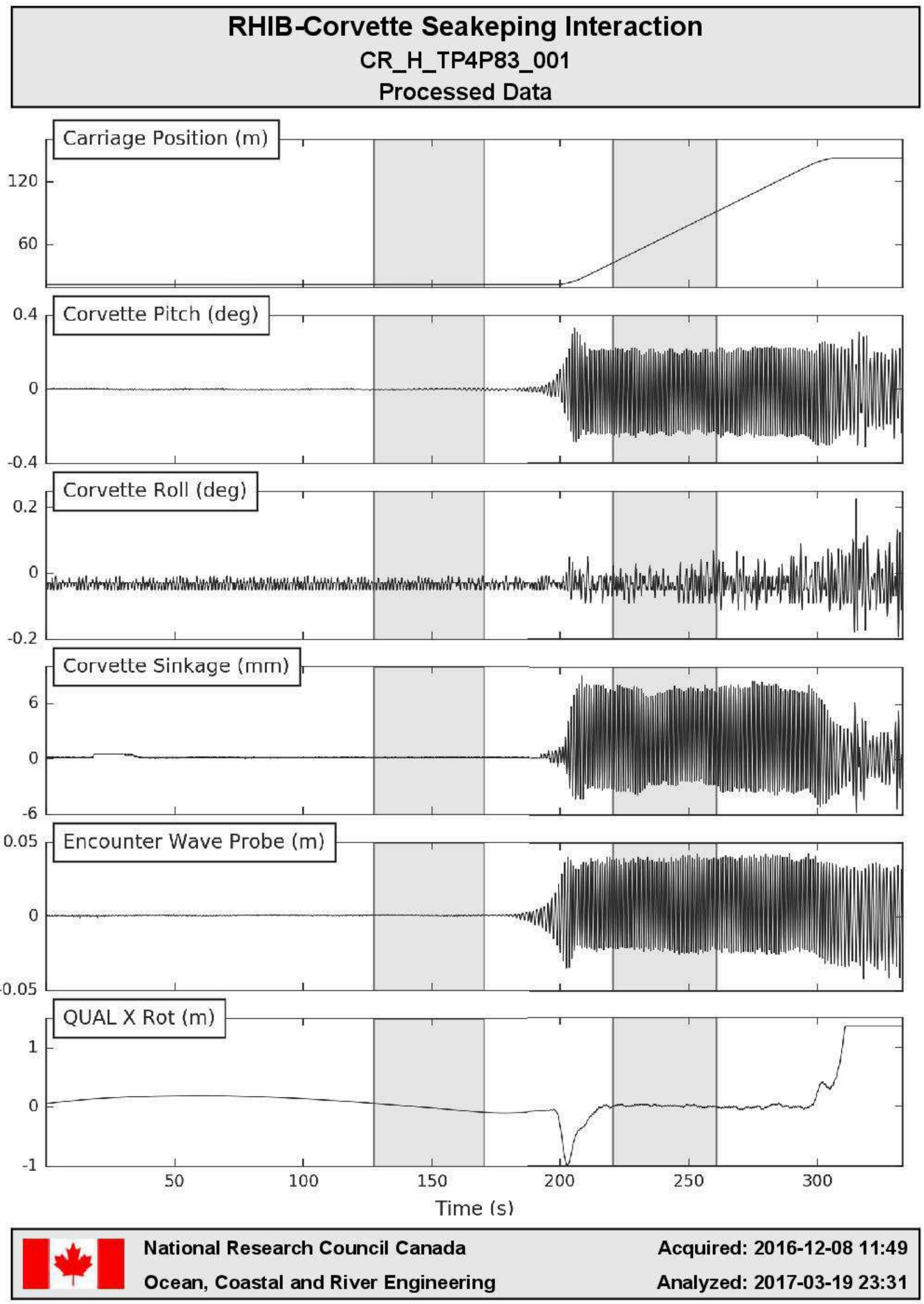
1

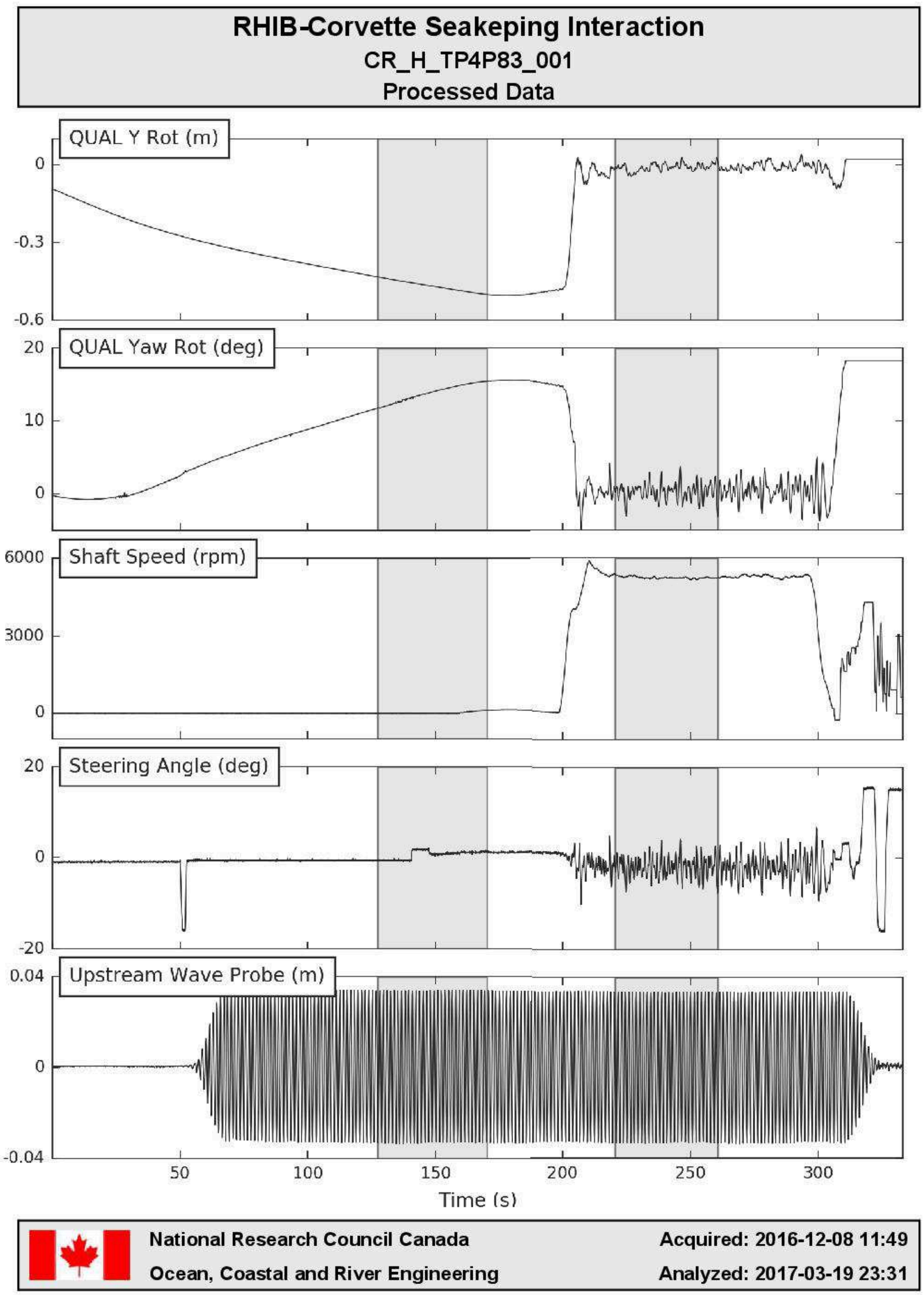


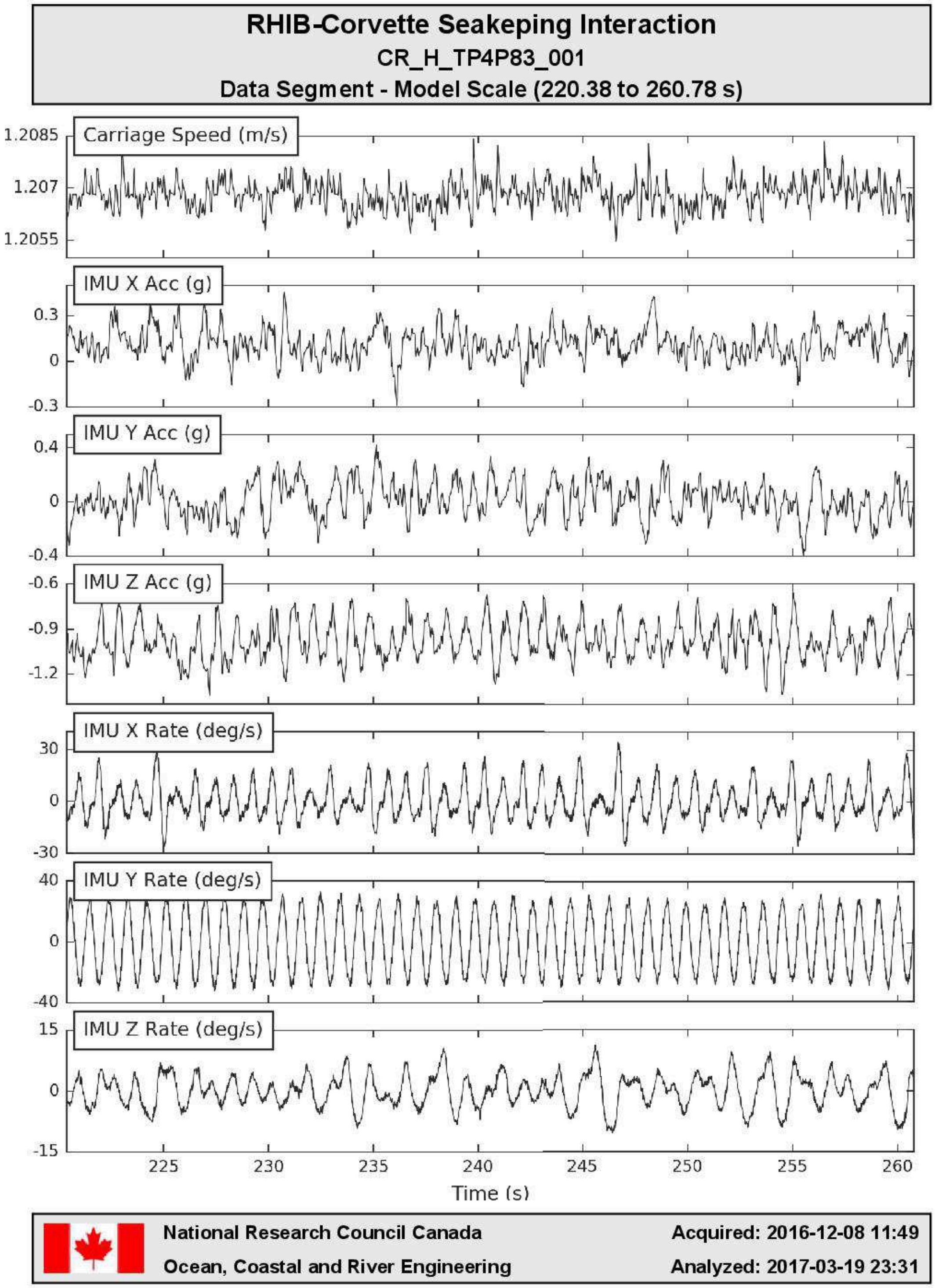
RHIB-Corvette Seakeping Interaction
CR_H_TP4P83_001
Processed Data
QUAL X (m)
QUAL Y (m)
QUAL Z (m)
QUAL Yaw (deg)
QUAL Pitch (deg)
QUAL Roll (deg)
QUAL Residual (mm)
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-08 11:49
Analyzed: 2017-03-19 23:31

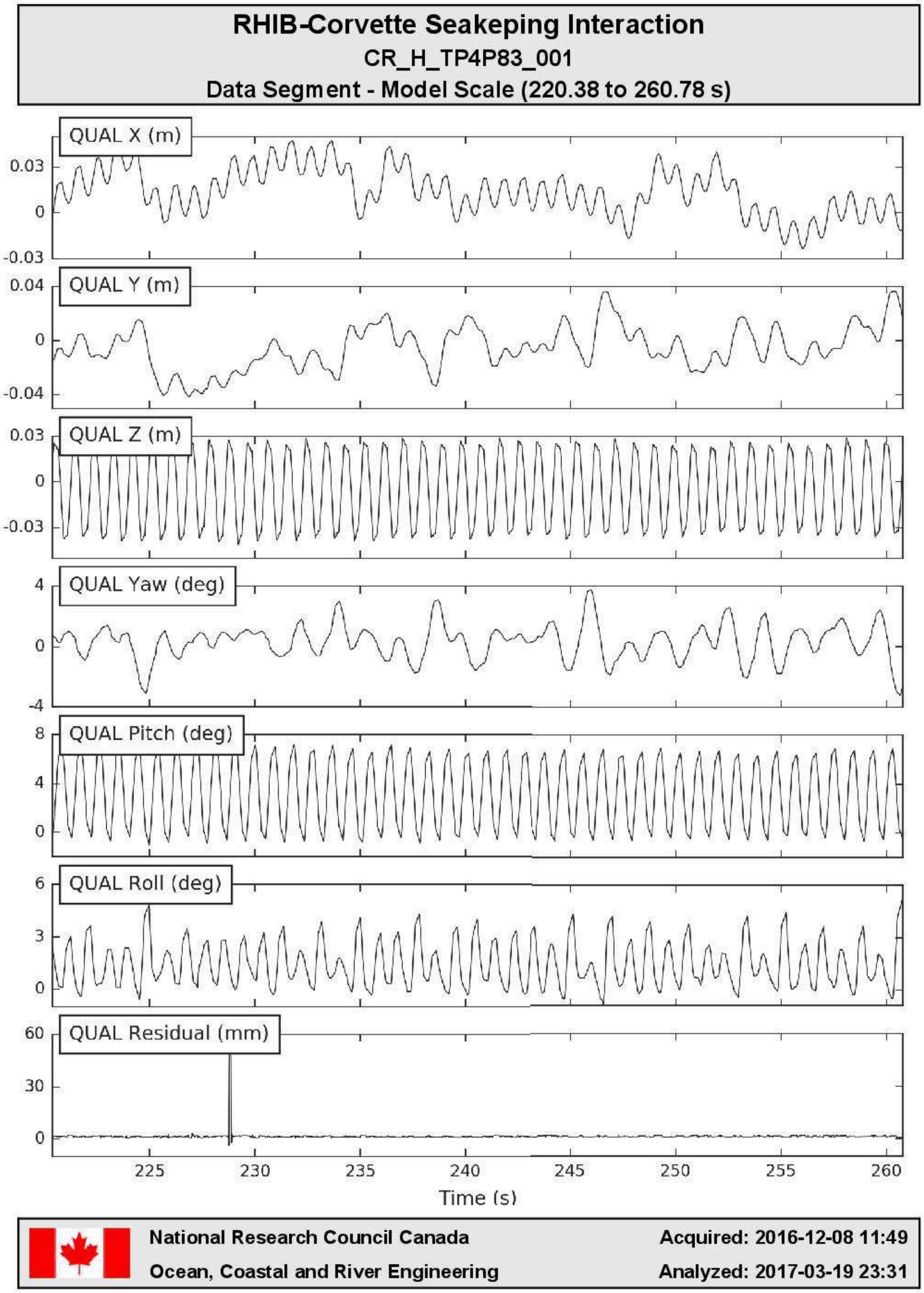
2

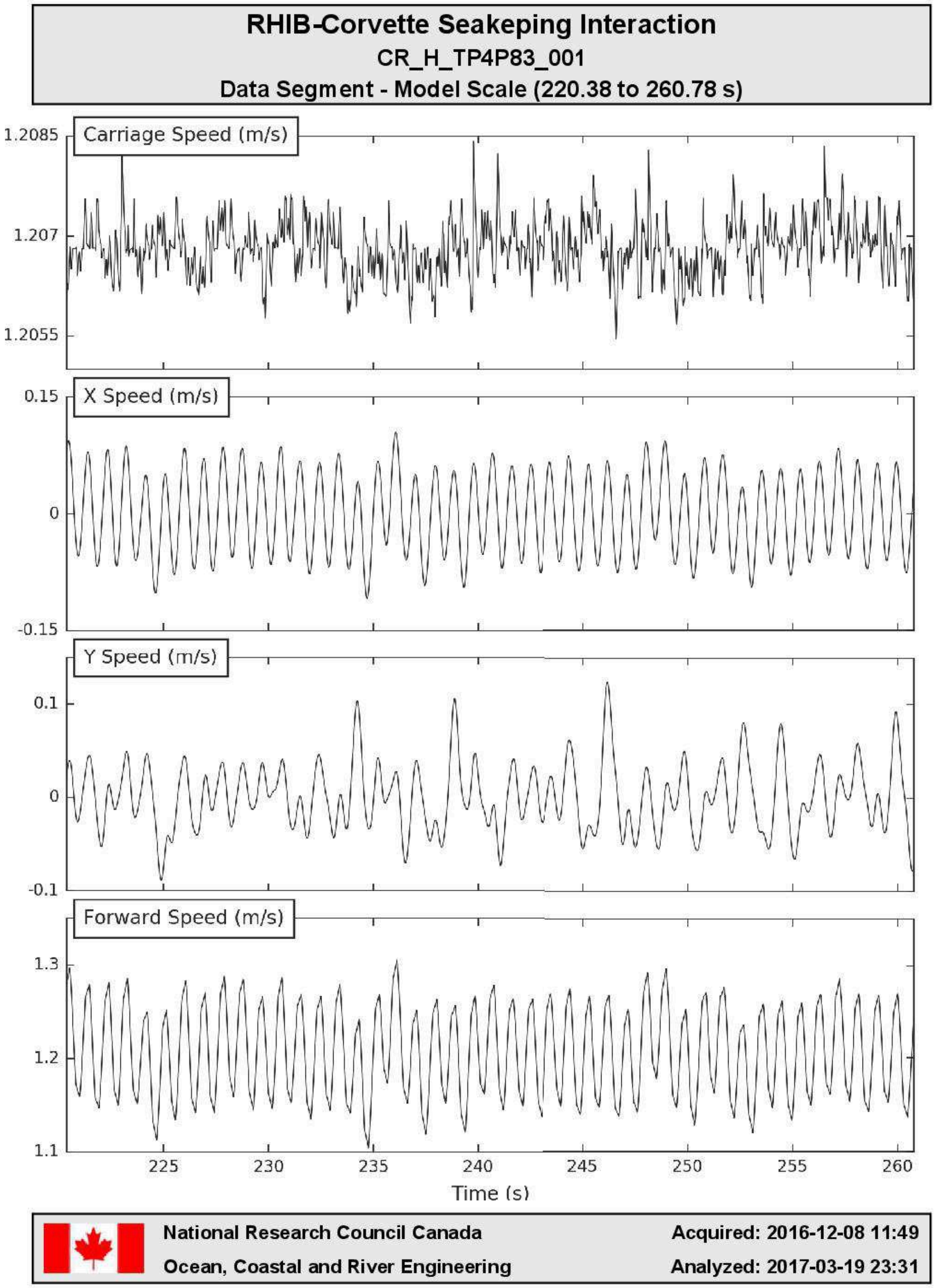

RHIB-Corvette Seakeping Interaction
CR_H_TP4P83_001
Processed Data
Carriage Speed (m/s)
X Speed (m/s)
Y Speed (m/s)
Forward Speed (m/s)
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-08 11:49
Analyzed: 2017-03-19 23:31

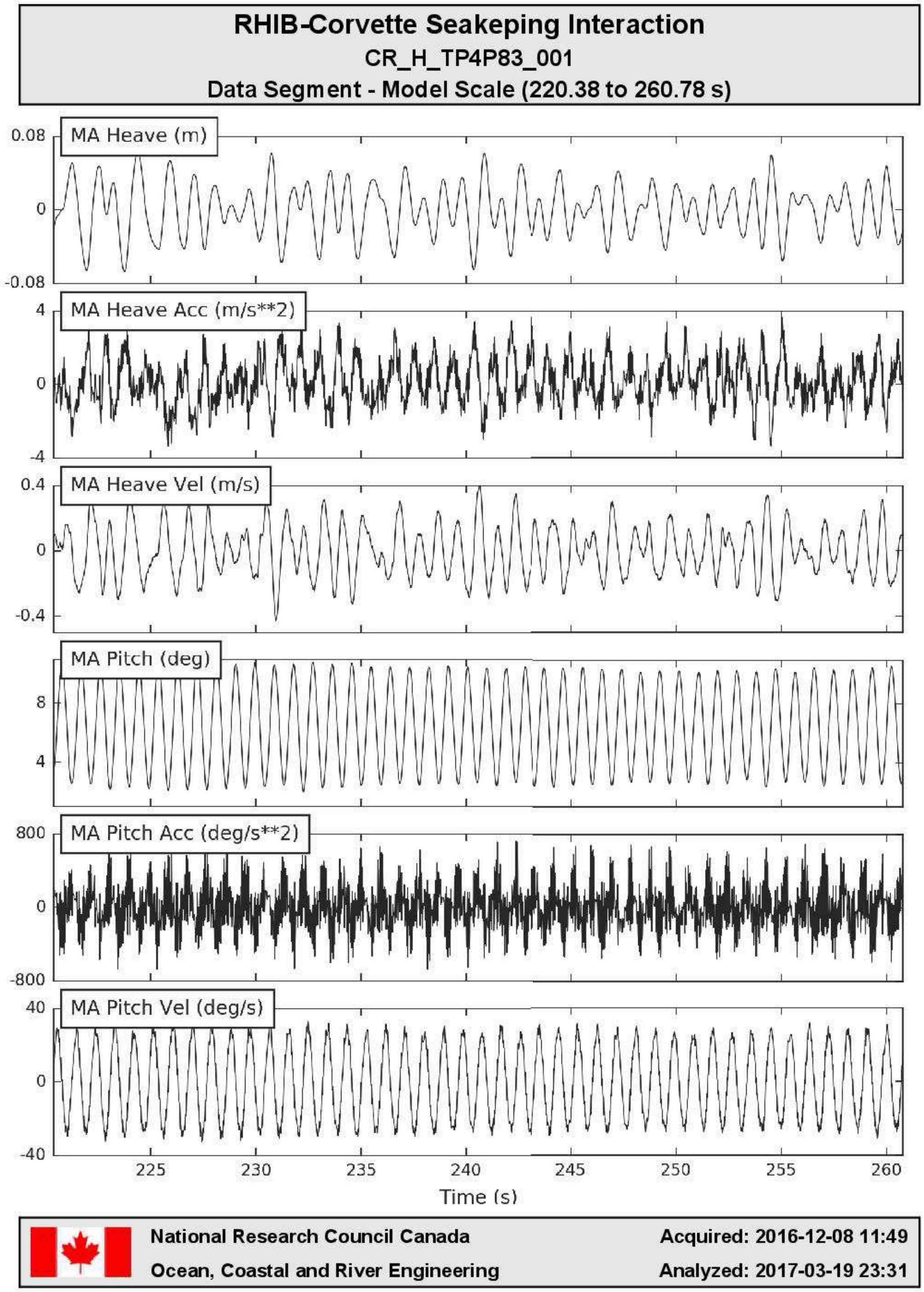

RHIB-Corvette Seakeping Interaction
CR_H_TP4P83_001
Processed Data
Carriage Position (m)
120
60
Corvette Pitch (deg)
0.4
0
-0.4
Corvette Roll (deg)
0.2
0
-0.2
Corvette Sinkage (mm)
6
0
-6
Encounter Wave Probe (m)
0.05
0
-0.05
QUAL X Rot (m)
1
0
-1
50
100
150
200
250
300
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-08 11:49
Analyzed: 2017-03-19 23:31


RHIB-Corvette Seakeping Interaction
CR_H_TP4P83_001
Processed Data
QUAL Y Rot (m)
0
-0.3
-0.6
QUAL Yaw Rot (deg)
20
10
0
Shaft Speed (rpm)
6000
3000
0
Steering Angle (deg)
20
0
-20
Upstream Wave Probe (m)
0.04
0
-0.04
50
100
150
200
250
300
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-08 11:49
Analyzed: 2017-03-19 23:31

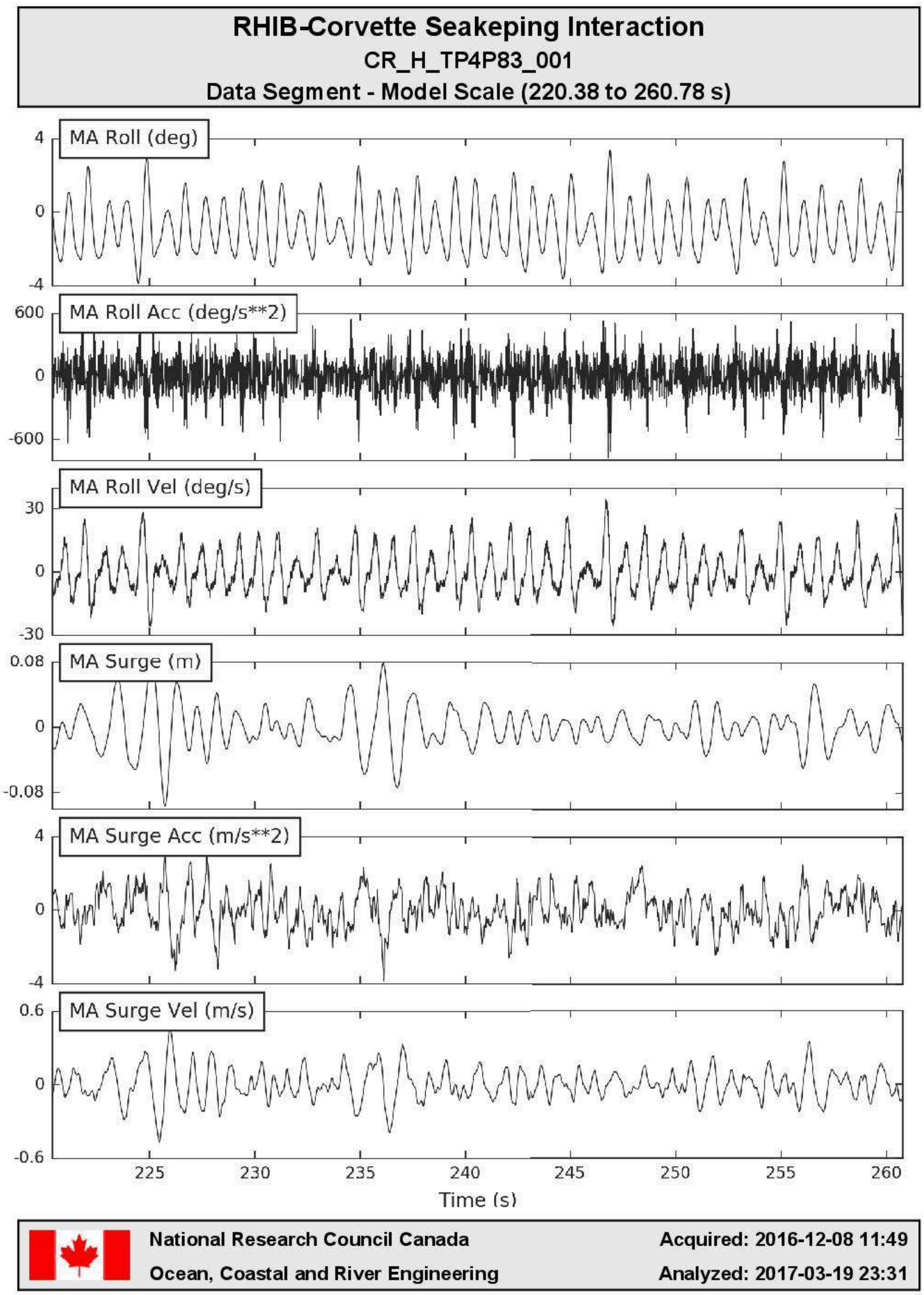

RHIB-Corvette Seakeping Interaction
CR_H_TP4P83_001
Data Segment - Model Scale (220.38 to 260.78 s)
Carriage Speed (m/s)
1.2085
1.207
1.2055
IMU X Acc (g)
0.3
0
-0.3
IMU Y Acc (g)
0.4
0
-0.4
IMU Z Acc (g)
-0.6
-0.9
-1.2
IMU X Rate (deg/s)
30
0
-30
IMU Y Rate (deg/s)
40
0
-40
IMU Z Rate (deg/s)
15
0
-15
225
230
235
240
245
250
255
260
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-08 11:49
Analyzed: 2017-03-19 23:31

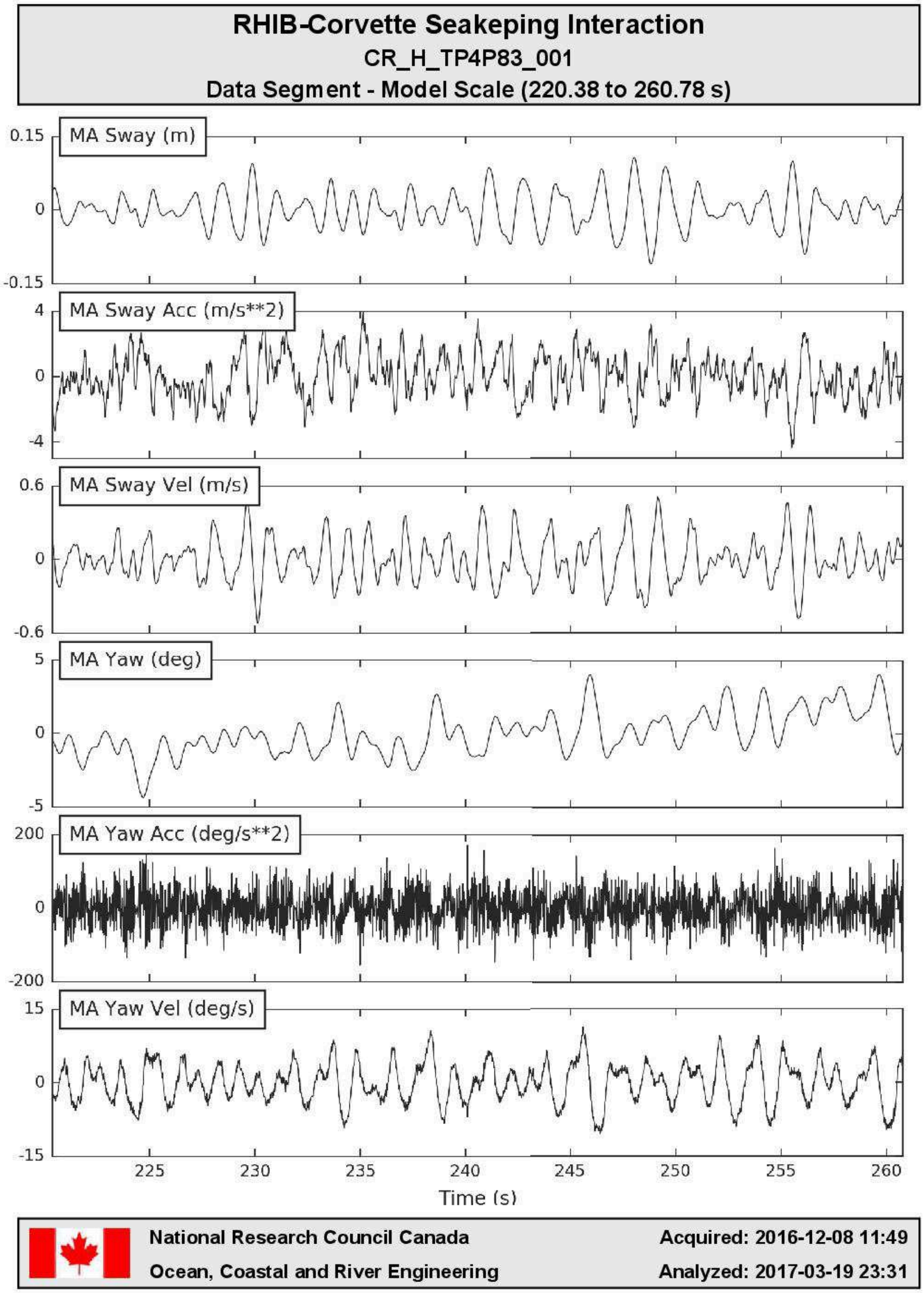

RHIB-Corvette Seakeping Interaction
CR_H_TP4P83_001
Data Segment - Model Scale (220.38 to 260.78 s)
QUAL X (m)
QUAL Y (m)
QUAL Z (m)
QUAL Yaw (deg)
QUAL Pitch (deg)
QUAL Roll (deg)
QUAL Residual (mm)
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-08 11:49
Analyzed: 2017-03-19 23:31


RHIB-Corvette Seakeping Interaction
CR_H_TP4P83_001
Data Segment - Model Scale (220.38 to 260.78 s)
Carriage Speed (m/s)
1.2085
1.207
1.2055
X Speed (m/s)
0.15
0
-0.15
Y Speed (m/s)
0.1
0
-0.1
Forward Speed (m/s)
1.3
1.2
1.1
225
230
235
240
245
250
255
260
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-08 11:49
Analyzed: 2017-03-19 23:31

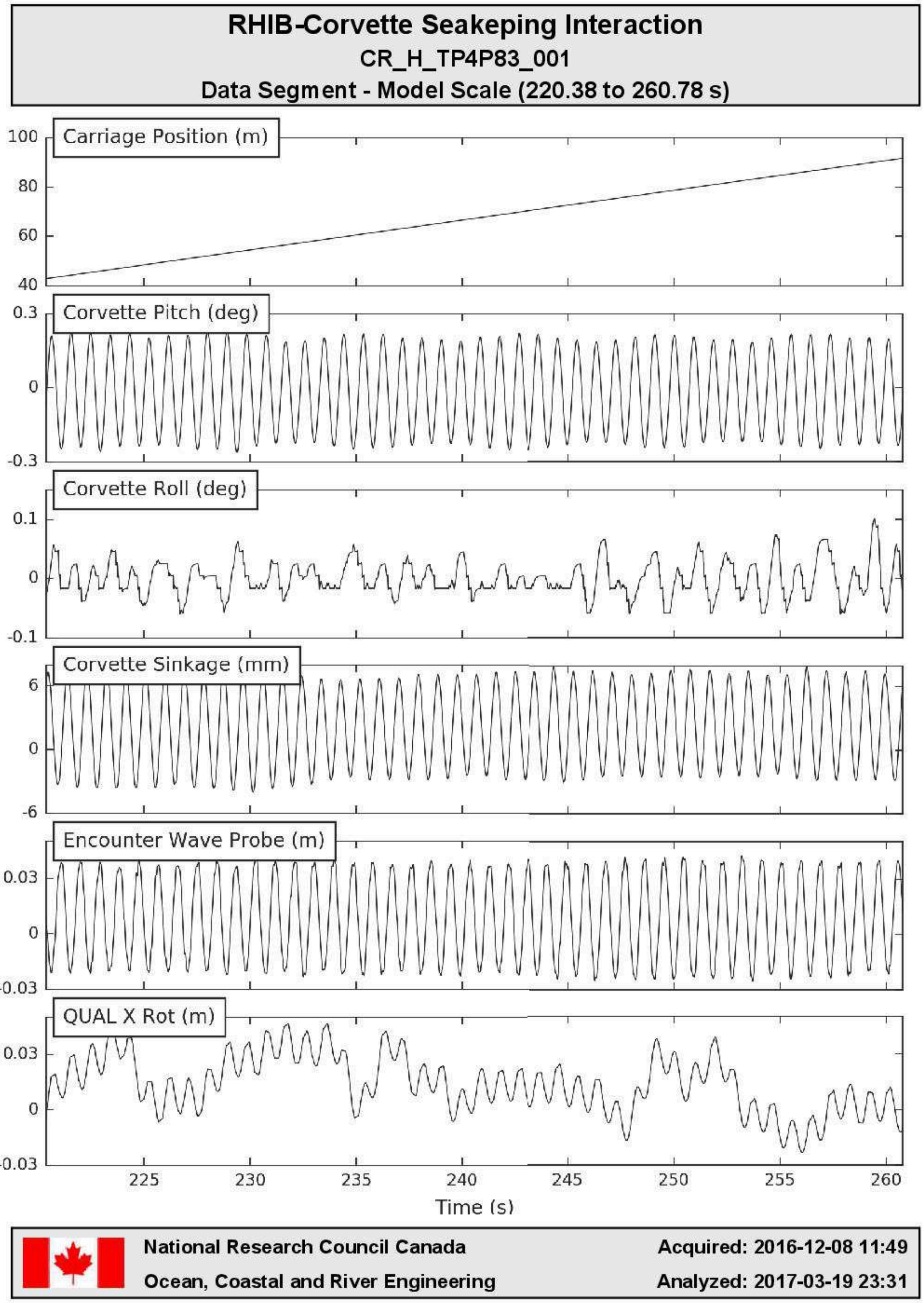


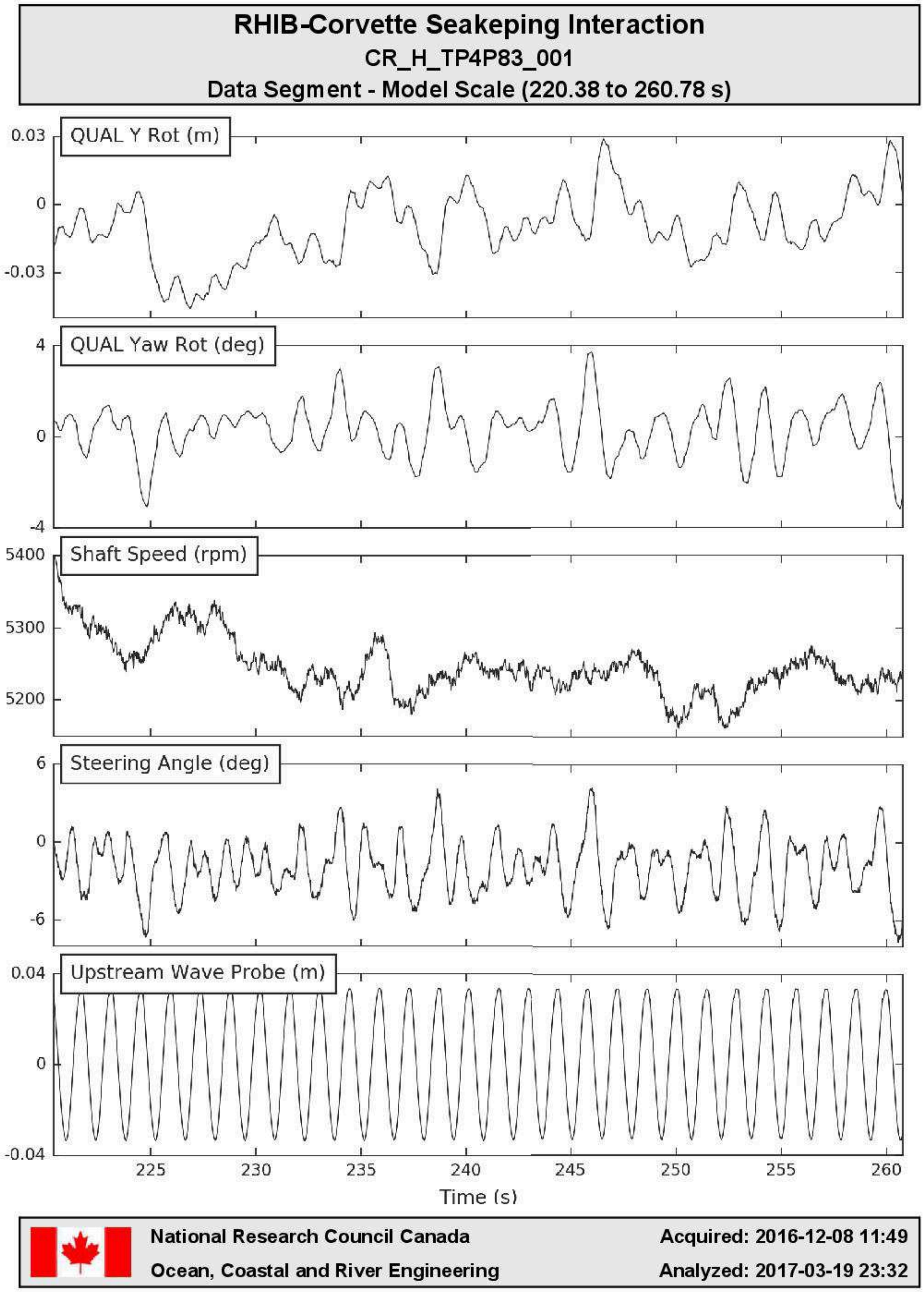
RHIB-Corvette Seakeping Interaction
CR_H_TP4P83_001
Data Segment - Model Scale (220.38 to 260.78 s)
MA Heave (m)
MA Heave Acc (m/s**2)
MA Heave Vel (m/s)
MA Pitch (deg)
MA Pitch Acc (deg/s**2)
MA Pitch Vel (deg/s)
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-08 11:49
Analyzed: 2017-03-19 23:31


RHIB-Corvette Seakeping Interaction
CR_H_TP4P83_001
Data Segment - Model Scale (220.38 to 260.78 s)
MA Roll (deg)
MA Roll Acc (deg/s**2)
MA Roll Vel (deg/s)
MA Surge (m)
MA Surge Acc (m/s**2)
MA Surge Vel (m/s)
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-08 11:49
Analyzed: 2017-03-19 23:31



RHIB-Corvette Seakeping Interaction
CR_H_TP4P83_001
Data Segment - Model Scale (220.38 to 260.78 s)
MA Sway (m)
0.15
0
-0.15
MA Sway Acc (m/s**2)
4
0
-4
MA Sway Vel (m/s)
0.6
0
-0.6
MA Yaw (deg)
5
0
-5
MA Yaw Acc (deg/s**2)
200
0
-200
MA Yaw Vel (deg/s)
15
0
-15
225
230
235
240
245
250
255
260
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-08 11:49
Analyzed: 2017-03-19 23:31


RHIB-Corvette Seakeping Interaction
CR_H_TP4P83_001
Data Segment - Model Scale (220.38 to 260.78 s)
Carriage Position (m)
Corvette Pitch (deg)
Corvette Roll (deg)
Corvette Sinkage (mm)
Encounter Wave Probe (m)
QUAL X Rot (m)
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-08 11:49
Analyzed: 2017-03-19 23:31


RHIB-Corvette Seakeping Interaction
CR_H_TP4P83_001
Data Segment - Model Scale (220.38 to 260.78 s)
QUAL Y Rot (m)
QUAL Yaw Rot (deg)
Shaft Speed (rpm)
Steering Angle (deg)
Upstream Wave Probe (m)
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-08 11:49
Analyzed: 2017-03-19 23:32

RHIB-Corvette Seakeping Interaction
CR_H_TP4P83_001
Data Segment - Model Scale (220.38 to 260.78 s)

Channel	Units	Min	Max	Mean	SD
Carriage Position	m	42.841	91.619	67.241	14.088
Carriage Speed	m/s	1.2055	1.2084	1.2068	0.00039253
Corvette Pitch	deg	-0.26193	0.22671	-0.015362	0.15666
Corvette Roll	deg	-0.060026	0.10134	0.00014138	0.029002
Corvette Sinkage	mm	-4.0142	7.9257	2.1604	3.6439
Encounter Wave Probe	m	-0.025286	0.042594	0.0086798	0.022032
Forward Speed	m/s	1.1043	1.3054	1.2068	0.046686
IMU X Acc	g	-0.29201	0.45287	0.11364	0.099189
IMU X Rate	deg/s	-25.937	34.514	0.17911	10.296
IMU Y Acc	g	-0.39623	0.42255	0.015645	0.13398
IMU Y Rate	deg/s	-32.527	32.881	-0.020842	19.527
IMU Z Acc	g	-1.3433	-0.65929	-0.97936	0.12530
IMU Z Rate	deg/s	-10.490	11.165	-0.023365	4.0231
MA Heave	m	-0.067161	0.062396	0.0000	0.027687
MA Heave Acc	m/s**2	-3.3594	3.6524	0.14818	1.2286
MA Heave Vel	m/s	-0.42624	0.39841	0.0000	0.15833
MA Pitch	deg	1.9632	10.939	6.4856	2.8349
MA Pitch Acc	deg/s**2	-677.14	721.91	0.14210	224.14
MA Pitch Vel	deg/s	-32.527	32.881	-0.020841	19.527
MA Roll	deg	-3.8946	3.3886	-0.83819	1.4434
MA Roll Acc	deg/s**2	-775.73	539.22	-0.38066	161.94
MA Roll Vel	deg/s	-25.937	34.514	0.17911	10.296
MA Surge	m	-0.096369	0.079257	0.0000	0.025275
MA Surge Acc	m/s**2	-3.8508	3.0767	-5.6926e-05	1.0126
MA Surge Vel	m/s	-0.47048	0.44385	0.0000	0.12804
MA Sway	m	-0.11065	0.10700	0.0000	0.037585
MA Sway Acc	m/s**2	-4.3923	3.9370	0.00035501	1.3450
MA Sway Vel	m/s	-0.52053	0.51042	0.0000	0.18113
MA Yaw	deg	-4.3733	4.0515	0.0000	1.4941
MA Yaw Acc	deg/s**2	-154.48	172.20	0.15930	44.056
MA Yaw Vel	deg/s	-10.490	11.165	-0.023365	4.0231
QUAL Pitch	deg	-1.0703	7.3784	3.1766	2.6440
QUAL Residual	mm	-3.7940	54.895	1.3808	2.4256
QUAL Roll	deg	-0.92786	5.1405	1.4600	1.2458
QUAL X	m	-0.023431	0.047535	0.014054	0.015262
QUAL X Rot	m	-0.023358	0.046778	0.013757	0.015151
QUAL Y	m	-0.041723	0.036435	-0.0055387	0.015986
QUAL Y Rot	m	-0.045936	0.028936	-0.0097985	0.014717
QUAL Yaw	deg	-3.1652	3.7337	0.29514	1.1539
QUAL Yaw Rot	deg	-3.1652	3.7337	0.29514	1.1539

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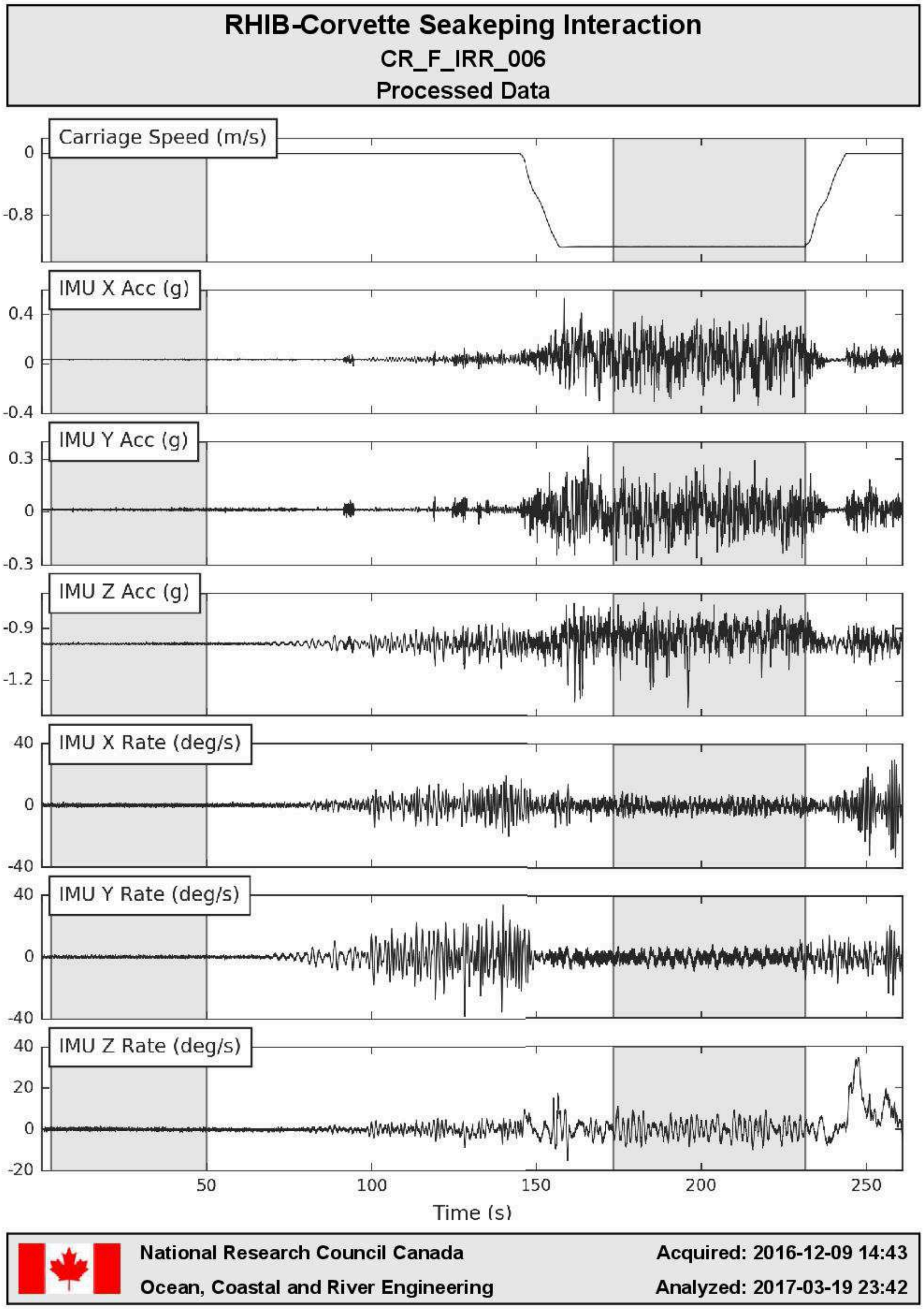
Ocean, Coastal and River Engineering

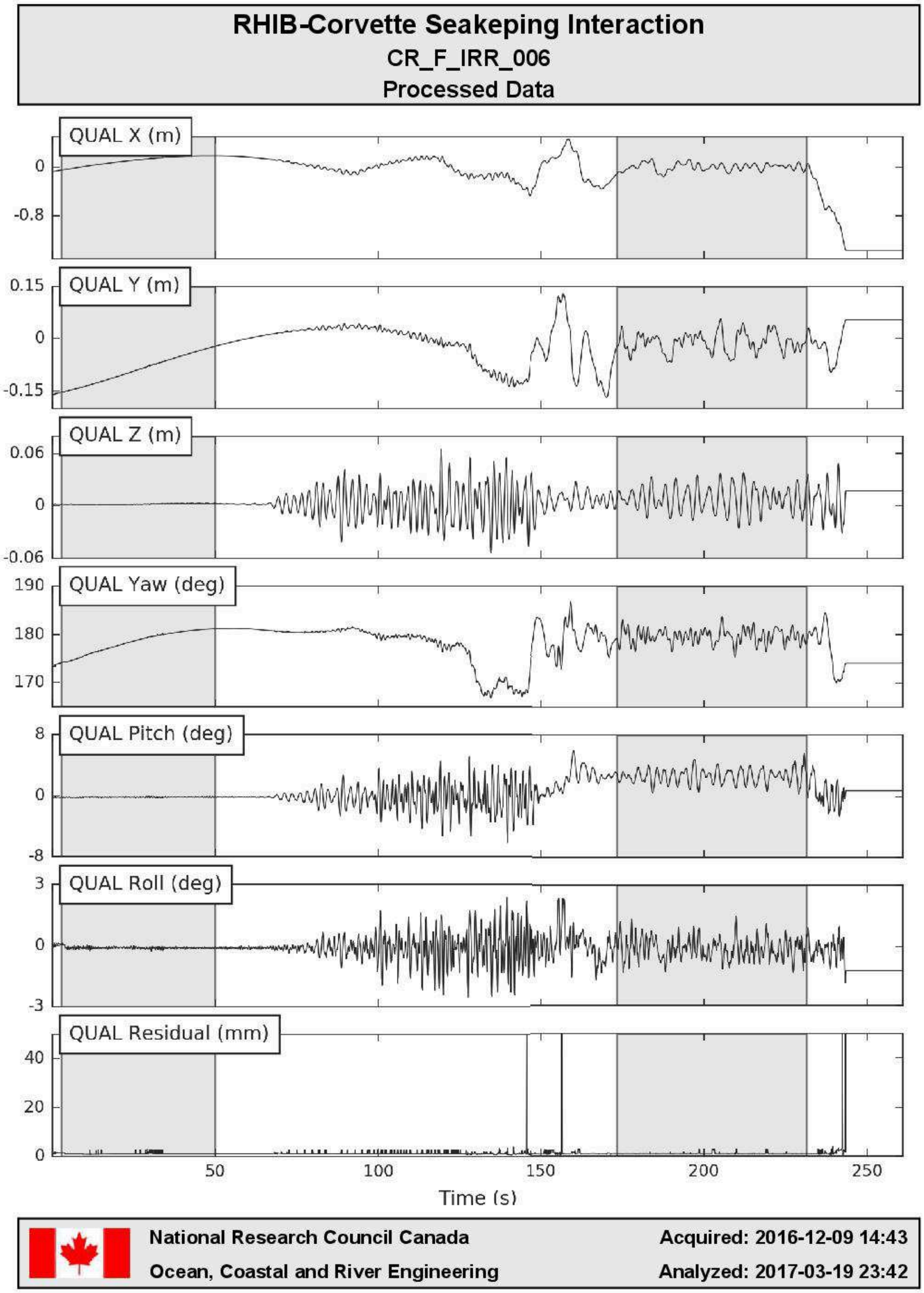
RHIB-Corvette Seakeping Interaction
CR_H_TP4P83_001
Data Segment - Model Scale (220.38 to 260.78 s)

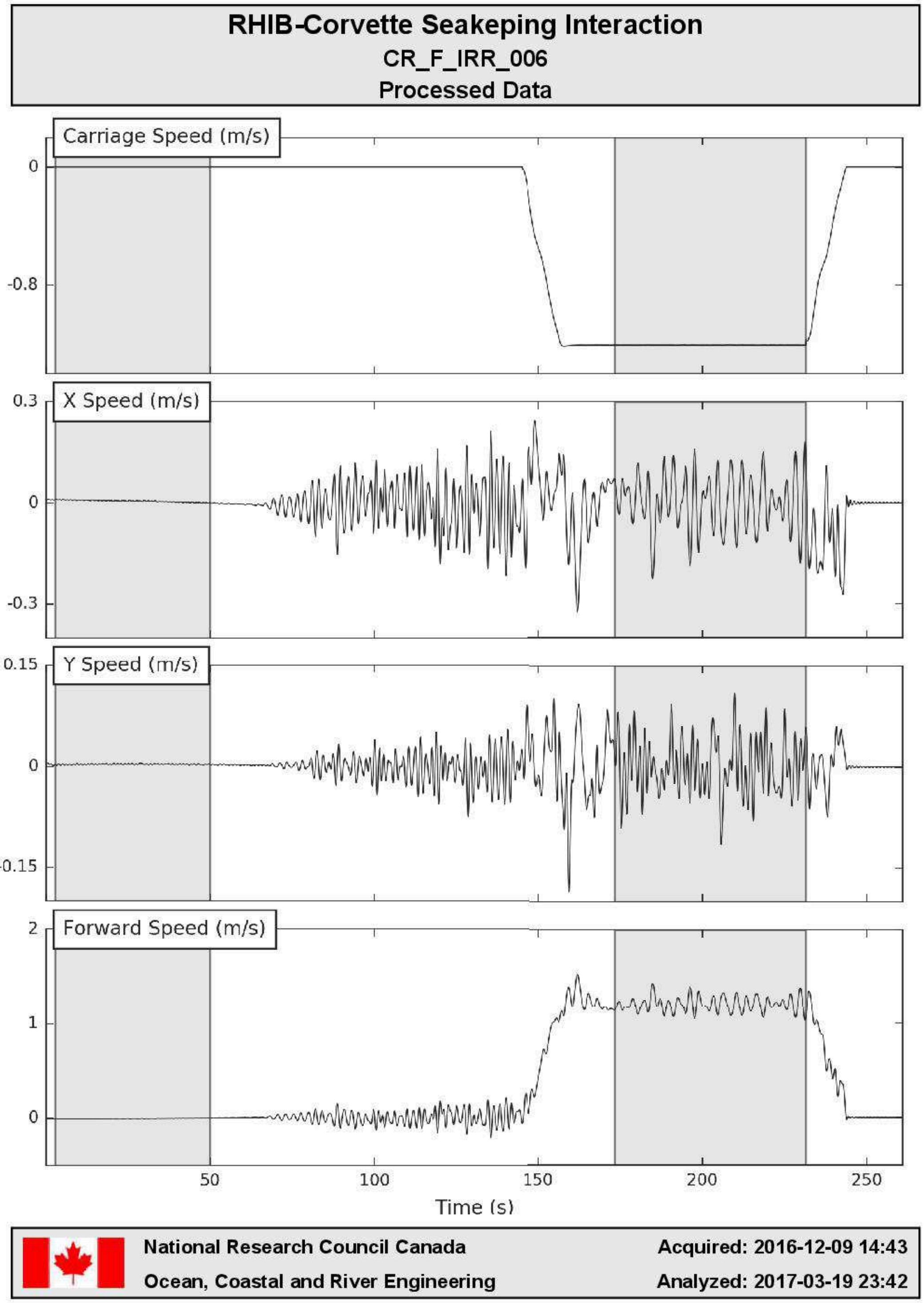
Channel	Units	Min	Max	Mean	SD
QUAL Z	m	-0.041158	0.029702	-0.0052759	0.023363
Shaft Speed	rpm	5162.1	5399.0	5245.8	38.971
Steering Angle	deg	-7.6707	4.2257	-1.9428	2.1918
Upstream Wave Probe	m	-0.033606	0.033723	0.00047204	0.023821
X Speed	m/s	-0.10912	0.10465	-0.00013611	0.050836
Y Speed	m/s	-0.089075	0.12432	0.00076252	0.036012

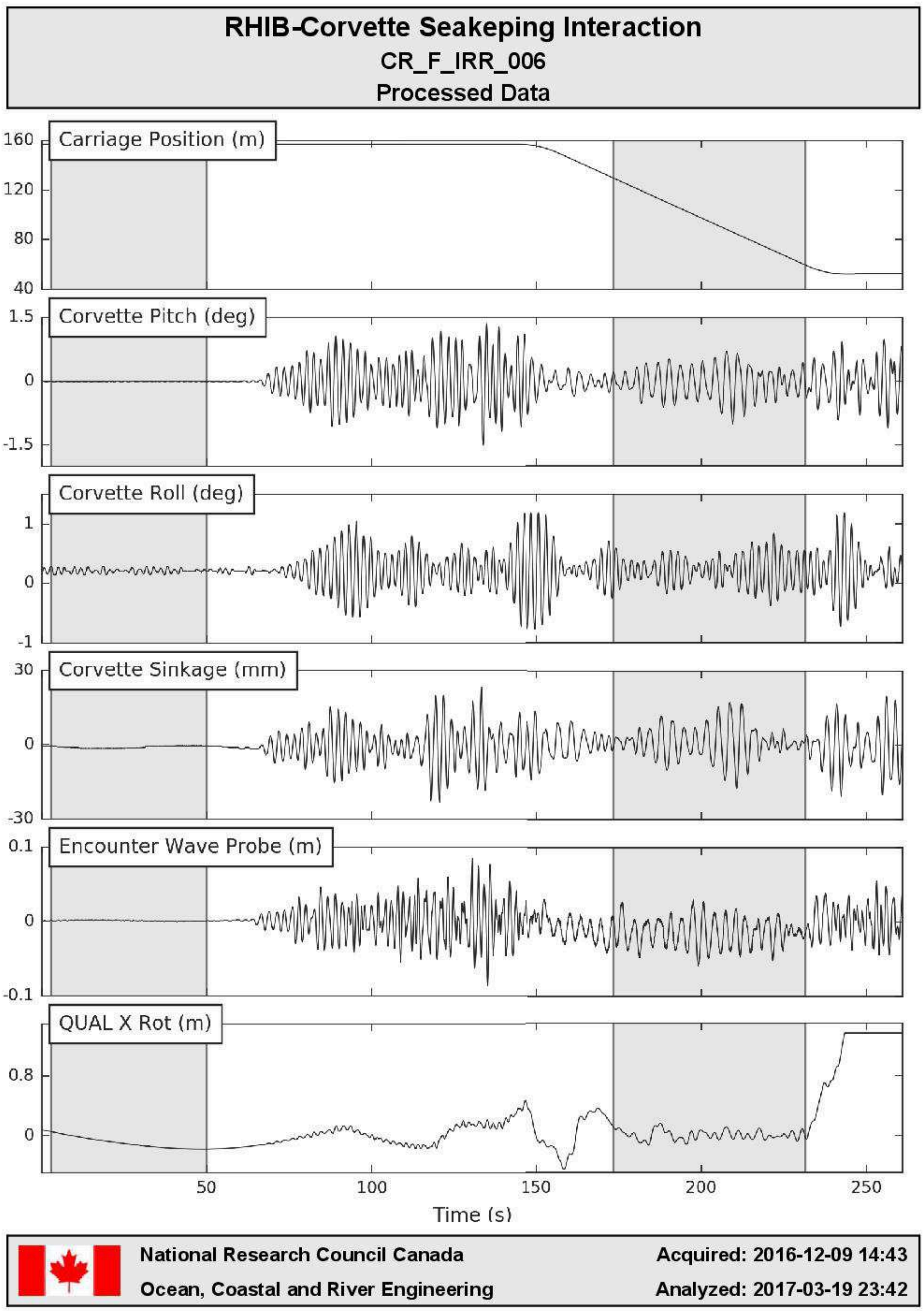
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-08 11:49


RHIB-Corvette Seakeping Interaction
CR_F_IRR_006
Processed Data
Carriage Speed (m/s)
IMU X Acc (g)
IMU Y Acc (g)
IMU Z Acc (g)
IMU X Rate (deg/s)
IMU Y Rate (deg/s)
IMU Z Rate (deg/s)
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-09 14:43
Analyzed: 2017-03-19 23:42

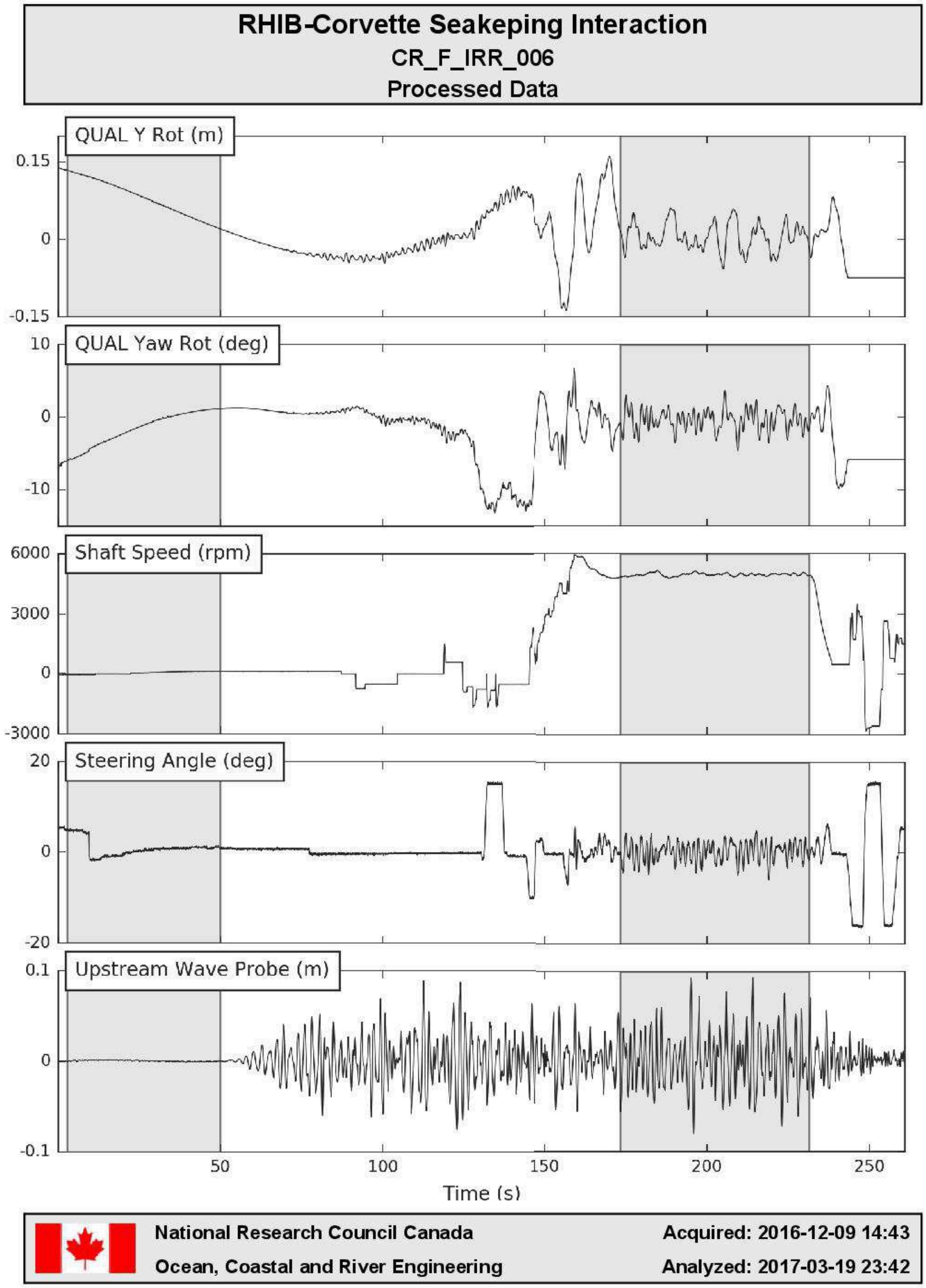
1

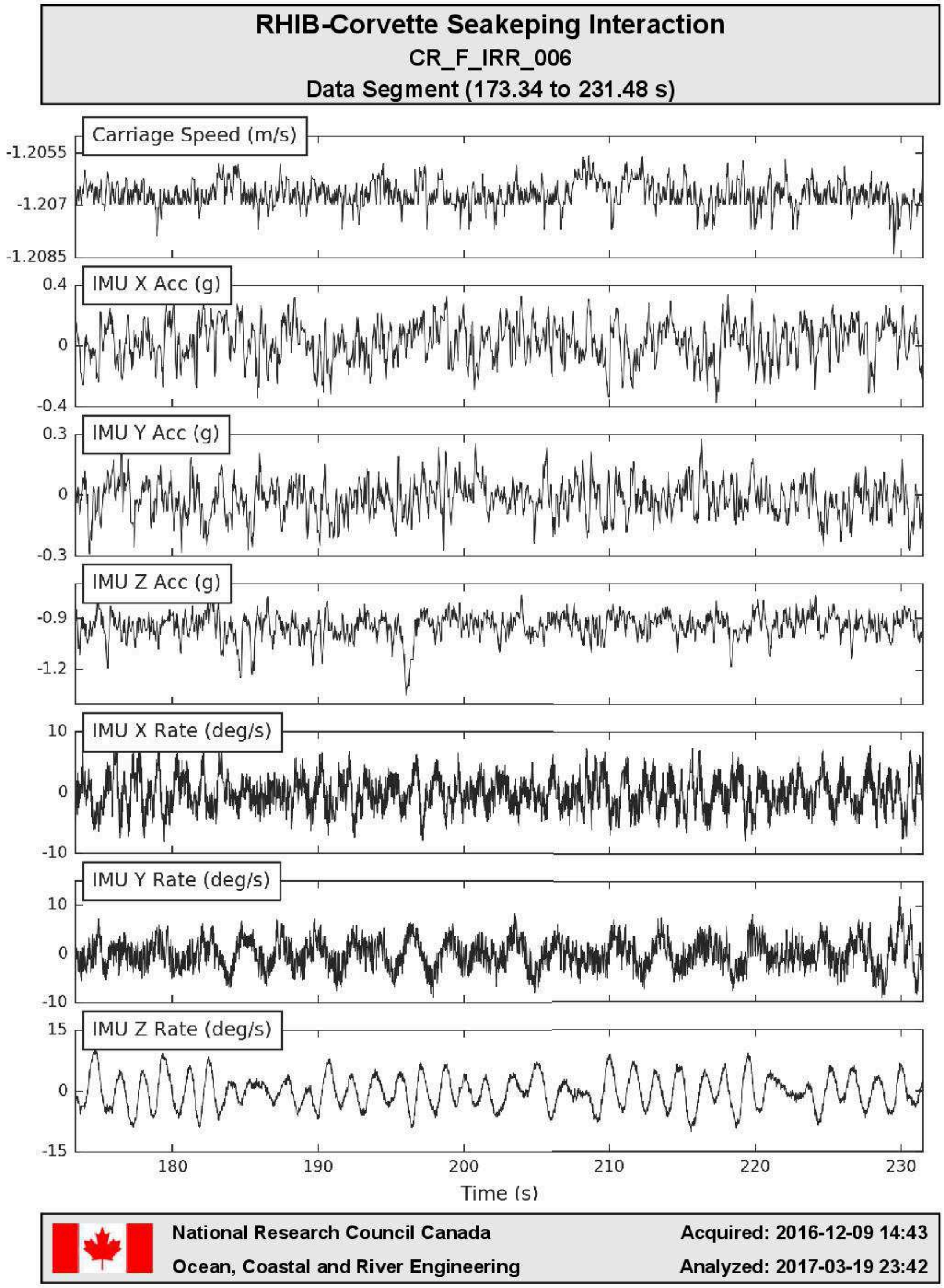

RHIB-Corvette Seakeping Interaction
CR_F_IRR_006
Processed Data
QUAL X (m)
QUAL Y (m)
QUAL Z (m)
QUAL Yaw (deg)
QUAL Pitch (deg)
QUAL Roll (deg)
QUAL Residual (mm)
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-09 14:43
Analyzed: 2017-03-19 23:42

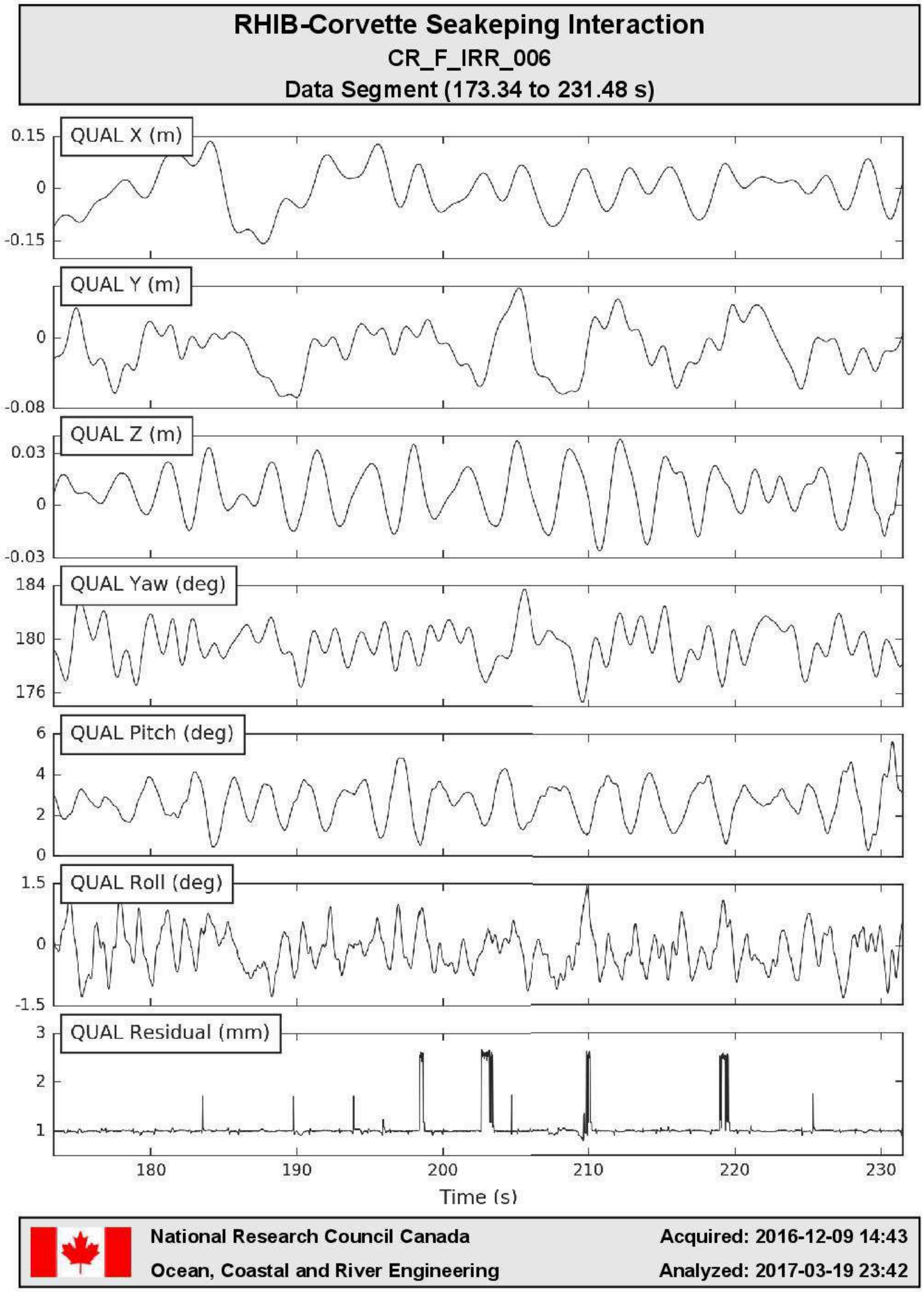

RHIB-Corvette Seakeping Interaction
CR_F_IRR_006
Processed Data
Carriage Speed (m/s)
0
-0.8
X Speed (m/s)
0.3
0
-0.3
Y Speed (m/s)
0.15
0
-0.15
Forward Speed (m/s)
2
1
0
50
100
150
200
250
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-09 14:43
Analyzed: 2017-03-19 23:42

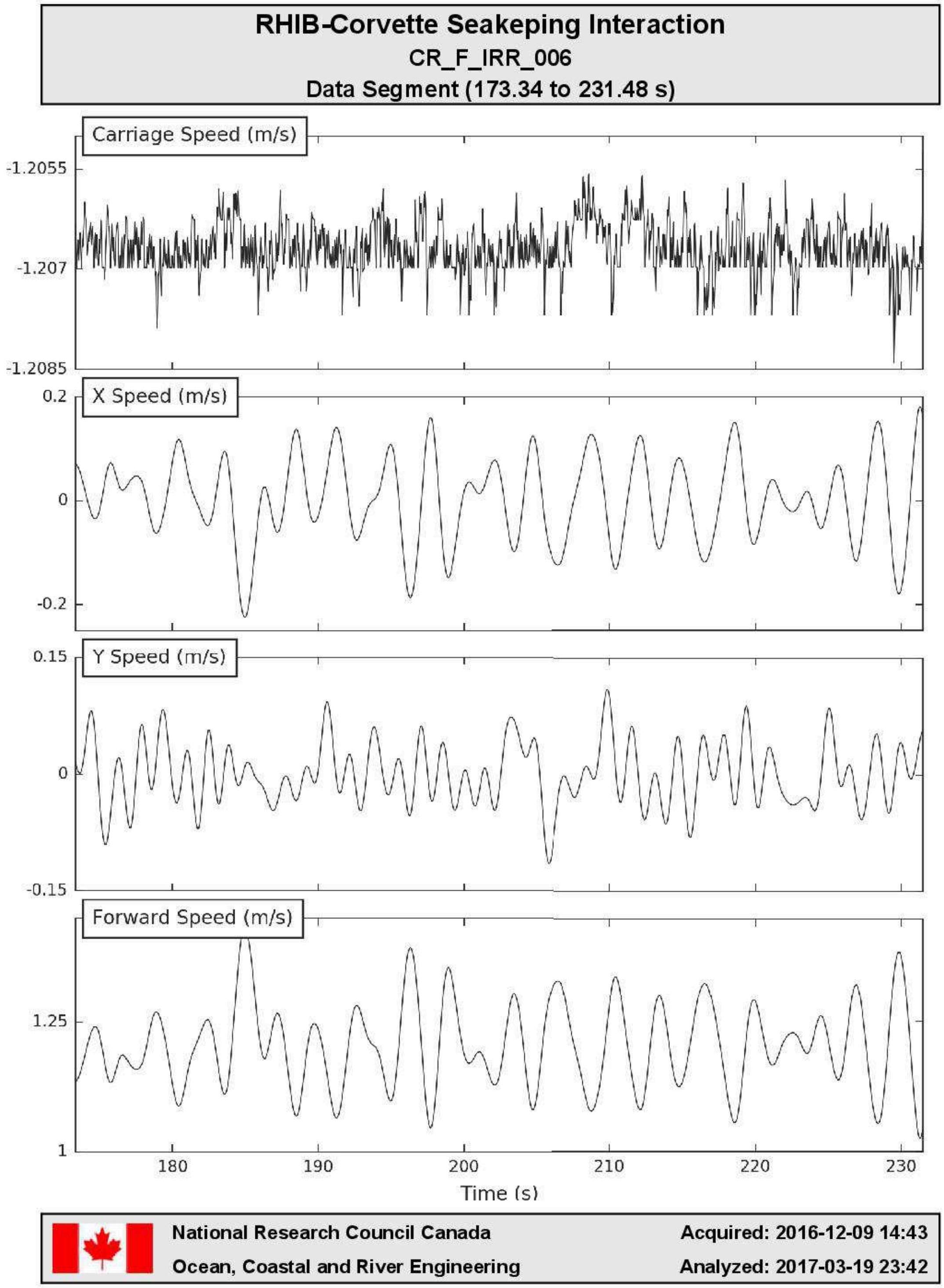

RHIB-Corvette Seakeping Interaction
CR_F_IRR_006
Processed Data
Carriage Position (m)
Corvette Pitch (deg)
Corvette Roll (deg)
Corvette Sinkage (mm)
Encounter Wave Probe (m)
QUAL X Rot (m)
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-09 14:43
Analyzed: 2017-03-19 23:42

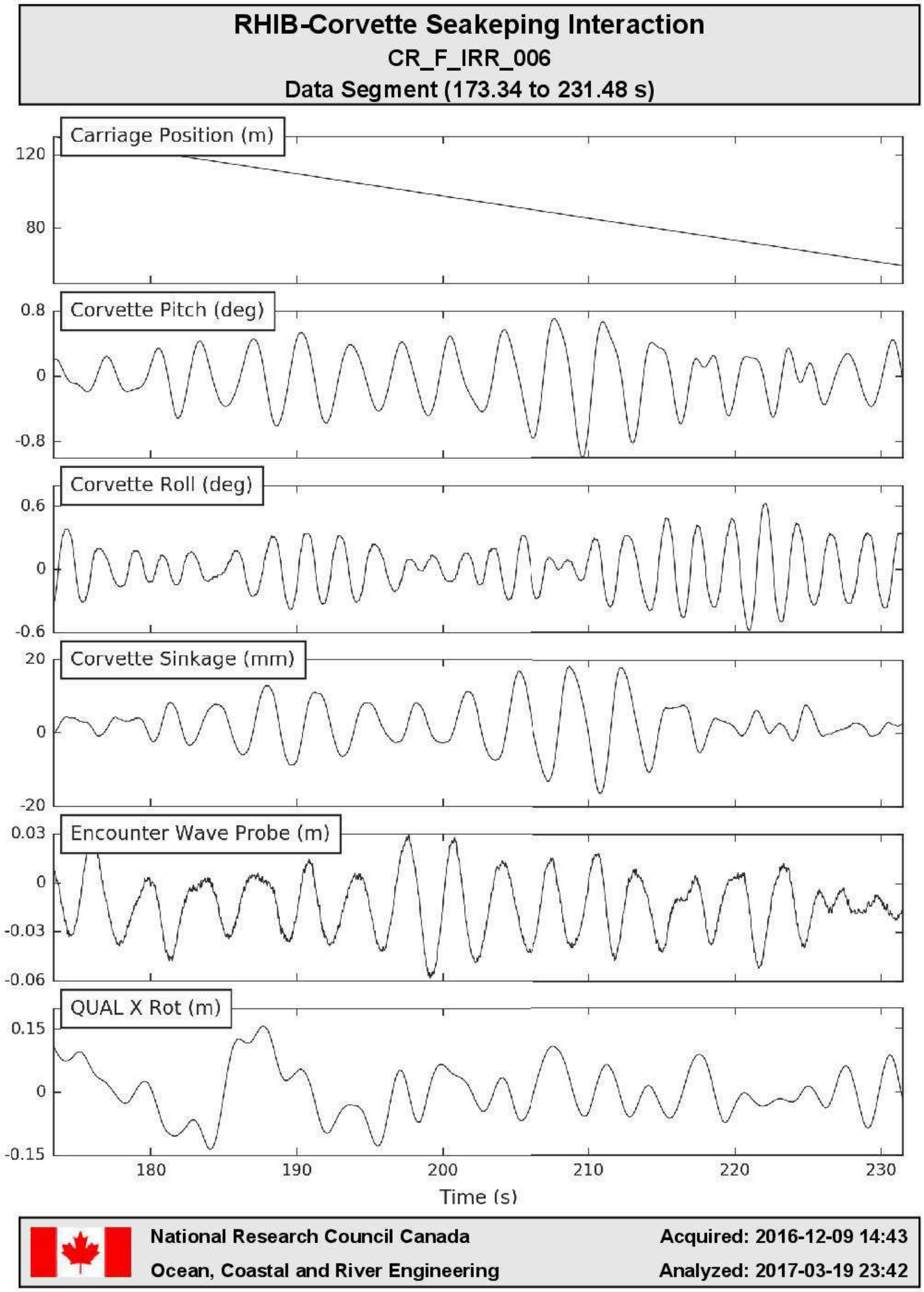
4

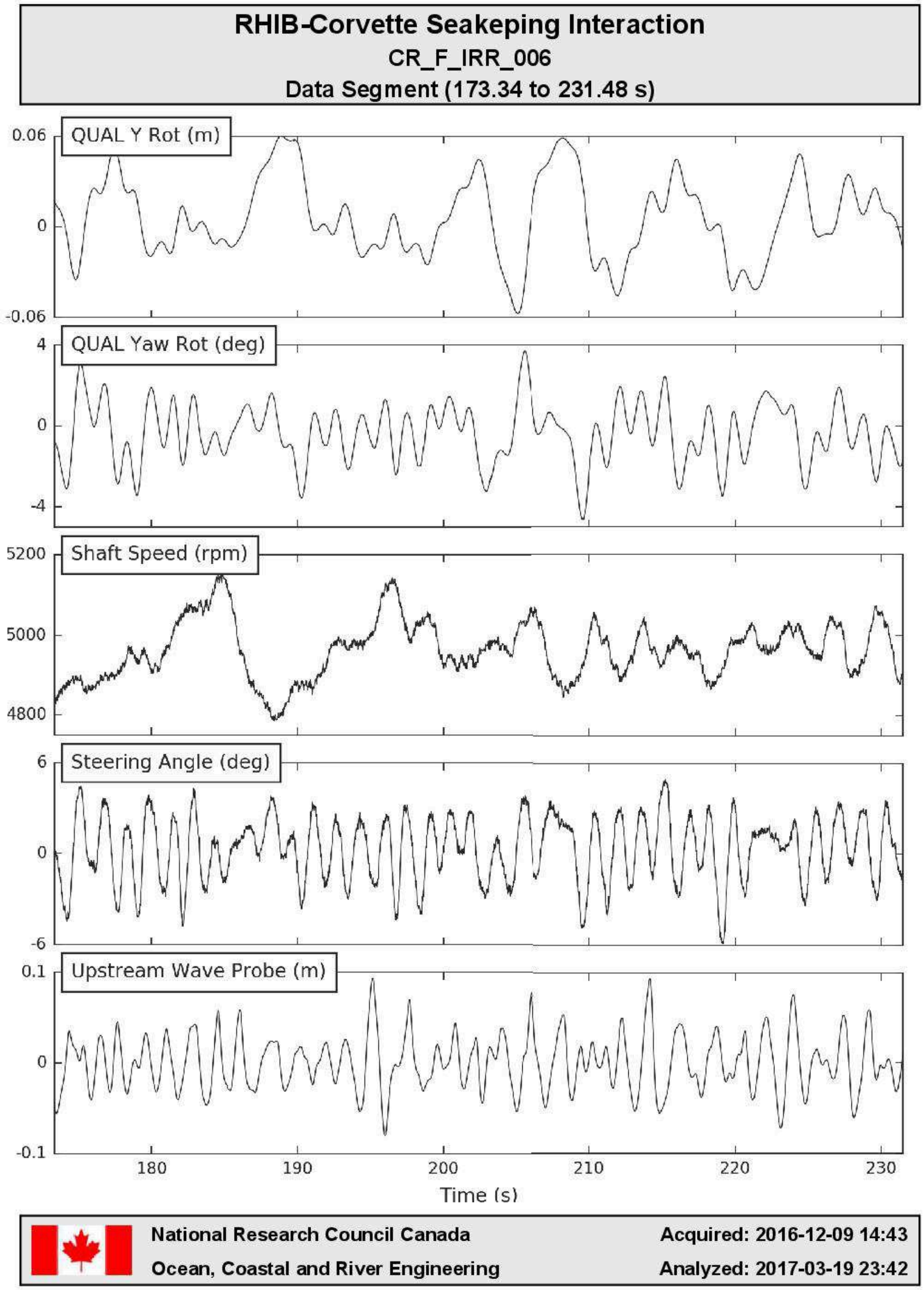

RHIB-Corvette Seakeping Interaction
CR_F_IRR_006
Processed Data
QUAL Y Rot (m)
0.15
0
-0.15
QUAL Yaw Rot (deg)
10
0
-10
Shaft Speed (rpm)
6000
3000
0
-3000
Steering Angle (deg)
20
0
-20
Upstream Wave Probe (m)
0.1
0
-0.1
50
100
150
200
250
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-09 14:43
Analyzed: 2017-03-19 23:42


RHIB-Corvette Seakeping Interaction
CR_F_IRR_006
Data Segment (173.34 to 231.48 s)
Carriage Speed (m/s)
-1.2055
-1.207
-1.2085
IMU X Acc (g)
0.4
0
-0.4
IMU Y Acc (g)
0.3
0
-0.3
IMU Z Acc (g)
-0.9
-1.2
IMU X Rate (deg/s)
10
0
-10
IMU Y Rate (deg/s)
10
0
-10
IMU Z Rate (deg/s)
15
0
-15
180
190
200
210
220
230
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-09 14:43
Analyzed: 2017-03-19 23:42


RHIB-Corvette Seakeping Interaction
CR_F_IRR_006
Data Segment (173.34 to 231.48 s)
QUAL X (m)
0.15
0
-0.15
QUAL Y (m)
0
-0.08
QUAL Z (m)
0.03
0
-0.03
QUAL Yaw (deg)
184
180
176
QUAL Pitch (deg)
6
4
2
0
QUAL Roll (deg)
1.5
0
-1.5
QUAL Residual (mm)
3
2
1
180
190
200
210
220
230
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-09 14:43
Analyzed: 2017-03-19 23:42


RHIB-Corvette Seakeping Interaction
CR_F_IRR_006
Data Segment (173.34 to 231.48 s)
Carriage Speed (m/s)
-1.2055
-1.207
-1.2085
X Speed (m/s)
0.2
0
-0.2
Y Speed (m/s)
0.15
0
-0.15
Forward Speed (m/s)
1.25
1
180
190
200
210
220
230
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-09 14:43
Analyzed: 2017-03-19 23:42

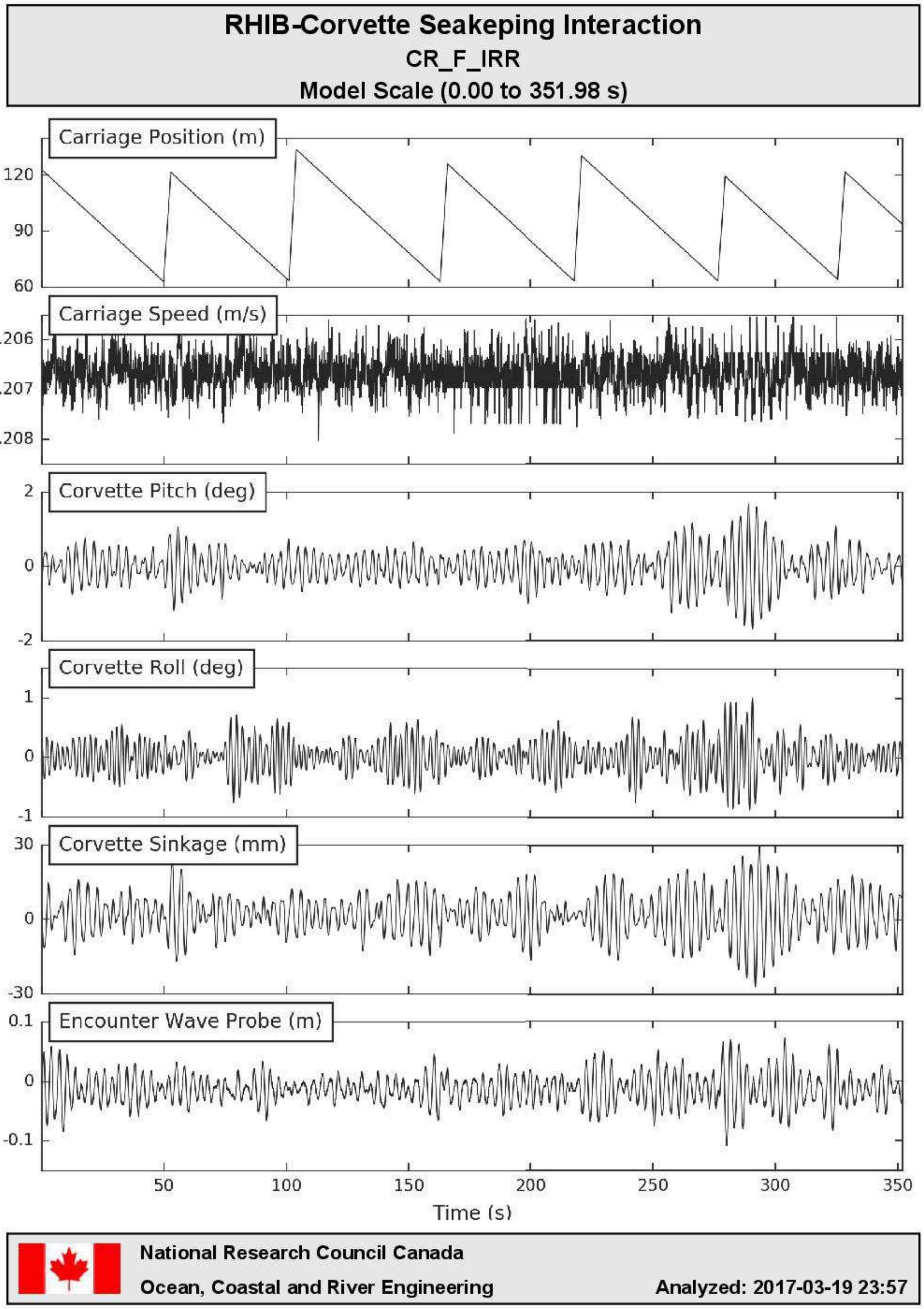

RHIB-Corvette Seakeping Interaction
CR_F_IRR_006
Data Segment (173.34 to 231.48 s)
Carriage Position (m)
Corvette Pitch (deg)
Corvette Roll (deg)
Corvette Sinkage (mm)
Encounter Wave Probe (m)
QUAL X Rot (m)
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-09 14:43
Analyzed: 2017-03-19 23:42


RHIB-Corvette Seakeping Interaction
CR_F_IRR_006
Data Segment (173.34 to 231.48 s)
QUAL Y Rot (m)
0.06
0
-0.06
QUAL Yaw Rot (deg)
4
0
-4
Shaft Speed (rpm)
5200
5000
4800
Steering Angle (deg)
6
0
-6
Upstream Wave Probe (m)
0.1
0
-0.1
180
190
200
210
220
230
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Acquired: 2016-12-09 14:43
Analyzed: 2017-03-19 23:42

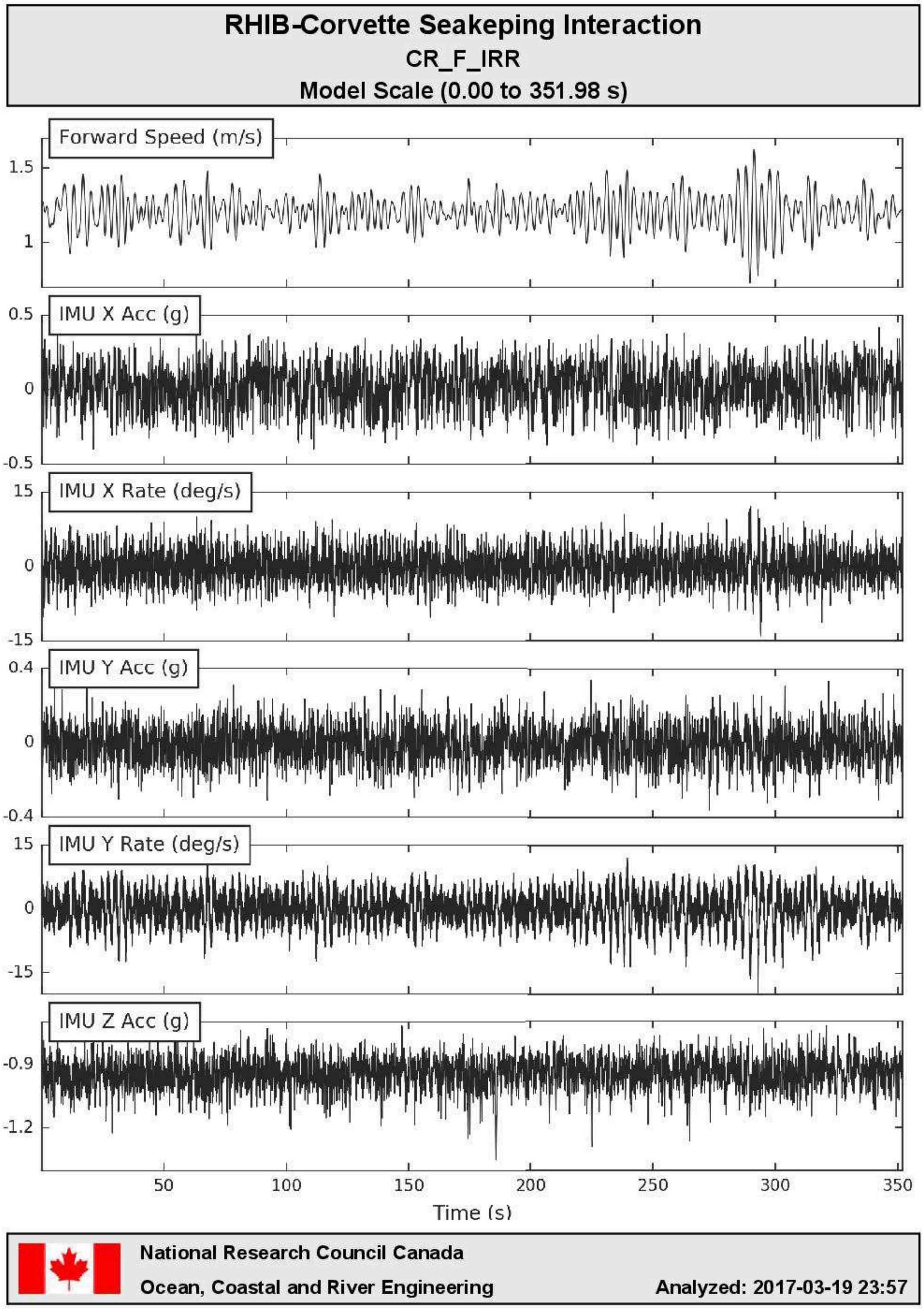
RHIB-Corvette Seakeping Interaction
CR_F_IRR_006
Data Segment (173.34 to 231.48 s)

Channel	Units	Min	Max	Mean	SD
Carriage Position	m	59.504	129.70	94.597	20.275
Carriage Speed	m/s	-1.2084	-1.2052	-1.2067	0.00036386
Corvette Pitch	deg	-0.99605	0.70854	-0.014169	0.34244
Corvette Roll	deg	-0.58208	0.63036	0.0089331	0.23325
Corvette Sinkage	mm	-16.316	18.267	2.2146	6.1515
Encounter Wave Probe	m	-0.058378	0.029746	-0.013668	0.018385
Forward Speed	m/s	1.0252	1.4310	1.2044	0.080894
IMU X Acc	g	-0.37393	0.35214	0.027063	0.12911
IMU X Rate	deg/s	-8.0447	9.5367	-0.020529	2.8697
IMU Y Acc	g	-0.28943	0.27790	-0.019984	0.086647
IMU Y Rate	deg/s	-9.2285	11.962	0.084905	3.0853
IMU Z Acc	g	-1.3503	-0.75644	-0.94527	0.072295
IMU Z Rate	deg/s	-10.178	10.987	-0.20431	3.9550
QUAL Pitch	deg	0.32254	5.6698	2.6660	0.95638
QUAL Residual	mm	0.79491	2.6715	1.0428	0.25539
QUAL Roll	deg	-1.2990	1.4758	-0.12064	0.50430
QUAL X	m	-0.15813	0.13545	-0.0020471	0.062011
QUAL X Rot	m	-0.13551	0.15799	0.0018692	0.061989
QUAL Y	m	-0.068203	0.057852	-0.011648	0.027712
QUAL Y Rot	m	-0.057381	0.059891	0.0056784	0.026417
QUAL Yaw	deg	175.35	183.72	179.63	1.4602
QUAL Yaw Rot	deg	-4.6517	3.7222	-0.36567	1.4602
QUAL Z	m	-0.026347	0.037824	0.0078073	0.014002
Shaft Speed	rpm	4785.4	5153.9	4962.3	71.330
Steering Angle	deg	-5.8825	4.9483	0.31363	2.1321
Upstream Wave Probe	m	-0.080524	0.093467	-7.2947e-05	0.030285
X Speed	m/s	-0.22444	0.18148	0.0023199	0.080807
Y Speed	m/s	-0.11505	0.10947	0.00050279	0.039614

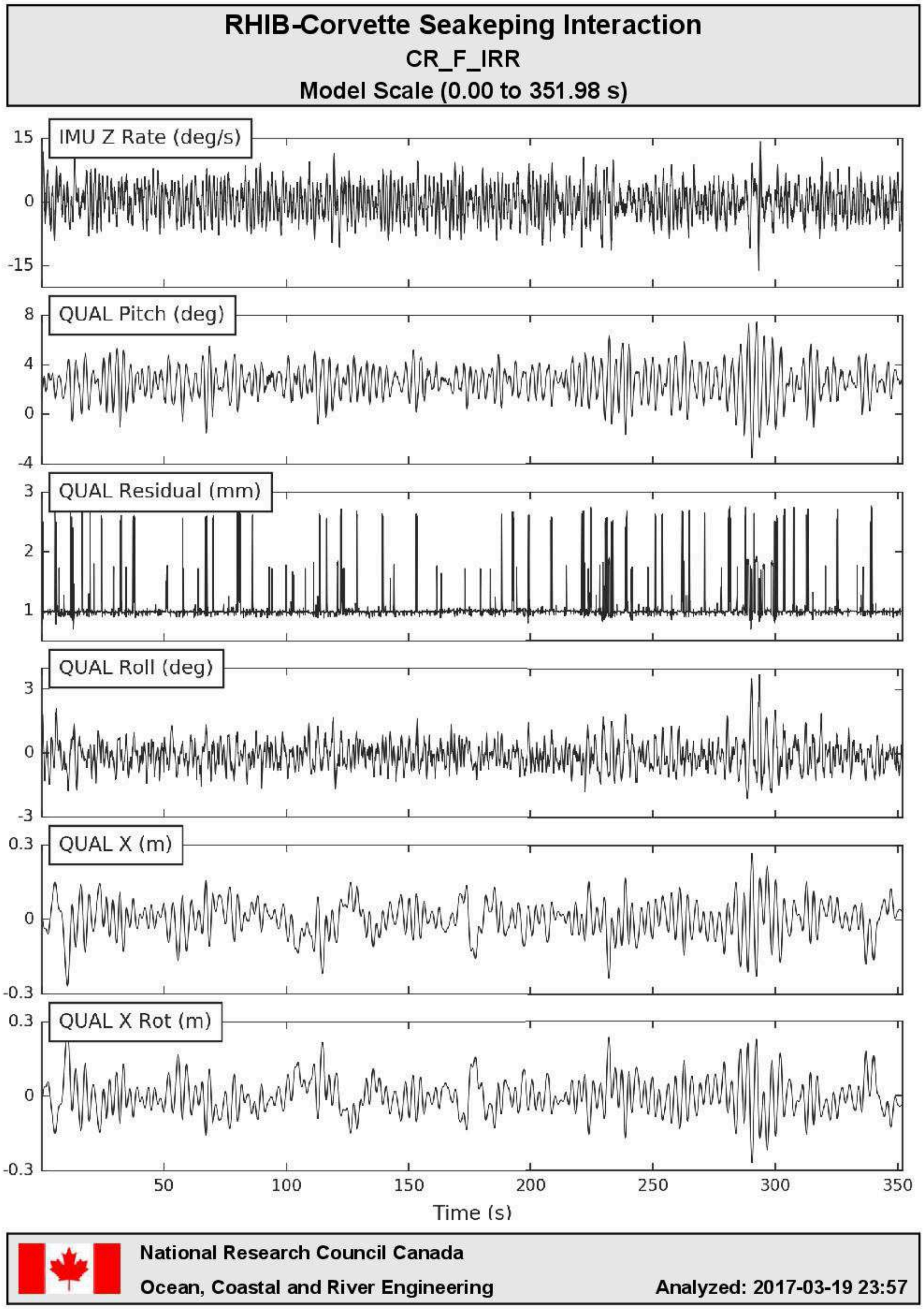
National Research Council Canada **Acquired: 2016-12-09 14:43**
Ocean, Coastal and River Engineering

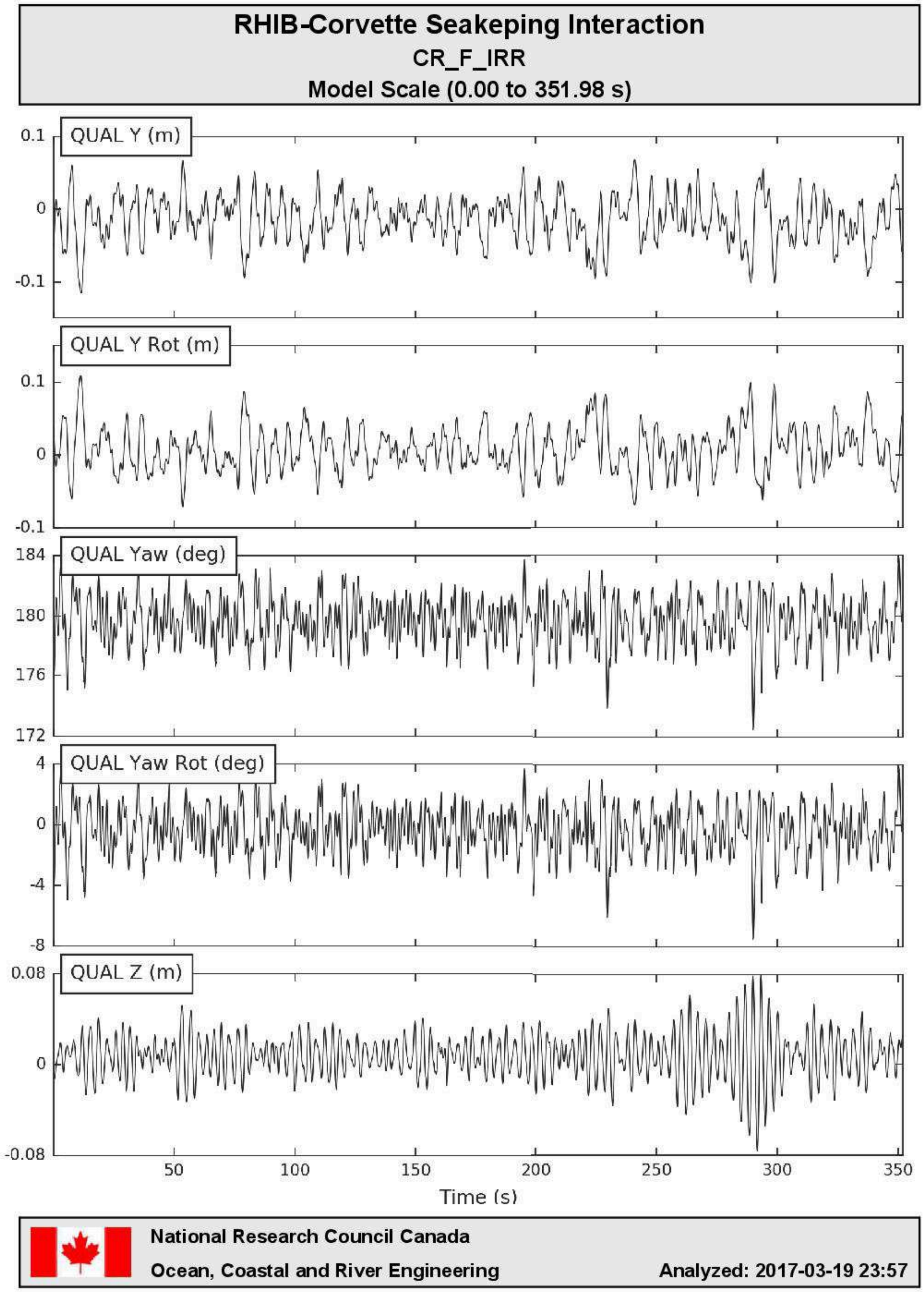

RHIB-Corvette Seakeping Interaction
CR_F_IRR
Model Scale (0.00 to 351.98 s)
Carriage Position (m)
120
90
60
Carriage Speed (m/s)
-1.206
-1.207
-1.208
Corvette Pitch (deg)
2
0
-2
Corvette Roll (deg)
1
0
-1
Corvette Sinkage (mm)
30
0
-30
Encounter Wave Probe (m)
0.1
0
-0.1
50
100
150
200
250
300
350
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Analyzed: 2017-03-19 23:57

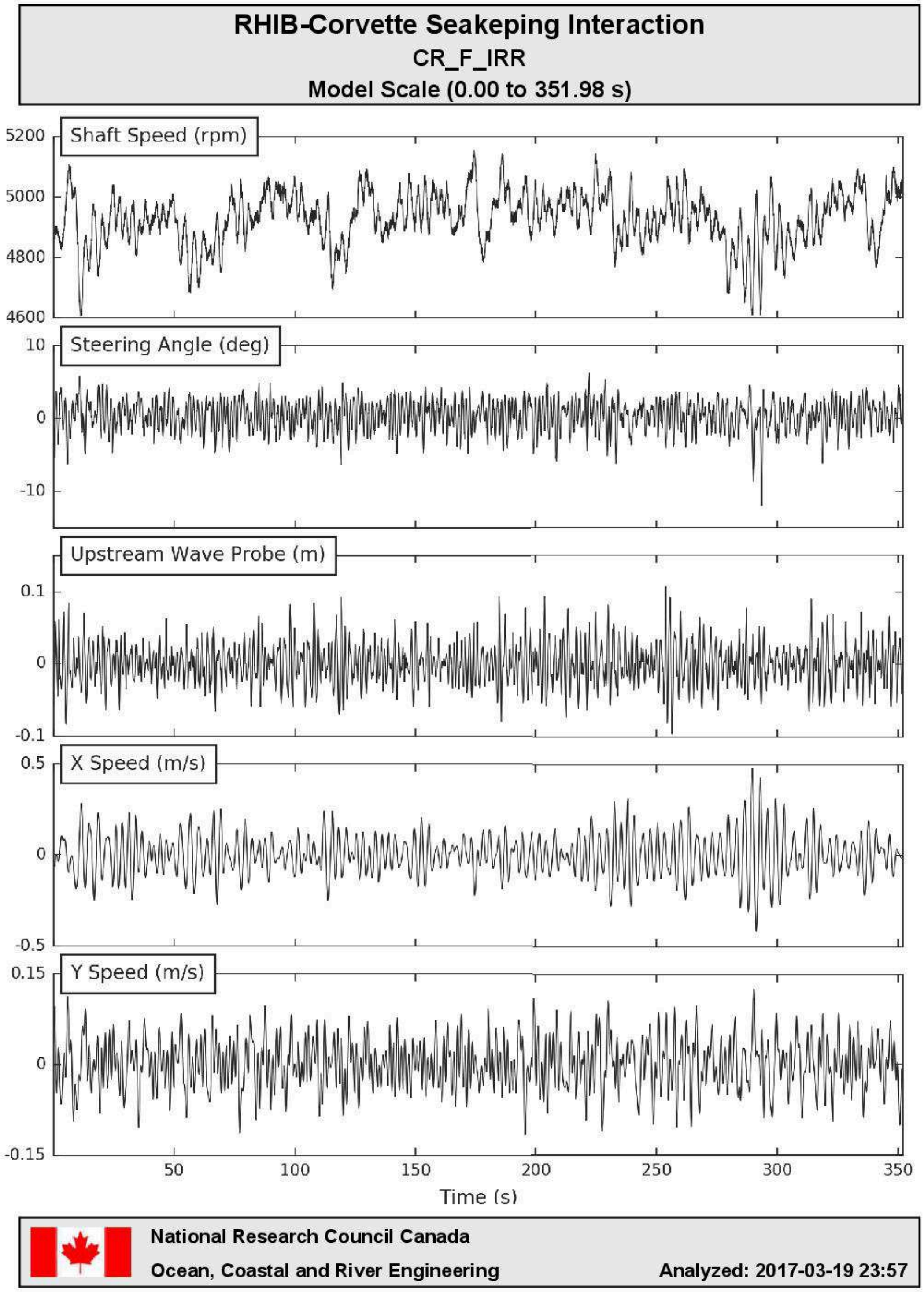
1


RHIB-Corvette Seakeping Interaction
CR_F_IRR
Model Scale (0.00 to 351.98 s)
Forward Speed (m/s)
IMU X Acc (g)
IMU X Rate (deg/s)
IMU Y Acc (g)
IMU Y Rate (deg/s)
IMU Z Acc (g)
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Analyzed: 2017-03-19 23:57

2


RHIB-Corvette Seakeping Interaction
CR_F_IRR
Model Scale (0.00 to 351.98 s)
IMU Z Rate (deg/s)
QUAL Pitch (deg)
QUAL Residual (mm)
QUAL Roll (deg)
QUAL X (m)
QUAL X Rot (m)
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Analyzed: 2017-03-19 23:57


RHIB-Corvette Seakeping Interaction
CR_F_IRR
Model Scale (0.00 to 351.98 s)
QUAL Y (m)
QUAL Y Rot (m)
QUAL Yaw (deg)
QUAL Yaw Rot (deg)
QUAL Z (m)
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Analyzed: 2017-03-19 23:57


RHIB-Corvette Seakeping Interaction
CR_F_IRR
Model Scale (0.00 to 351.98 s)
Shaft Speed (rpm)
5200
5000
4800
4600
Steering Angle (deg)
10
0
-10
Upstream Wave Probe (m)
0.1
0
-0.1
X Speed (m/s)
0.5
0
-0.5
Y Speed (m/s)
0.15
0
-0.15
50
100
150
200
250
300
350
Time (s)
National Research Council Canada
Ocean, Coastal and River Engineering
Analyzed: 2017-03-19 23:57

RHIB-Corvette Seakeping Interaction CR_F_IRR Model Scale (0.00 to 351.98 s)					
Channel	**Units**	**Min**	**Max**	**Mean**	**SD**
Carriage Position	m	62.862	133.86	95.557	18.186
Carriage Speed	m/s	-1.2080	-1.2055	-1.2067	0.00033600
Corvette Pitch	deg	-1.6798	1.6823	-0.018779	0.44555
Corvette Roll	deg	-0.87286	1.0043	0.0058150	0.27332
Corvette Sinkage	mm	-26.924	29.493	2.0079	8.1728
Encounter Wave Probe	m	-0.10804	0.071473	-0.013512	0.025123
Forward Speed	m/s	0.72515	1.6250	1.2054	0.11333
IMU X Acc	g	-0.40235	0.41502	0.018719	0.13175
IMU X Rate	deg/s	-14.053	12.120	-0.043311	2.9758
IMU Y Acc	g	-0.35881	0.33824	-0.012782	0.087401
IMU Y Rate	deg/s	-19.609	12.102	0.047160	3.7012
IMU Z Acc	g	-1.3503	-0.71914	-0.94486	0.064366
IMU Z Rate	deg/s	-16.094	14.223	0.057649	3.7308
QUAL Pitch	deg	-3.5301	7.4451	2.5719	1.3758
QUAL Residual	mm	0.68836	2.7752	1.0655	0.32333
QUAL Roll	deg	-2.1051	3.7266	-0.099829	0.65524
QUAL X	m	-0.26878	0.26860	0.0020065	0.072441
QUAL X Rot	m	-0.27019	0.26867	-0.0022012	0.072417
QUAL Y	m	-0.11569	0.068376	-0.013821	0.031814
QUAL Y Rot	m	-0.071718	0.10947	0.0079545	0.030904
QUAL Yaw	deg	172.46	183.89	179.67	1.5342
QUAL Yaw Rot	deg	-7.5368	3.8949	-0.32708	1.5342
QUAL Z	m	-0.076019	0.079891	0.0073795	0.019157
Shaft Speed	rpm	4605.0	5153.8	4928.9	86.540
Steering Angle	deg	-11.966	6.2762	0.38918	2.0576
Upstream Wave Probe	m	-0.095741	0.10719	0.00042285	0.027892
X Speed	m/s	-0.41786	0.48091	0.0012225	0.11324
Y Speed	m/s	-0.11505	0.12591	0.00028298	0.039657

Appendix F

Test log

National Research Council Canada / Conseil national de recherches Canada

TEST LOG

Clearwater Towing Tank(CWT)

OCEAN, COASTAL & RIVER ENGINEERING(OCRE)

RHIB / CORVETTE SEAKEEPING INTERACTION

DATE	TIME	WAIT TIME ACTUAL	Speed (m/s)	FILENAME(.DAC)	Wave Drive Signal	RUN DESCRIPTION	COMMENTS
10-May-16							installation of test equipment and calibrations
11-May-16							ballast model and install - Corvette
12-May-16	8:30						setting model flotation
"	11:00						Rezero WP, Sinkage, Roll encoders, and Pitch
"	11:39	0:23	1.207	Hs0p31_Tp3p14_001	Hs0p31_Tp3p14_DRV2	Regular wave test	Corvette on towpost, head seas
"	12:02	0:16	1.207	Hs0p34_Tp3p31_001	Hs0p34_Tp3p31_DRV4	Regular wave test	
"	12:18	0:14	1.207	Hs0p38_Tp3p49_001	Hs0p38_Tp3p49_DRV1	Regular wave test	Side beach down, repeat run
"	12:32	0:12	1.207	Hs0p38_Tp3p49_002	Hs0p38_Tp3p49_DRV1	Regular wave test	repeat
"	12:44	0:12	1.207	Hs0p43_Tp3p70_001	Hs0p43_Tp3p70_DRV1	Regular wave test	
"	12:56	0:13	1.207	Hs0p48_Tp3p93_001	Hs0p48_Tp3p93_DRV1	Regular wave test	
"	13:09	0:14	1.207	Hs0p55_Tp4p19_001	Hs0p55_Tp4p19_DRV1	Regular wave test	
"	13:23	0:13	1.207	Hs0p63_Tp4p49_001	Hs0p63_Tp4p49_DRV1	Regular wave test	
"	13:36	0:15	1.207	Hs0p73_Tp4p83_001	Hs0p73_Tp4p83_DRV1	Regular wave test	
"	13:51	0:14	1.207	Hs0p86_Tp5p24_001	Hs0p86_Tp5p24_DRV1	Regular wave test	
"	14:05	0:16	1.207	Hs1p02_Tp5p71_001	Hs1p02_Tp5p71_DRV1	Regular wave test	
"	14:21	0:22	1.207	Hs1p23_Tp6p28_001	Hs1p23_Tp6p28_DRV1	Regular wave test	
"	14:43	0:14	1.207	Hs1p52_Tp6p98_001	Hs1p52_Tp6p98_DRV1	Regular wave test	
"	14:57	0:16	1.207	Hs1p93_Tp7p85_001	Hs1p93_Tp7p85_DRV1	Regular wave test	
"	15:13	0:14	1.207	Hs2p51_Tp8p98_001	Hs2p51_Tp8p98_DRV1	Regular wave test	Side beach down, repeat run
"	15:27	0:15	1.207	Hs2p51_Tp8p98_002	Hs2p51_Tp8p98_DRV1	Regular wave test	repeat
"	15:42	#########	1.207	Irr_hs1p25_tp7p5_001	Irr_hs1p25_tp7p5_DRV3	Irregular wave test - segment 1	check run
13-May-16		9:02	1.207	calm_001		Irregular wave test - segment 1	Start waveboard at 110 seconds
"							Rezero WP, Sinkage, Roll encoders, and Pitch
"	9:02	0:22	1.207	Irr_hs1p25_tp7p5_002	Irr_hs1p25_tp7p5_DRV3	Irregular wave test - segment 1	Offset at 0 sec for wave, allowing 0 sec overlap
"	9:24	0:21	1.207	Irr_hs1p25_tp7p5_003	Irr_hs1p25_tp7p5_DRV3	Irregular wave test - segment 2	94 sec of good data, Offset at 89 sec for wave, allowing 5 sec overlap
"	9:45	0:21	1.207	Irr_hs1p25_tp7p5_004	Irr_hs1p25_tp7p5_DRV3	Irregular wave test - segment 3	95 sec of good data, Offset at 181 sec for wave, allowing 3 sec overlap
"	10:06	1:57	1.207	Irr_hs1p25_tp7p5_005	Irr_hs1p25_tp7p5_DRV3	Irregular wave test - segment 4	94 sec of good data, Offset at 272 sec for wave, allowing 3 sec overlap
"							
"							Rotate model on towpost for following seas
							NOTE: When model was rotated, pitch encoder went from 0 to 0.4°, But was not rezeroed, therefore leaving an offset for all the following sea tests
"							Rezero Encounter WP & Sinkage
"	12:03	0:14	1.207	Hs0p31_C_F_001	Hs0p31_Tp3p14_DRV2	Regular wave test - Corvette (C) - Following (F) Seas	Corvette on towpost, head seas
"	12:17	0:16	1.207	Hs0p34_C_F_001	Hs0p34_Tp3p31_DRV4	Regular wave test - Corvette (C) - Following (F) Seas	
"	12:33	0:16	1.207	Hs0p38_C_F_001	Hs0p38_Tp3p49_DRV1	Regular wave test - Corvette (C) - Following (F) Seas	
"	12:49	0:16	1.207	Hs0p43_C_F_001	Hs0p43_Tp3p70_DRV1	Regular wave test - Corvette (C) - Following (F) Seas	
"	13:05	0:18	1.207	Hs0p48_C_F_001	Hs0p48_Tp3p93_DRV1	Regular wave test - Corvette (C) - Following (F) Seas	
"	13:23	0:17	1.207	Hs0p55_C_F_001	Hs0p55_Tp4p19_DRV1	Regular wave test - Corvette (C) - Following (F) Seas	
"	13:40	0:18	1.207	Hs0p63_C_F_001	Hs0p63_Tp4p49_DRV1	Regular wave test - Corvette (C) - Following (F) Seas	
"	13:58	0:15	1.207	Hs0p73_C_F_001	Hs0p73_Tp4p83_DRV1	Regular wave test - Corvette (C) - Following (F) Seas	
"	14:13	0:15	1.207	Hs0p86_C_F_001	Hs0p86_Tp5p24_DRV1	Regular wave test - Corvette (C) - Following (F) Seas	
"	14:28	0:19	1.207	Hs1p02_C_F_001	Hs1p02_Tp5p71_DRV1	Regular wave test - Corvette (C) - Following (F) Seas	waveboard tripped out of run mode
"	14:47	0:15	1.207	Hs1p23_C_F_001	Hs1p23_Tp6p28_DRV1	Regular wave test - Corvette (C) - Following (F) Seas	
"	15:02	0:15	1.207	Hs1p52_C_F_001	Hs1p52_Tp6p98_DRV1	Regular wave test - Corvette (C) - Following (F) Seas	
"	15:17	0:15	1.207	Hs1p93_C_F_001	Hs1p93_Tp7p85_DRV1	Regular wave test - Corvette (C) - Following (F) Seas	
"	15:32	#########	1.207	Hs2p51_C_F_001	Hs2p51_Tp8p98_DRV1	Regular wave test - Corvette (C) - Following (F) Seas	
16-May-16	8:00						Hydraulic pumps on
"							Start waveboard at 100 seconds
"	8:40						Rezero waveprobes and sinkage pot
"	8:48	0:25	1.207	Irr_Hs1p25_C_F_001	Irr_hs1p25_tp7p5_DRV3	Irregular wave test - Corvette (C) - Following (F) Seas	Offset at 0 sec for wave
"	9:13	0:20	1.207	Irr_Hs1p25_C_F_002	Irr_hs1p25_tp7p5_DRV3	Irregular wave test - Corvette (C) - Following (F) Seas	68 sec of good data, Offset at 65 sec for wave, allowing 3 sec overlap
"	9:33	0:17	1.207	Irr_Hs1p25_C_F_003	Irr_hs1p25_tp7p5_DRV3	Irregular wave test - Corvette (C) - Following (F) Seas	68 sec of good data, Offset at 130 sec for wave, allowing 3 sec overlap

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TEST LOG

Clearwater Towing Tank(CWT)

OCEAN, COASTAL & RIVER ENGINEERING(OCRE)

RHIB / CORVETTE SEAKEEPING INTERACTION

DATE	TIME	WAIT TIME ACTUAL	Speed (m/s)	FILENAME(.DAC)	Wave Drive Signal	RUN DESCRIPTION	COMMENTS
"	9:50	0:16	1.207	Irr_Hs1p25_C_F_004	Irr_hs1p25_tp7p5_DRV3	Irregular wave test - Corvette (C) - Following (F) Seas	68 sec of good data, Offset at 195 sec for wave, allowing 3 sec overlap
"	10:06	0:17	1.207	Irr_Hs1p25_C_F_005	Irr_hs1p25_tp7p5_DRV3	Irregular wave test - Corvette (C) - Following (F) Seas	68 sec of good data, Offset at 260 sec for wave, allowing 3 sec overlap
"	10:23	#########	1.207	Irr_Hs1p25_C_F_006	Irr_hs1p25_tp7p5_DRV3	Irregular wave test - Corvette (C) - Following (F) Seas	68 sec of good data, Offset at 325 sec for wave, allowing 3 sec overlap
6-Dec-16	8:00						installation of test equipment and calibrations
"	to						ballast model and install - Corvette
"	16:00						
7-Dec-16	8:00						setting model flotation
"							Continue tank and model set up
8-Dec-16	8:00						Hydraulic pumps on
"	9:00						Rezero waveprobes, sinkage, pitch
"	9:12	0:34	1.207	CR_H_Tp3p14_001	Hs0p31_Tp3p14_drv2	Corvette & RHIB interaction, Head seas, Reg wave	
"	9:46	0:24	1.207	CR_H_Tp3p31_001	Hs0p34_Tp3p31_drv4	Corvette & RHIB interaction, Head seas, Reg wave	
"	10:10	0:20	1.207	CR_H_Tp3p49_001	Hs0p38_Tp3p49_drv1	Corvette & RHIB interaction, Head seas, Reg wave	
"	10:30	0:19	1.207	CR_H_Tp3p70_001	Hs0p43_Tp3p70_drv1	Corvette & RHIB interaction, Head seas, Reg wave	
"	10:49	0:20	1.207	CR_H_Tp3p93_001	Hs0p48_Tp3p93_drv1	Corvette & RHIB interaction, Head seas, Reg wave	
"	11:09	0:20	1.207	CR_H_Tp4p19_001	Hs0p55_Tp4p19_drv1	Corvette & RHIB interaction, Head seas, Reg wave	
"	11:29	0:20	1.207	CR_H_Tp4p49_001	Hs0p63_Tp4p49_drv1	Corvette & RHIB interaction, Head seas, Reg wave	
"	11:49	0:21	1.207	CR_H_Tp4p83_001	Hs0p73_Tp4p83_drv1	Corvette & RHIB interaction, Head seas, Reg wave	
"	12:10	1:01	1.207	CR_H_Tp5p24_001	Hs0p86_Tp5p24_drv1	Corvette & RHIB interaction, Head seas, Reg wave	
"	13:11	0:20	1.207	CR_H_Tp5p71_001	Hs1p02_Tp5p71_drv1	Corvette & RHIB interaction, Head seas, Reg wave	
"	13:31	0:23	1.207	CR_H_Tp6p28_001	Hs1p23_Tp6p28_drv1	Corvette & RHIB interaction, Head seas, Reg wave	
"	13:54	0:24	1.207	CR_H_Tp6p98_001	Hs1p52_Tp6p98_drv1	Corvette & RHIB interaction, Head seas, Reg wave	
"	14:18	0:21	1.207	CR_H_Tp7p85_001	Hs1p93_Tp7p85_drv1	Corvette & RHIB interaction, Head seas, Reg wave	
"	14:39	0:21	1.207	CR_H_Tp8p98_001	Hs2p51_Tp8p98_drv1	Corvette & RHIB interaction, Head seas, Reg wave	
"							Allow 3 sec overlap for wave segments
"	15:00	0:24	1.207	CR_H_Irr_001	irr_hs1p25_tp7p5_003	Corvette & RHIB interaction, Head seas, Irr wave	Start cariage @ 115 sec, wave segment start @ 0 offset
"	15:24	0:24	1.207	CR_H_Irr_002	irr_hs1p25_tp7p5_003	Corvette & RHIB interaction, Head seas, Irr wave	Start cariage @ 115 sec, wave segment start @ 85 offset
"	15:48	#########	1.207	CR_H_Irr_003	irr_hs1p25_tp7p5_003	Corvette & RHIB interaction, Head seas, Irr wave	Start cariage @ 115 sec, wave segment start @ 167 offset
9-Dec-16	8:00						Hydraulic pumps on
"	8:55						Rezero waveprobes & sinkage
"							
"							Allow 3 sec overlap for wave segments
"	9:03	0:23	1.207	CR_H_Irr_004	irr_hs1p25_tp7p5_003	Corvette & RHIB interaction, Head seas, Irr wave	Start cariage @ 115 sec, wave segment start @ 0 offset
"	9:26	0:22	1.207	CR_H_Irr_005	irr_hs1p25_tp7p5_003	Corvette & RHIB interaction, Head seas, Irr wave	Start cariage @ 115 sec, wave segment start @ 82.5 offset
"	9:48	0:22	1.207	CR_H_Irr_006	irr_hs1p25_tp7p5_003	Corvette & RHIB interaction, Head seas, Irr wave	Start cariage @ 115 sec, wave segment start @ 159.9 offset
"	10:10	0:22	1.207	CR_H_Irr_007	irr_hs1p25_tp7p5_003	Corvette & RHIB interaction, Head seas, Irr wave	Start cariage @ 115 sec, wave segment start @ 236.7 offset
"	10:32	0:16	1.207	CR_H_Irr_008	irr_hs1p25_tp7p5_003	Corvette & RHIB interaction, Head seas, Irr wave	Start cariage @ 115 sec, wave segment start @ 318.7 offset
"							
"	10:48	2:17	1.207	CR_H_Tp8p98_002	Hs2p51_Tp8p98_drv1	Corvette & RHIB interaction, Head seas, Reg wave	For picture purposes only
"							
"							Rotate model to following seas
"							Model pitch showed -0.13° when model was rotated, was rezeroed
"	13:05	0:21	1.207	CR_F_Irr_001	irr_hs1p25_tp7p5_003	Corvette & RHIB interaction, Following seas, Irr wave	Start cariage @ 110 sec, wave segment start @ 0 offset
"							Change settings
"	13:26	0:21	1.207	CR_F_Irr_002	irr_hs1p25_tp7p5_003	Corvette & RHIB interaction, Following seas, Irr wave	Start cariage @ 100 sec, wave segment start @ 0 offset
"	13:47	0:20	1.207	CR_F_Irr_003	irr_hs1p25_tp7p5_003	Corvette & RHIB interaction, Following seas, Irr wave	Start cariage @ 100 sec, wave segment start @ 49.8 offset
"	14:07	0:19	1.207	CR_F_Irr_004	irr_hs1p25_tp7p5_003	Corvette & RHIB interaction, Following seas, Irr wave	Start cariage @ 100 sec, wave segment start @ 101 offset
"	14:26	0:17	1.207	CR_F_Irr_005	irr_hs1p25_tp7p5_003	Corvette & RHIB interaction, Following seas, Irr wave	Start cariage @ 100 sec, wave segment start @ 162.8 offset, discard run, RHIB out of control
"	14:43	0:20	1.207	CR_F_Irr_006	irr_hs1p25_tp7p5_003	Corvette & RHIB interaction, Following seas, Irr wave	Start cariage @ 100 sec, wave segment start @ 162.8 offset
"	15:03	0:18	1.207	CR_F_Irr_007	irr_hs1p25_tp7p5_003	Corvette & RHIB interaction, Following seas, Irr wave	Start cariage @ 100 sec, wave segment start @ 218 offset
"	15:21	0:20	1.207	CR_F_Irr_008	irr_hs1p25_tp7p5_003	Corvette & RHIB interaction, Following seas, Irr wave	Start cariage @ 100 sec, wave segment start @ 276.6 offset

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TEST LOG

Clearwater Towing Tank(CWT)

OCEAN, COASTAL & RIVER ENGINEERING(OCRE)

RHIB / CORVETTE SEAKEEPING INTERACTION

DATE	TIME	WAIT TIME ACTUAL	Speed (m/s)	FILENAME(.DAC)	Wave Drive Signal	RUN DESCRIPTION	COMMENTS
"	15:41	0:19	1.207	CR_F_Irr_009	irr_hs1p25_tp7p5_003	Corvette & RHIB interaction, Following seas, Irr wave	Start cariage @ 100 sec, wave segment start @ 322 offset
12-Dec-16	8:08						Hydraulic pumps on
"	9:00						Rezero waveprobes & sinkage - Charge qualisys
"	10:15	0:19	1.207	CR_F_Tp3p14_001	Hs0p31_Tp3p14_drv2	Corvette & RHIB interaction, Following seas, Reg wave	
"	10:34	0:18	1.207	CR_F_Tp3p14_002	Hs0p31_Tp3p14_drv2	Corvette & RHIB interaction, Following seas, Reg wave	
"	10:52	0:18	1.207	CR_F_Tp3p31_001	Hs0p34_Tp3p31_drv4	Corvette & RHIB interaction, Following seas, Reg wave	
"	11:10	0:16	1.207	CR_F_Tp3p49_001	Hs0p38_Tp3p49_drv1	Corvette & RHIB interaction, Following seas, Reg wave	
"	11:26	0:16	1.207	CR_F_Tp3p70_001	Hs0p43_Tp3p70_drv1	Corvette & RHIB interaction, Following seas, Reg wave	
"	11:42	0:18	1.207	CR_F_Tp3p93_001	Hs0p48_Tp3p93_drv1	Corvette & RHIB interaction, Following seas, Reg wave	
"	12:00	0:16	1.207	CR_F_Tp4p19_001	Hs0p55_Tp4p19_drv1	Corvette & RHIB interaction, Following seas, Reg wave	
"	12:16	0:18	1.207	CR_F_Tp4p49_001	Hs0p63_Tp4p49_drv1	Corvette & RHIB interaction, Following seas, Reg wave	
"	12:34	0:17	1.207	CR_F_Tp4p83_001	Hs0p73_Tp4p83_drv1	Corvette & RHIB interaction, Following seas, Reg wave	
"	12:51	0:19	1.207	CR_F_Tp5p24_001	Hs0p86_Tp5p24_drv1	Corvette & RHIB interaction, Following seas, Reg wave	
"	13:10	0:22	1.207	CR_F_Tp5p71_001	Hs1p02_Tp5p71_drv1	Corvette & RHIB interaction, Following seas, Reg wave	
"	13:32	0:18	1.207	CR_F_Tp6p28_001	Hs1p23_Tp6p28_drv1	Corvette & RHIB interaction, Following seas, Reg wave	
"	13:50	0:16	1.207	CR_F_Tp6p98_001	Hs1p52_Tp6p98_drv1	Corvette & RHIB interaction, Following seas, Reg wave	
"	14:06	0:17	1.207	CR_F_Tp7p85_001	Hs1p93_Tp7p85_drv1	Corvette & RHIB interaction, Following seas, Reg wave	
"	14:23	0:25	1.207	CR_F_Tp8p98_001	Hs2p51_Tp8p98_drv1	Corvette & RHIB interaction, Following seas, Reg wave	
"	14:48	0:12	1.207	CR_F_Tp8p98_002	Hs2p51_Tp8p98_drv1	Corvette & RHIB interaction, Following seas, Reg wave	
14/12/2016	8:15						Hydraulic pumps on
"	9:00						Rezero waveprobes
"	9:05	0:20	1.207	R_H_Tp3p14_001	Hs0p31_Tp3p14_drv2	RHIB, Head seas, Reg wave	
"	9:25	0:23	1.207	R_H_Tp3p31_001	Hs0p34_Tp3p31_drv4	RHIB, Head seas, Reg wave	
"	9:48	0:19	1.207	R_H_Tp3p49_001	Hs0p38_Tp3p49_drv1	RHIB, Head seas, Reg wave	
"	10:07	0:19	1.207	R_H_Tp3p70_001	Hs0p43_Tp3p70_drv1	RHIB, Head seas, Reg wave	
"	10:26	0:20	1.207	R_H_Tp3p93_001	Hs0p48_Tp3p93_drv1	RHIB, Head seas, Reg wave	
"	10:46	0:21	1.207	R_H_Tp4p19_001	Hs0p55_Tp4p19_drv1	RHIB, Head seas, Reg wave	
"	11:07	0:20	1.207	R_H_Tp4p49_001	Hs0p63_Tp4p49_drv1	RHIB, Head seas, Reg wave	
"	11:27	0:20	1.207	R_H_Tp4p83_001	Hs0p73_Tp4p83_drv1	RHIB, Head seas, Reg wave	
"	11:47	0:24	1.207	R_H_Tp5p24_001	Hs0p86_Tp5p24_drv1	RHIB, Head seas, Reg wave	
"	12:11	0:18	1.207	R_H_Tp5p71_001	Hs1p02_Tp5p71_drv1	RHIB, Head seas, Reg wave	
"	12:29	0:25	1.207	R_H_Tp6p28_001	Hs1p23_Tp6p28_drv1	RHIB, Head seas, Reg wave	
"	12:54	0:19	1.207	R_H_Tp6p98_001	Hs1p52_Tp6p98_drv1	RHIB, Head seas, Reg wave	
"	13:13	0:20	1.207	R_H_Tp7p85_001	Hs1p93_Tp7p85_drv1	RHIB, Head seas, Reg wave	
"	13:33	0:21	1.207	R_H_Tp8p98_001	Hs2p51_Tp8p98_drv1	RHIB, Head seas, Reg wave	
"	13:54	0:22	1.207	R_H_Irr_001	irr_hs1p25_tp7p5_drv3	RHIB, Head seas, Irr wave	Start cariage @ 115 sec, wave segment start @ 0 offset
"	14:16	0:19	1.207	R_H_Irr_002	irr_hs1p25_tp7p5_drv3	RHIB, Head seas, Irr wave	Start cariage @ 115 sec, wave segment start @ 78.3 offset
"	14:35	0:20	1.207	R_H_Irr_003	irr_hs1p25_tp7p5_drv3	RHIB, Head seas, Irr wave	Start cariage @ 115 sec, wave segment start @ 78.3 offset Repeat model out of qualisys at start
"	14:55	0:20	1.207	R_H_Irr_004	irr_hs1p25_tp7p5_drv3	RHIB, Head seas, Irr wave	Start cariage @ 115 sec, wave segment start @ 159.6 offset
"	15:15	0:20	1.207	R_H_Irr_005	irr_hs1p25_tp7p5_drv3	RHIB, Head seas, Irr wave	Start cariage @ 115 sec, wave segment start @ 241.4offset
"	15:35	0:10	1.207	R_H_Irr_006	irr_hs1p25_tp7p5_drv3	RHIB, Head seas, Irr wave	Start cariage @ 115 sec, wave segment start @ 322.7offset
15-Dec-16	8:30						Hydraulic pumps on
"	9:00						Rezero waveprobes
"	9:14	0:21	1.207	R_F_Tp3p14_001	Hs0p31_Tp3p14_drv2	RHIB, Following seas, Reg wave	
"	9:35	0:25	1.207	R_F_Tp3p14_002	Hs0p31_Tp3p14_drv2	RHIB, Following seas, Reg wave	
"	10:00	0:25	1.207	R_F_Tp3p31_001	Hs0p34_Tp3p31_drv4	RHIB, Following seas, Reg wave	
"	10:25	0:23	1.207	R_F_Tp3p31_002	Hs0p34_Tp3p31_drv4	RHIB, Following seas, Reg wave	
"	10:48	0:21	1.207	R_F_Tp3p49_001	Hs0p38_Tp3p49_drv1	RHIB, Following seas, Reg wave	
"	11:09	0:21	1.207	R_F_Tp3p70_001	Hs0p43_Tp3p70_drv1	RHIB, Following seas, Reg wave	
"	11:30	0:19	1.207	R_F_Tp3p93_001	Hs0p48_Tp3p93_drv1	RHIB, Following seas, Reg wave	
"	11:49	0:53	1.207	R_F_Tp4p19_001	Hs0p55_Tp4p19_drv1	RHIB, Following seas, Reg wave	