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Technical Report

JOINT VENTURE (HSV-X1) SEAKEEPING AND STRUCTURES MEASUREMENTS FROM OCTOBER 2001 THROUGH NOVEMBER 2002

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14. ABSTRACT
Seakeeping and Structural Loads trials were conducted about Joint Venture during ship availability periods from October 2001 through November 2002. The primary objective has been to quantify the operational performance of the test ship so as to access its applicability to proposed future missions. A test plan was documented to evaluate an operational profile of HSV-X1, but not all of the planned test conditions were found. The combination of the ship's availability and the seas that were encountered during the available periods did not yield a complete set of sea conditions that were necessary to fully define the operational profile of Joint Venture.

The operability of Joint Venture was not impacted in low to mid Sea States 4 regardless of speed and heading. Operating in Sea State 5 (above 8 feet) can have an impact on the operability of the ship depending on the relative wave heading and encounter period. During the 24 Hour Load-Out South test period and the transit from Rota to Larvik, significant slamming occurred in a high Sea State 4 to low Sea State 5, for head/bow seas. In some instances wave impact loading lead to damage of transverse frames and smaller structural details in the flat portion of the bow flare outboard of the center bow. A large data set for wave impact measurements was collected for the bow region.

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A comparison of motions at three speeds demonstrated that the HSV-X1 behaves like a wave piercing catamaran at high speeds and like a displacement hull at low speeds. The ride control system provided a beneficial reduction in roll and pitch motion and transverse accelerations during the test conditions in a Sea State 4. Structural responses increase with speed, but drop off dramatically after 33 knots in the absence of bow slamming. Two follow-on programs have been started to convert measured structural response as strain to load. These loads will support future developments of high speed Naval vessel rules.

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Abstract

Seakeeping and Structural Loads trials were conducted aboard *Joint Venture* HSV-X1 during ship availability periods from October 2001 through November 2002. The primary objective was to quantify the operational performance of the test ship so as to assess its suitability for proposed future missions. A test plan was documented to evaluate an operational profile of HSV-X1, but not all of the planned test conditions were found. Although the combination of the ship's availability for testing and the seas that were encountered during the available periods did not yield a complete set of sea conditions that were necessary to fully define the operational profile of *Joint Venture*, substantial data were acquired.

The operability of *Joint Venture* was not impacted in low to mid Sea States 4 regardless of speed and heading. Operating in Sea State 5 (above 8 feet) can have an impact on the operability of the ship depending on relative wave heading, encounter period, trim and displacement. During the USMC 24 hour load-out LOE transit between Little Creek and Morehead City NC, and the transit from Rota, Spain to Larvik, Norway, significant slamming occurred in a high Sea State 4 to low Sea State 5, for head/bow seas. In some instances wave impact loading led to damage of transverse frames and smaller structural details in the flat portion of the bow flare outboard of the center bow. A large data set for wave impact measurements was collected for the bow region. A comparison of motions at three speeds demonstrated that the HSV-X1 behaved like a wave piercing catamaran at high speeds and like a displacement hull at low speeds. The ride control system provided a beneficial reduction in roll and pitch motion and transverse accelerations during the test conditions in a Sea State 4. Structural responses increased with speed but dropped off dramatically after 33 knots in the absence of bow slamming. Two follow-on programs have been started to convert measured structural response (strain) to load. These loads will support future developments of high speed Naval vessel rules.

Administrative Information

The work described in the report was performed by the Seakeeping Department (Code 55) and the Structures and Composites Department (Code 65) of the Naval Surface Warfare Center Carderock Division (NSWCCD). The work was sponsored by the Office of Naval Research (ONR), Littoral Combat and Power Projection FNC, Expeditionary Logistics Component, High Speed Shuttle Product Line and the ONR Swampworks. The Principal Investigators from ONR were Andy Kondracki (ExLog FNC) and Dr Maribel Soto (Swampworks). The Project Manager from NSWCCD was Jack Offutt (Code 28).

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Introduction

The United States Government is currently exploring the use of high-speed vessels for a variety of military and Coast Guard missions in the High Speed Vessel (HSV) Project. This project involves the leasing of a Commercial-Off-The-Shelf (COTS) high-speed ferry (*Joint Venture* HSV-X1) and the use of this vessel in a number of limited-objective experiments (LOEs). The opportunity to study seakeeping and structural performance of an existing high-speed craft provides critical information for future Naval designs. The subject test ship is a wave-piercing catamaran built by INCAT of Tasmania, Australia. The joint experimentation team, led by the Naval Warfare Development Command (NWDC), is using this vessel as a experimental platform to explore the potential benefits of relatively small high speed vessels to a number of missions through the LOEs and participation in specific military exercises and fleet experiments. The primary objective has been to quantify the operational performance of the test ship so as to assess its applicability to proposed future missions. An operational profile would be defined by the envelope of safe seakeeping and structural performance demonstrated during dedicated trials.

Testing to define the operational profile was conducted over a 14-month period, from October 2001 to December 2002. During this period, several LOEs, dedicated trials and transits were performed. Each of the data collection periods was reported by way of a NSWCCD Quick-Look report, providing details on the test operation and the events that occurred. This report summarizes and further examines the dedicated trials data that were collected during the duration of the test program.

A test plan, Reference 1, was written to evaluate an operational profile of HSV-X1, but not all of the planned test conditions were found. The combination of the ship's availability and the seas that were encountered during the available periods did not yield a complete set of sea conditions that were necessary to fully define the operational profile of Joint Venture. This report will provide a description of the ship particulars, the data collection instrumentation, a brief summary of the trials, LOEs, and comparisons of characteristics at different sea states, headings, displacements, speeds and ride control operation.

Background

Joint Venture (HSV-X1) is a 96 meter wave piercing catamaran that was modified for the experimentation program to provide multiple mission capability. The primary modifications were the installation of a helicopter flight deck and communications (C4ISR) room, and the addition of a starboard aft slewing stern ramp to accommodate heavy Roll On / Roll Off

(RO/RO) vehicles. The ship can be seen in Figures 1, 2, and 3 with its particulars shown in Table 1.

Monitoring ship motions, ship control functions, and the wind wave environment provides the basis for assessing the seakeeping performance of the ship. The sensors monitored are comprised of a combination of NSWC provided transducers and tie-ins to shipboard systems. Seakeeping objectives include quantification of the ships motions as a function of sea state, ship heading, ship speed and displacement. Ride Control system effectiveness is assessed through comparison of ship motions with control system on and off.

The structural instrumentation installed on the HSV-X1 provides measurements of primary hull girder response and local wave impact response for the wet deck and center hull. Structural monitoring provides critical information on primary structural loading up to the design operating limits of the craft. Analysis of this data provides knowledge of hull girder steady state and transient vibratory responses and their relation to ordinary wave responses. The measured structural responses are used in conjunction with Finite Element Modeling (FEM) to generate load time histories. The load time histories are used in the development of Response Amplitude Operators (RAOs) and the determination of parent population statistics used in extreme load prediction and reliability analyses.

The design of lightweight high-speed craft requires the optimization of structural details to reduce weight. Secondary loads data resulting from wave impacts at high speed are invaluable for future designs that utilize advanced, light weight materials.

Results of this effort will quantify structural performance and provide knowledge to advance the state of the art of HSV technology. Additional strain gage instrumentation was installed to monitor helicopter flight deck stresses resulting from the combination of landing gear wheel loads and environmental loads.

The seakeeping and structural loads trials and LOEs provided several opportunities to collect data in Sea State 4, while exposure to Sea States 3 and 5 was limited. A brief description of each trial or LOE will be provided accompanied by a nominal discussion of the data. A list of the milestones of data collection can be seen in Table 2, while a more thorough presentation of each of the test periods can be found in References 1 through 5. Following the discussion of the data, comparative data plots will be presented with discussion.

The goal of defining the operational profile of the HSV-X1 for seakeeping and structures began with the “Seakeeping” trial in October 2001. *Joint Venture* put to sea for a three day period from October 29 to 31, 2001, to conduct helicopter flight deck certification and seakeeping and loads trials. Helicopter operations were conducted approximately 10 miles offshore of Wallops Island, Virginia, on October 30 and 31. Seakeeping and loads trials were conducted during the evening of October 30, further offshore in deep water. Details of the trials can be found in Reference 2.

Sea conditions present for these operations were mid-level Sea State 4 with winds of 15 to 20 knots. There were no unusual or limiting motions evident in the performance of the vessel throughout its operating speed range. The seas, which ranged from 4.8 feet significant on initial reading to 5.7 feet on final reading, represent the low end of the range of sea conditions of interest.

Two Marine Corps exercises were conducted in the following months. The first exercise was the Morehead City, NC to Blount Island, FL load-out, 27-29 November 2001, and the second was the Little Creek, VA to Morehead City and return 24-hour load-out, 09-11 January 2002. The seaway was the major distinction between the two load-outs. The Blount Island load-out experienced mild seaway conditions and slamming did not develop. During the 24-Hour load-out severe slamming loads were measured in the transit south from Little Creek NAB to Morehead City for approximately five hours. The slamming loads resulted in significant damage to the starboard cross structure between Frames 57 and 63, see Reference 3. The same area on the port side received minor damage.

Static and dynamic structural response measurements were successfully made during the Blount Island load out exercise on 27-29 November 2001. The data will provide for an evaluation of structural response due to an increased displacement resulting from eight Assault Amphibious Vehicles (AAVs). The load-out provided a means to conduct a controlled experiment by which significant structural responses could be achieved through vehicle loading. The AAV loading provided a dense vehicle deck loading and the ships displacement was maximized for the transit to Blount Island by having the fuel tanks at high capacity. This data can be used in conjunction with the whole ship Finite Element Model (FEM) of Hull 050 to provide calibrations necessary to convert measured strains to load. Knowledge of environmental loading is critical to future HSV designs for unrestricted applications. During the transit to Blount Island no wave impact events were observed.

One objective of the USMC 24-hour LOE was to transit from NAB Little Creek, VA to Morehead City, NC, pick up approximately 175 Marines and their equipment, and return to NAB Little Creek within 24 hours. Shortly after midnight on the night of January 10th, 2002, *Joint Venture* departed NAB Little Creek, VA in route to Morehead City, NC. The HSV had a full load of fuel, long range and day tanks, but no cargo on deck for the transit south. The return trip had approximately 175 Marines and their cargo onboard and a fuel load reduced by the expenditure of fuel on the transit to Morehead City. Based on draft mark readings the ship displacement for the return trip was approximately 1650 to 1700 mtons. Available draft marks, heal and trim are presented in Table 3. Return departure occurred at approximately 1800 hours. Total time to transit to Morehead City, load the Marines and their gear, and return to NAB was approximately 32 hours. The seas were measured to be 6.7 feet significant with a modal period of 6.3 seconds by the shipboard TSK wave sensor. The sea condition was measured earlier by a NOAA wave buoy in the general vicinity. The NOAA marine service identified the waves as being steep. Additional details of the two Marine Corps LOEs are provided in Reference 3.

During the winter of 2002, operational and war game exercises were conducted in the North Sea and Baltic Sea areas. The process of defining the operational profile of the HSV-X1 for seakeeping and structures thus shifted to the North and Baltic Sea areas. Data were collected for dedicated seakeeping/structures testing and during the various operational exercises and war games. Moreover, the North Atlantic crossing en route to Norway provided an opportunity to collect additional seakeeping and structural data. Data were also collected during the crossing in an effort to determine if a relationship between fuel consumption and speed could be determined. The Atlantic transit occurred between 5 and 16 February 2002, while the North Sea and Baltic Sea data collection took place from 1 to 8 March 2002. The Transatlantic trip began with a displacement of approximately 1700 mtons, while the Rota, Spain to Larvik, Norway run started with a displacement of about 1545 mtons.

The Transatlantic - North Sea - Baltic trials have contributed valuable structural measurements to the growing database established over the past year. A significant population of wave impacts was recorded during the Rota to Larvik transit supplementing the wave impact data collected in January off the coast of Cape Hatteras. Damage due to wave impact loading was observed in both port and starboard bow structure. The pattern of damage observed in the past was different in that only the starboard bow structure was affected. Details of the Transatlantic crossing and North Sea – Baltic Sea trials can be found in Reference 4.

The Transatlantic – North Sea – Baltic trials also provided a test bed for ship to shore data collection. This allowed for operation of shipboard data collection hardware from the lab at NSWCCD. This capability required access to the ships existing non-secure network. Operation of data collection software was successful as was the transfer of data. A second attempt at remote data collection during the ships operations in the Persian Gulf Region failed as a result of undetermined network firewall issues.

The goal of further defining the operational profile of the HSV-X1 provided impetus to schedule additional trials during the lease period. Trials were scheduled for two periods during the first quarter of FY 2003 in an attempt to collect data in sea and ship conditions that hadn't yet been realized. In addition, propulsion trials were added to the schedule to be conducted as time allowed.

The first set of FY03 trials was scheduled for and took place aboard HSV-X1 *Joint Venture* from November 19 to November 22, 2002. There were no limiting conditions encountered during the trial period in transit between Little Creek, VA and Newport, RI. The second trial period scheduled for December was postponed due to engine repair period for the casualty that occurred during the first trial. The port inner main engine (PIME) failed due to a crankshaft bearing failure. The vessel was in for repairs during the second scheduled period. An alternate second trial period was scheduled but canceled due to operational deployment of *Joint Venture* to the Persian Gulf Region.

The aforementioned engine failure occurred on the engine that was instrumented to provide torque and fuel measurements in support of the propulsion trials. As a consequence the propulsion trials could not be performed. However, the portable, Caterpiller-provided fuel-metering equipment was shifted from the PIME to the starboard inner main engine and the fuel economy trials were conducted using three engines. Details of the Newport trials and fuel economy tests can be found in Reference 5.

Instrumentation

Prior to the delivery of the HSV-X1 to the United States, a team of NSWCCD personnel traveled to INCAT ship building facilities in Tasmania to install motion sensors and strain gages. At that time, Hull 050 was undergoing substantial modifications to meet the needs of the forth-coming lease program. Prior to the arrival of NSWCCD, significant engineering and yard support was provided by INCAT that included the installation of special purpose transducer mounts and cabling. Extensive cabling was required to connect transducers and strain gages with the data recording hardware located on the Passenger Deck. The Instrumentation Room was a modified space provided by INCAT to support termination of all signal cables, 120 volt 60 Hz power, a foundation for two data recording equipment racks, and a table for keyboards and computer monitors. INCAT also provided special purpose antenna installations and connections with many shipboard systems. Installation of sensors, strain gages and recording equipment began in Tasmania on 29 August 2001 and finished on 10 September 2001. Installation was completed at Little Creek Amphibious Base in Norfolk, Virginia by the end of October 2001. Details of the instrumentation system are provided in Reference 1.

Data Acquisition System

The data acquisition system is comprised of two data collection computers and one archiving computer networked together within the data collection room located on the Passenger Deck. These PC-based computer systems have Windows 2000 operating systems and use National Instruments hardware with "LabVIEW" software. Measurements of rigid body ship motion and primary structural response are made by a "low-speed" system. Sample rates for low-speed measurements are typically 100 samples per second (100 Hz, based on a maximum frequency of interest of 5 Hz). Measurements of secondary structural responses resulting from wave impacts will be made by a "high-speed" system. Sample rates for high-speed measurements are typically 2000 samples per second (2000 Hz, maximum frequency of interest of 100 Hz). This system is programmed to record just the wave impacts based on pre-programmed triggering values. This economical technique allows for the digitization of slamming events rather than continuous time histories. High-speed data collection can also be performed continuously, if required. The high-speed computer runs independent of the low-speed data collection computer. The archiving computer is dedicated to backing up the data stored on both data acquisition computers. Real time data can be examined visually using the data collection software on the low-speed system. The archiving computer can analyze both high-speed and low-speed data after a run is completed. A run is the process of recording time history data from the installed sensors as the ship is operated at a constant speed and heading for a predetermined length of time. The run log for each of the trials runs and LOEs is provided in the appropriate quick look report.

Seakeeping Performance Instrumentation

Seakeeping is monitored using the sensors listed in Tables 4 and 5. The monitoring sensors are comprised of a combination of NSWCCD provided transducers and various ship board systems. All seakeeping related channels are digitized by the low speed system at 100 Hz or less. Primary ship motion parameters such as angles, rates, and accelerations are monitored at various locations around the ship. There are three-axis accelerometer packages located at the bow, bridge, LCG, and flight deck. Roll and pitch angles and rates are measured at the LCG. In addition to ship motions, the wind-wave environment is also monitored and recorded. A TSK wave height system is installed at the bow of the ship. A wind speed and direction sensor is installed on the ship's mast. A wave height buoy system has also been installed on board to allow deployment of wave height buoys, which after being deployed telemeter wave height data back to the ship.

Several shipboard control systems are also monitored as well. The position of the T-foils and trim tabs are monitored along with waterjet nozzle angle, and waterjet shaft speed. The tie-ins to these shipboard systems are made through optical isolators as not to corrupt the integrity of the shipboard system due to the monitoring process. Fuel flow meters were installed by INCAT on each of the four main engines. They failed to operate. Towards the end of the test period, Caterpillar was contracted to install a temporary system for a limited period of powering tests, as discussed in Reference 5. A tie-in to the ships GPS system is also provided by INCAT. The ships track, course, and speed channels listed in Table 6 are recorded from the GPS.

Structural Performance Strain Gage Instrumentation

Strain gage instrumentation was installed on aluminum structure to support the measurements listed in Tables 7 and 8. The global structural response channels listed in Table 7 are digitized by the slow-speed system. The wave impact channels were installed on longitudinal stiffeners located in the center bow and wet deck and digitized by the high-speed system. Major transverse bulkheads and frames were constructed of 5383-H321 or H116 aluminum. Other parts of the structure are comprised of 6082 and 5083 aluminum extrusions.

The previous instrumentation efforts put forth on INCAT Hull Number 050 have significant merit for stress measurement and validation of Finite Element Modeling (FEM) and analysis. However, the ideal locations of interest and the measurement techniques particular to the U.S. Navy greatly differ. The approach needed for the Navy was to define global loading requiring strain gage instrumentation on continuous longitudinal structure and transverse bulkheads. It is important to locate gages in specific areas of the structure insuring sensitivity to one type of seaway loading. Sample rates were chosen to define peak accuracy at 98 percent using a sample rate 20 times above the highest frequency of interest which is based on first mode responses. Higher structural modal responses require higher sample rates but these responses are small in magnitude and of less interest to the designer. Global structural responses during slam events can have rise times of 0.10 seconds (100 milliseconds), and local structure has much faster rise times of 3 to 5 milliseconds. The sample duration for strain gage signals measuring ordinary wave response ranged from 20 to 30 minutes in length to adequately define a transfer function or Response Amplitude Operator (RAO). RAO's are an important step in the probabilistic approach to ship structural design and for making fatigue life estimates in the frequency domain. Complete details on HSV-X1 structural strain gage instrumentation can be found in Reference 1.

The measurement of wave impact loading is made using local structural response. On the HSV-X1, strain gages were installed on longitudinal stiffeners, or T-Bars, to measure differential bending, which can be related to a uniform static pressure. Because of the transient nature of wave impact loading high sample rates are required by the data recording computer.

The success of the loads measurement approach requires the use of a whole ship FEM. A detailed Finite Element Analysis (FEA) of the global structure and local structure provide the means of converting measured structural response in strain to load (i.e. vertical, lateral, torsional, or transverse bending), which in tern can be used to determine design loads for follow-on designs.

Seakeeping

Dedicated seakeeping and loads trials are performed using an octagon pattern of ship headings with respect to the predominant wave direction, each leg of which is run at constant speed. Each octagon begins and ends with the recording of sea conditions using the onboard

TSK wave sensor. To accomplish this, the HSV-X1 was run at near zero, or steerage, speed and headed directly into the seas during the two data runs recorded to document the sea conditions. This orientation yields the natural wave conditions, vice the encountered wave conditions. The natural significant wave height and modal periods for the octagons and LOEs are shown in Table 9. For the series of Seakeeping and Loads test runs, the HSV-X1 was operated at a designated speed, and held steady on course and speed for each test run. The series of runs, known as legs of an octagon, included five ship headings relative to the direction of the seaway. The five runs included relative wave headings of Head, Bow, Beam, Quarter, and Following sea conditions. The run matrix, shown in Table 10, was designed to collect data over a variety of sea conditions, speeds and headings. The cells of the matrix that are occupied by a date indicate the condition was completed on the indicated date. An "O" in a cell indicates the condition was not realized. Completing a seakeeping and loads test plan is limited by the sea conditions encountered during the availability period of the ship.

Preliminary data taken from these dedicated trials were compared with motion criteria limiting values in References 4 and 5. The limiting values are described in NAVSEA report "Motion Induced Degradation of Ship Systems", Report 3213-79-24 of September 1979 (Reference 6). The "Personnel" limit is stated to be "motion limit criteria for full personnel effectiveness", page 85 of the referenced document. The referenced document states that "seasickness is a function of frequency, acceleration and time of exposure", page 84. Note that the reference to limiting values here are for motion amplitudes only. The referenced document provides limiting "Personnel" values for four motions; roll – 10 degrees, pitch – 3 degrees, vertical acceleration – 0.4 gs, and lateral acceleration – 0.2 gs. The speed and wave height operational limits set by DNV for the HSV-X1 are shown in Figure 4.

The raw data for each of the octagons and LOEs have been presented and discussed in the appropriate quick look report (References 1 – 5). Measured data values presented are computed as twice the standard deviation. This value corresponds to the statistical value for Significant Single Amplitudes (SSA). In the referenced reports the significant single amplitude values of channels 24, 25, and 29 through 40 are plotted for each octagon. The data were high-pass filtered to eliminate the low frequency noise and are presented in Tables 11 through 14. The octagons in these tables are grouped for comparisons to be discussed later. The first column in the table consists of the octagon name and the relative heading. The second column indicates the condition that is being compared. The remaining columns provide the significant single amplitude values of the channels of interest. The last column represents the encountered significant wave height, i.e. the measured waves that are encountered while the ship is underway.

Seakeeping Octagon

The first octagon was conducted with the vessel at 35 knots, with the ride control system engaged, in a Sea State 4. The track of *Joint Venture* is shown in Figure 5. It is depicted as red bullets offshore of Wallops Island, VA. The waves were measured prior to and following the octagon. Prior to the octagon, the significant wave height was 4.8 feet with a wave period of 11.7 seconds. Following the octagon, the waves were 5.7 feet significant with a period of 10.2 seconds. The vessel was able to reach and maintain a speed of 35 knots through all relative wave headings without difficulty, as described in Reference 2.

24 Hour Load Out LOE

During the 24 Hour Load Out South, Joint Venture passed in the vicinity of a NOAA wave buoy that indicated the seas were approximately 8.5 feet significant. The peak period of the seaway, as measured, was between 5.8 and 6 seconds, corresponding to a wavelength of 180 to 200 feet. The waves were later measured by the shipborne TSK to be 6.7 feet significant with a modal period of 6.3 seconds. Much of the transit was conducted in fairly shallow water, often less than 20 fathoms in depth. The HSV-X1 track is shown in Figure 6.

Transit through the steep seas produced a very rough ride while heading south and southwest. As indicated in Reference 3, the accelerations were high due in part to the short, steep sea conditions. This explains the high incidence of seasickness during the transit. The average period for the roll motions was between 6 and 6.5 seconds while for pitch it was between 4 and 5 seconds. The ride south took approximately 10.5 hours. There was a great deal of bow and aft wet deck slamming during the transit. In the worst portions of the transit, analysis of the impact data indicates there were periods of 100 to 120 slams per hour. The ship speed was varied during the transit, as was the ship heading relative to the waves. These variations in heading and speed were tried with the objective of reducing slamming. The speed was varied from 20 knots to 32 knots, and relative wave headings of head sea, 20 degrees off the bow, 30 degrees off the bow, 45 degrees off the bow, and 60 degrees off the bow were run. The 30 plus knot speeds were run to see if the ride improved past hump speed with the vessel on plane. The headings off the bow were run to effectively lengthen the wave spacing relative to ship heading. Off bow headings did reduce slamming somewhat, but not significantly until headings of 45 and 60 degrees were reached. Slamming continued to occur to some degree at all headings forward of beam and all speeds run between 20 and 32 knots until near the end of the transit. The ride did improve somewhat at planing speeds, but at the higher speed the impacts were more violent so no clear advantage was realized. Frequent large accelerations associated with the wave impacts were recorded. Review of the data reported in Reference 3 indicates peak accelerations reached values of -1.8 g's at the LCG and +2.4 g's at the bow. The waves were steep enough to induce 'double slamming' events on many occasions. The HSV-X1 would nose down and slam into a sea ahead of it, pitch up quickly upon bow impact, causing a smaller slam from another wave crest in the after portions of the wet deck cross structure. A limitation of 35 knots in 12.5-foot seas, and 30 knots in 16.4-foot seas is posted on the ship's bridge. The ship was operated within these speed / wave height limitations. This violent ride in these 6 to 10 foot seas indicates that a better understanding of ship performance as a function of wave period, or wavelength, in combination with wave height must be gained through further testing. Encountering 6 to 10 foot seas at wave periods of 10 to 12 seconds would be of interest for comparison purposes. Also, operation at relative wave headings aft of the beam resulted in a much improved ride quality with no slamming.

Transatlantic Crossing

During the transatlantic crossing, Joint Venture was able to operate at high speed in beam to following seas of five to nine feet as demonstrated in the Morehead City, NC. to Rota, Spain leg. During the Rota, Spain to Larvik, Norway leg, the ship was able to operate at high speed in head seas for low wave heights at approximately a 10-second period. The swell height was initially low and then grew to seven feet, before darkness prevented further observations. The number and magnitude of slams forced the HSV-X1 to reduce speed during the night. By morning light, the swell had grown to eight to nine feet, and a wind sea had grown from two feet, two seconds to four to five feet, four to five seconds. The track of Joint Venture can be seen in Figure 7, while the details of the measured sea conditions and the motions can be found in Reference 4. Each day's transit in Figure 7 is distinguished by a separate color.

Baltic Octagons

On 2 March 2002 a sequence of three octagons, referred to as Baltic Octagons 1, 2, and 3, respectively, were run to evaluate the seakeeping characteristics of the vessel. The track of *Joint Venture* during each of the octagons can be seen in Figure 8. The first octagon series was conducted with the vessel at 35 knots, with the ride control system secured, in a Sea State 4. Significant wave height immediately prior to this series was 4.8 feet with a wave period of 4.8 seconds. The second series was commenced in virtually the same sea condition (5.1 feet significant and 5.1 seconds) with the vessel at 20 knots, again with the ride control system secured. The seaway increased in height as this series progressed. The third condition was conducted in somewhat higher seas, a high Sea State 4 to low Sea State 5. For this series the vessel speed was increased back to 35 knots, again with the ride control system secured. Wave height during this third octagon varied from 7.2 feet significant and 5.9 seconds prior to the octagon to 8.4 feet significant and 6.3 seconds following. On the following day, 3 March 2002, a fourth octagon sequence, referred to as Baltic Octagon 4, was conducted with the vessel at 35 knots and the ride control system active. Significant wave height during this series was measured at the start to be 5.4 feet with a wave period of 5.5 seconds and 5 feet with a period of 4.6 seconds at the conclusion of the octagon.

As described in Reference 4, the motions encountered during Baltic Octagon 1 at all headings were well below the limiting conditions. The values can be seen in Table 11. Movement at 35 knots in a 5-foot seaway with an approximate wavelength of 125 feet is unrestricted by vessel motions even with the ride control system secured. Similar data for these motions are shown in Table 11 for Baltic Octagon 2 in which vessel speed was slowed to 20 knots in slightly higher seaway – two feet higher at the end. It can be seen that roll motion increases in Bow, Beam, and Quartering headings but is still well below the limiting value. This increase in roll is due, in part, to the reduced hull damping produced at the lower speed. Pitch and vertical acceleration values, while marginally higher, are again well below the limiting criteria. The only notable change is the increase in vertical bow acceleration at the lower speed. Transverse accelerations increase, especially on the bridge, primarily due to the increase in roll angle. During this series, the transverse acceleration on the bridge in beam seas is right at the limiting value. It is to be remembered that these motions are recorded with the ride control system secured. It is expected that roll motion, and the resultant transverse accelerations, would be mitigated with the ride control system active. A ride control comparison is presented in a later section at a ship speed of 35 knots.

Baltic Octagon 3 was conducted with the vessel speed returned to 35 knots, with the ride control system remaining secured. The seas had increased to a significant height of 7.2 to 8.4 feet, corresponding to a high Sea State 4 or a low Sea State 5. Roll and pitch motions, shown in Table 12, remain at about the same, or slightly higher, than the values observed in Baltic Octagon 2 (Table 11). The increase in sea height mitigated any benefit derived from the increase in speed. Vertical motions increase due to the increase in sea height, but remain well under the limiting value, especially on the bridge and at the LCG locations. Transverse accelerations also increase, with the value in beam seas being above the limiting value. The increase in transverse accelerations is continuous throughout this series of three octagon patterns and is indicative of the increasing wave height as the day progressed.

Baltic Octagon 4 (see Table 13) was conducted the following day, 3 March 02. The seaway was very similar to the conditions experienced the previous day during octagons 1 and 2; although it could be argued that the seas were marginally higher during octagon 4. Baltic Octagon 4 was conducted at a vessel speed of 35 knots and the ride control system was active. As reported in Reference 4, the motion values were well below the limiting values indicating that movement in this condition at 25 knots is unrestricted.

Newport Octagons

Joint Venture departed Little Creek 19 November 2002 under a light load condition of 1525 metric tons. The first octagon, Newport Octagon 1, was conducted using three of the four engines, as mentioned earlier. The vessel made 27 knots in a Sea State 4 and the ride control was secured. Newport Octagon 2 was conducted using the two outboard engines. This octagon was conducted at 10 knots, with the ride control secured, in a low Sea State 4. At this slow speed condition the vessel operated in a displacement mode. The tracks of *Joint Venture* can be seen in Figure 5. The first octagon is depicted in yellow and occurs furthest offshore. The second octagon is depicted in orange and is offshore of New Jersey.

Significant data events did not occur during the mild environmental conditions encountered. The highest significant wave height occurred at the beginning of Newport Octagon 1, in a multi-directional sea. Prior to conducting the octagon, the seas were measured to be 5.2 feet significant with a modal period of 9.1 seconds – a low Sea State 4. The spectrum indicated a secondary peak at 6.8 seconds. Following the octagon, the seas were measured to be 4.8 feet significant with a modal period of 8.2 seconds. The second octagon also was conducted in a low Sea State 4, but with a shorter period – 4.4 feet and 5.5 seconds. In addition, some zero speed data were collected demonstrating an interesting multi-modal response of this vessel.

The motions encountered during Newport Octagon 1 can be seen in Table 12. The relative wave headings are presented differently, in this table, than the standard presentation of headings, i.e., head sea through following sea headings. A multi-directional sea was present and the initial heading was not into the predominant wave direction, as was originally observed. The relative headings were re-evaluated and found to be as shown in the table. As could be seen in the figures described in Reference 5, the motions encountered in this condition at all headings were well below the limiting conditions. A speed of 27 knots in a five-foot seaway with a modal wave period of 9.1 seconds is unrestricted by vessel motions even with the ride control system secured. The effect of the multi-directional sea can be seen in the roll motions. The roll angle for starboard bow condition approaches that of the beam and quartering seas conditions. Also the roll angle is not at a minimum for head seas.

The single significant amplitude bow vertical accelerations are on the order of 0.3 gs for head and bow sea conditions. These accelerations are greater than those recorded in head/bow sea conditions for previous octagons in Sea State 4. This is likely due to the longer modal wave period for this octagon. The longer encounter period gives the vessel more time to respond to the wave crests than the shorter periods do. The transverse accelerations increase as the roll motion increases. The greatest transverse accelerations occur on the bridge where there is a greater radius from the center of flotation than for the other accelerometer locations.

Data for Newport Octagon 2 motions are shown in Table 11 in which vessel speed was slowed to 10 knots in essentially the same sea state as Newport Octagon 1, but with a shorter wave period. These conditions are closer to the conditions found in previous trial periods. The vessel responses are indicative of a unimodal sea condition. The motions are lower than those of Newport Octagon 1 and well below the limiting conditions. Roll and transverse acceleration are greatest for beam seas, while pitch and vertical acceleration are greatest for head seas and decrease progressively towards following seas. Vertical accelerations are greater at the ends of the ship (bow and flight deck) than towards the center. Transverse accelerations are greater on the bridge, followed by the flight deck. Again, this is due to the distance from the center of flotation.

A dead-in-the-water (DIW) condition occurred in a multi-modal wave condition. The wave spectrum, along with the roll and pitch responses, can be seen in Figure 9, with wave spectral peaks at frequencies equivalent to 9.1 and 4.3 seconds. Note that the vessel responds to both wave periods in roll and pitch. This is particularly interesting for the roll motion, as it demonstrates that this hull can be excited at more than one roll frequency.

Seakeeping Comparisons

The several opportunities to conduct octagons provided data for some of the test plan conditions shown in Table 10. The run matrix for Sea State 4 was completed, with limited completion of Sea State 5 and no conditions found in Sea State 3. There were no significantly large motions occurring during these test periods.

The data presented in Figure 10 through Figure 27, are comprised of three different groups of comparisons: the effect of speed on motion, the effect of ride control on motion, and the effect of wave period on motion. For each group of comparison, there is a plot of roll, pitch, vertical and transverse accelerations. The accelerations were measured at the bow, the bridge, the LCG, and the flight deck. While vertical, transverse, and longitudinal accelerations are presented in Tables 11 through 14, the comparison plots are for vertical and transverse accelerations only, as these two motions have a more significant effect on ship's company and operations than does the longitudinal acceleration. The measured data values are shown as point symbols with the value given on the vertical scale to the left. Vessel heading relative to the prevailing sea direction is shown on the horizontal scale on the bottom of the figure

Speed Comparison

Figure 10 through Figure 14 present speed comparison trends for a Sea State 4 condition with ride control secured. These data were collected during Baltic Octagon 1, Baltic Octagon 2, and Newport Octagon 2 trials. Figure 10 and Figure 11 provide comparisons of roll angular data and pitch angular data, respectively, while vertical and transverse acceleration data are presented in Figure 12 , 13, 14, and 15, for speeds of 35, 20 and 10 knots.

During these three octagons, *Joint Venture* exhibited conventional roll behavior in these seas. All the runs were conducted in a Sea State 4, but the waves during the 20-knot runs were

40% higher than the waves measured for the two other speeds. Higher seas cause expected higher roll angles, particularly in bow, beam, quartering seas. *Joint Venture* pitches more in head seas at low speed than high speed, as seen in pitch and bow acceleration for 10 knots and 35 knots. The HSV-X1 demonstrates pitch motion behavior of a displacement mode while traveling at 10 knots and wave-piercing characteristics at 35 knots. At high speed, pitching motion is essentially the same magnitude at head and bow seas as it is for beam, quartering and following seas.

Speed had minimal effect on vertical acceleration at the LCG for a given wave height (35 knots v. 10 knots). Also, the vertical accelerations are similar between the LCG and the bridge for all speeds. This is expected since they are located at similar longitudinal locations. Bridge transverse accelerations are two or more times larger than the transverse LCG accelerations. Though the accelerations are not large, it is indicative of the motions experienced on the bridge and should be remembered when ride control systems are based on motions at the LCG. With respect to human factors, it may be advantageous to include a bridge transverse acceleration feedback to the ride control system. Also, vertical accelerations at the bow are significantly larger than on the bridge and so the bridge personnel could be physically unaware of the severity of the ride in the forward part of the ship.

Ride Control Comparison

The second comparative analysis examines the influence of ride control on reducing motions of the ship. In this comparison, it is necessary to operate in similar sea conditions, at a consistent ship speed and equivalent relative wave headings with ride control status on and off. The octagon data used in this comparison is the Baltic Octagon 1 and the Baltic Octagon 4. The ship operated at 35 knots and the seas were low Sea State 4.

Figure 16 through Figure 21 provide the motion data for this comparison in the same format as for the previous cases. As expected, the active ride control system appears to reduce the magnitude of the roll motion. While a roll angle value of 2.08 degrees was recorded in beam seas with the ride control system secured (Figure 16), a roll angle value of 1.23 degrees was recorded with the ride control system active. This indicates that a 41 percent reduction in rolling motion has been achieved. While the reductions in roll motion at other headings vary, the reduction in roll motion is consistent with the ride control system active at all headings. A comparison of pitch motions also shows a consistent, albeit minimal, reduction. Pitch motion is fairly constant across headings with and without ride control on. This demonstrates that, under these conditions, the wave piercing characteristics of HSV-X1 limits the pitch motion in head seas. Another contributor to the above characteristics is that the ride control system may have been tuned to reduce roll motion more than pitch motion. It would be helpful to have a record of the ride control gains for roll and pitch.

Vertical motions are small in both cases with respect to the limiting value and relatively consistent between series, with the exception of quartering seas. When comparing the transverse motions in beam seas, a condition for which a significant reduction would be most welcome, it can be seen that with the ride control system active the transverse motion has been reduced 45 percent. Transverse motions at other relative headings are also reduced, again with the exception of quartering seas. Although not verified within these trials, it is to be expected that similar reductions in transverse motions due to the ride control system would be achieved in higher seas.

As noted above, the vertical acceleration in quartering seas is slightly smaller at all four measurement locations when the ride control is secured than when active. Also, the transverse acceleration is essentially the same at these locations between secured and active ride control. A possible explanation for this occurrence may be due to reduced water flow over the control surfaces at this relative wave heading, limiting the lift effect of the control surfaces.

Wave Period Comparison

The third comparative analysis considers the effect of wave period on the motions of the ship. In this comparison, it is necessary to operate in a similar wave height, at a consistent ship speed and ride control status, and equivalent relative wave headings. The octagon data used in this comparison is the Seakeeping Octagon and the Baltic Octagon 4. The ship operated at 35 knots, the ride control was active and the seas were low Sea States 4. It was noted earlier that a wave period comparison would be useful for the 6 to 10 feet significant height. Unfortunately, seas of a 10 to 12 second period were not to be found at the desired height.

Figure 22 through Figure 27 provide the motion data for this comparison in the same format as for the previous cases. (It should be noted that the plots in this section do not address slamming events). All the motion data for the 11-second wave period condition exhibit the effects of a bi-directional sea. The wave spectrum indicates that a bimodal system was present and the motion data suggests that a secondary wave system is approaching from a direction close to the primary system. When conducting an octagon, the first heading generally is into head seas. If, in this case, discerning the primary wave direction was difficult, it may be that the initial heading was not directly into the primary wave system. As the data suggests, the initial heading was likely between head and starboard bow seas.

The roll, pitch and acceleration trends indicate that Joint Venture exhibits conventional behavior consistent with the relative headings in these seas. Roll behavior is essentially the same between wave periods. Pitch motion at the 5-second wave period exhibits the wave piercing attributes of the HSV-X1 with little variation in magnitude with respect to heading. The greater pitch motion at the 11-second period suggests that the ship has more time to respond to the waves at this greater encounter period. The same can be said for the vertical acceleration trends for both wave periods. Transverse accelerations for the four measurement locations are essentially unchanged between the 11 and 5 second wave periods.

Seakeeping Summary

Testing of the HSV-X1 was conducted over a 14-month period, from October 2001 to December 2002. During this period, several LOEs, dedicated trials and transits were performed. The test plan was designed to examine the HSV-X1 behavior in Sea States 3, 4, and 5. The Sea State 4 condition was encountered primarily, with limited encounters of Sea State 5 and essentially no test periods in Sea State 3.

The operability of Joint Venture was not impacted in Sea State 4 regardless of speed and heading. Operating in Sea State 5 (above 8 feet) can have an impact on the operability of the ship depending on the relative wave heading and encounter period. During the 24 Hour Load-Out South test period, significant slamming occurred in a high Sea State 4 to low Sea State 5. The seas were defined by NOAA as being steep, i.e., having a short wave period for its height.

During the Atlantic transit, the ship was able to operate smoothly at high speed in beam to following seas in up to 9-foot seas, as demonstrated in the Morehead City to Rota leg. During the Rota to Larvik leg, the ship was able to operate at high speed in head seas for low sea conditions of approximately 10-second period. However, as the seas grew, the frequency of slamming forced the HSV-X1 to reduce speed during the night. These wave heights were undefined, as observations could not be made due to darkness. Damage due to wave impact loading was later observed in both port and starboard bow structure. The pattern of damage observed in the past was different in that only the starboard bow structure was affected.

The pitch and vertical accelerations were greater in head and bow seas for an 11-second wave period than for a 5-second wave period in a Sea State 4. The vertical motions for the 5-second period varied little with respect to heading change. This indicates that the ship cuts through the waves at the shorter wave periods and rides over the seas at the longer wave periods.

A comparison of motions at three speeds demonstrated that the HSV-X1 behaves like a wave piercing catamaran at high speeds and like a displacement hull at low speeds.

The ride control system provided a beneficial reduction in roll motion and transverse accelerations during the test conditions in a Sea State 4. Although not verified within these trials, it is to be expected that similar reductions in transverse motions due to the ride control system would be achieved in higher seas. The ride control system can be set to provide varying proportions of roll and pitch reduction. It would be beneficial in future testing to record the gain setting of the roll and pitch.

It was noted that the motions occurring at one location, obviously, does not represent the motions at another location. This is particularly appropriate for the ride control system, which measures motions at the LCG. It does not account for motions experienced on the bridge. It may be advantageous to include a bridge transverse acceleration feedback to the ride control system. Also, vertical accelerations at the bow are significantly larger than on the bridge and so the bridge personnel could be physically unaware of the severity of the ride, i.e., slamming, in the forward part of the ship.

Structures

The HSV-X1 trials were conducted to provide critical information on the primary and secondary structural response for a commercially available high-speed craft. The vessel design was intended to meet IMO HSC and Det Norske Varitas (DNV) rules for classification of high speed, light craft. Analysis of HSV-X1 data will provide knowledge of hull girder steady state and transient vibratory responses and their relation to ordinary wave responses. The design of lightweight high-speed craft requires the optimization of structural details to reduce weight. Secondary loads data resulting from wave impacts at high speed will be invaluable for future designs that utilize advanced, light weight, materials. Results of this effort will quantify structural performance and provide knowledge to increase capability.

The focus of this report is to summarize the statistical analysis of dedicated trials data and identify structural response trends as a function of speed, sea state and relative heading. The results of other minor operational venues are summarized in References 1 through 5. Dedicated structural experiments are run in conjunction with seakeeping measurements using constant speed and relative heading test runs over a period of time for which sea conditions are assumed to be stationary. In characterizing the structural response as a function of the seaway it is important to define both wave height and modal period. For most of the dedicated trials, bow slamming did not develop. As a result, the secondary loads data analysis focuses on data runs collected outside of the dedicated octagon database and uses data collected over the time period from January through March 2002. Most of the slam data comes from high speed operations in head to bow sea relative headings. Detailed descriptions of structural strain gage locations are listed in Table 15 and Table 16 with typical placements shown in Figure 28 and Figure 29.

Hull Girder Response Data Analysis

Results of hull girder analysis are reported for both time and frequency domain analyses. The time domain results summarize the measured mean, minimum (Min), maximum (Max), peak to peak (PK-PK) and standard deviation (Std Dev) values for measurements recorded in each of the octagon runs. Detailed statistical analyses were performed on selected structural response channels using amplitudes from ordinary wave, whipping, and wave plus whipping time histories. Trends in hull girder response based on test condition were developed highlighting the effects of sea state, speed or heading on various responses. The measured data are comprised of wave plus whipping responses due to weight minus buoyancy variations as well as contributing inertial effects due to rigid body motions. Separation of the various responses begins with digital filtering to develop wave only and whipping only time histories, see Figure 30. Wave only amplitudes (LPmax and LPmin), as well as wave peak (WavePeaks) double amplitudes, were parsed from selected low-pass filtered time histories. In a similar manner, whipping amplitudes can be parsed from high-pass filtered time histories. Analysis of wave only time histories typically contain 200 to 300 wave encounters for a half hour period. The low-pass amplitudes and related wave peaks were found using a simple mean crossing algorithm. Whipping events are fewer in number than wave peaks and are parsed using a more complex algorithm based on a pattern recognition process with user defined parameters. The whipping analysis will be completed after the measured strain is converted to load. Whipping is a higher frequency vibratory response superimposed on the low frequency, wave-induced response. The higher frequency vibratory response varies depending on the location of the measurement on the structure. The contribution of whipping loads becomes important when estimating combined maximum lifetime loads or developing a stress exceedance spectrum needed for fatigue analysis. The combined amplitudes of wave plus whipping are parsed from the original unfiltered time history using the time of each whipping event as a guide. To provide a means of extrapolating lifetime maximum values, probability distributions were developed for several response measurements. Based on previous experience, it was assumed that these responses could be estimated using a two or three parameter Weibull distribution, see References 7, 8, 9 and 10. The Weibull distribution is used because of its versatility in conforming to different shaped distributions. It also accounts for a zero offset value (a non-zero minimum) which naturally occurs in either fatigue life, measured loads data, and many other physical processes. The Weibull Analysis will also be applied later in the report to wave impact responses.

The frequency domain analysis is the process of calculating power spectral densities (PSDs) for hull girder response along with matching PSDs of measured wave height for the purpose of calculating response amplitude operators (RAOs). Typically, the low pass filtered primary load time histories, developed in the time domain analysis, are used to make RAOs. An

RAO is determined by dividing the response PSD by the corresponding wave height PSD. It has been shown that RAOs for conventional hull forms are constant over a wide range of input sea conditions. More detail on the frequency domain analysis is explained in the results below.

Time Domain Hull Girder Response Statistics and Results

The results of statistical analyses for the octagon conditions were tabularized by channel in Appendix A. The statistics in Appendix A are from unfiltered (raw) time histories and include the combined or ordinary-wave plus whipping response. The largest response statistics for each channel was recorded during the "24 Hour Load Out Trials", not the octagon runs, and is reported separately in Table 17. More details on the "24 Hour Load Out Trials" can be found in Reference 3.

Hull Girder Response Speed and Heading Relationships

Analysis of primary loads data has typically involved the determination of speed and heading effects. Results of trend building for many ships were used to develop predictive tools which estimate monohull hull girder loads, e.g., the SPECTRA computer code. The direct comparison of trends from the HSV-X1 data would indicate how well existing predictive tools would work on such a novel hull form. The result of trend building supports many of the conclusions presented later in the report. Trends based on a summary of standard deviation (Std Dev) response are shown for each group of global response measurements in Figure 31 through Figure 34.

Primary Hull Girder Response Analysis

Processing the data with digital filters aids in identification of whipping events and associated combined peaks (ordinary wave plus whipping load). Separation of wave and whipping response is accomplished by filtering the data twice, once with a low-pass filter to obtain ordinary wave responses and a second time with a high-pass filter to obtain vibratory responses. The combined responses (wave plus whipping) are actually parsed from the raw unfiltered data but require the identification of whipping events in the high-pass data to be accurately detected. The filtering process is presented in Figure 30 showing several large whipping events as measured by the keel gage at Frame 45 on the Port side.

Probability distributions provide a means of extrapolating lifetime maximum values for each type of response mentioned above. Based on past analyses and the findings in a number of reports, see References 7, 8, 9 and 10, hull girder loads were assumed to fit a Weibull probability distribution. Once Weibull probability distribution parameters are determined, extrapolations can determine lifetime maximum values, provided a sufficient number of amplitude peaks are recorded for a given sea state, speed and relative heading. The general three-parameter Weibull cumulative distribution function may be expressed as follows:

$$P(x) = 1 - e^{-\left(\frac{x - x_o}{\theta - x_o}\right)^{\beta}}$$ Equation 1

Where,

χ	represents the data ($\chi \geq \chi_o$),
$P(\chi)$	represents the cumulative probability at x,
χ_o	is the positive threshold value below which there are no measurable data,
β	Weibull shape parameter or slope, and
θ	Characteristic value of the data, corresponding to the value with a cumulative probability of 0.632.

Depending on the Weibull shape parameter, β, the distribution can be exponential (β = 1.0), Rayleigh (β = 2.0), or approximate a normal distribution (β = 3.44), with many other distributions possible. The characteristic value, θ, occurs at the same cumulative probability (0.632) on every Weibull distribution, independent of the shape parameter. Estimates of the Weibull parameters may be obtained in a variety of ways; two in use currently at NSWC are the linear regression and moment analysis methods. The following sections describe several types of hull girder response and the resulting Weibull Analyses using the linear regression method.

Wave and Whipping Analysis

The low-pass filtered time history in the middle of Figure 30 is the ordinary wave-induced portion of the vertical bending response shown on top of the figure. A complete Weibull Analysis of ordinary wave responses for selected global response measurements was performed and is summarized in Appendix B. A summary of Weibull parameter estimates for global response measurements is shown in Figure 35. These plots are generalized but show a trend that suggests most global response for a range of sea state, speed and heading combinations can be fit to a Weibull distribution with a shape parameter near two.

Ordinary wave response, which is "quasi-static" in nature, is produced by changes in buoyancy and inertial forces. Wave energy in a seaway typically lies between 0.01 and 0.4 Hz, from which the quasi-static phrase is coined since this is an ultra low frequency process. The range of wave energy defines the portion of the global response associated with Response Amplitude Operators (RAOs). The vibratory nature of global response resulting from wave impact events cannot be represented by the wave frequency RAO's. As such algorithms must be developed based on Weibull analysis of whipping events. Whipping can be defined as a significant natural mode of vibration (typically first mode) responses of the hull girder resulting from bow slamming. The bottom of Figure 30 shows such an event. For conditions with high whipping rates, Weibull analyses have shown that whipping peaks tend to be exponentially distributed, see References 8, 9 and 10. After the measured strain is converted to load a complete wave and whipping analysis will be performed using a Weibull fitting process. Once the whipping peaks are detected, the combined peaks within a given whipping event can be parsed out or located. The combined effect of a whipping event will augment load prediction methods that rely on RAO's.

Spectral Analysis and Response Amplitude Operators

The frequency domain analysis processes digitized time histories of ship structural response (longitudinal, transverse and pitch connecting moment response) and wave height into power spectral densities (PSDs). Typical bending strain response PSDs are shown in Figure 36 through Figure 39 including the corresponding wave height spectra. These spectra define the energy present in a response time history as a function of frequency in Hertz (Hz). The area under the PSD approximates the mean square value of the original time history or the variance, assuming a zero mean. The response of the ship as measured by a PSD will change with speed, heading, and wave height. The frequency axes of the PSDs are referenced to an "encounter frequency" specific to the speed and heading of the ship. For a given test condition, the ratio of the ship response PSD (output) to the wave height PSD (input) is known as a response amplitude operator (RAO), see Figure 40. The RAO is useful for predicting hull girder response to random seas when ship response is linear with wave energy or identifying conditions that produce non-linear ship response. Comparison of RAOs between different sea states will determine whether or not a particular ship response is linear with wave height. Other RAO comparisons may indicate heading or speed effects. The PSDs also show the portion of structural response resulting from wave impacts. In Figure 36 through Figure 39 , this is the smaller secondary peak. In the previous section on wave and whipping analysis, the loads from the whipping analysis account for the response associated with the higher frequency peak.

Measured Local Wave Impact Response Data Analysis

Local structure in areas suspected of having significant numbers of wave impacts was instrumented to measure wave impact pressures. The type of measurement used by NSWCCD is not sensitive to global structural response and will only produce output under local out of plane loading. As such, differential-bending strains can be converted to equivalent uniform static pressure loads for the instrumented structure free of global load response. The technique for converting measured strain to load requires physical jack loading or Finite Element Analysis (FEA) of the local structure. A typical strain gage installation for a differential bending measurement is shown in Figure 29. Details of the location of each wave impact measurement are listed in Table 16.

Measurements of secondary structural responses resulting from wave impacts were collected by a "high-speed" data acquisition system sampling at 2000 samples per second (2000 Hz). This system was programmed to record wave impacts based on pre programmed triggering values of 100 to 200 micro strain (uin/in). This economical technique allows for the digitization of slamming events rather than continuous time histories. The system records all the slam channels any time a trigger is met on any channel. Slam data were usually recorded simultaneously with the slower global response data allowing for correlation of the two data sets.

Wave Impact Time Histories and Analysis

An example time history for one channel is shown in Figure 41. The time history is compressed to fit on the page so wave impacts appear as vertical lines. The actual measurement is the change in response from the mean, or zero level, to the positive peak of the impact event; note positions of triangles in Figure 41. Unlike the continuous global response measurement, local wave impact measurements are one sided transient responses with rise times in the millisecond range. The largest wave impacts for a collection of channels between Frames 57 and 58 are shown in Figure 42. The impact amplitudes for a single location (or channel number) for a single run are typically fitted to a Three Parameter Weibull Distribution, see results in Figure 43. The parameters of the Weibull fit are used to predict maximum lifetime values that would result from extending the exposure time to an amount representing a lifetime exposure. The amount of time in a given condition is based on speed, heading, and wave height probabilities. Further extrapolations can be made to represent the maximum lifetime value for more than one ship.

Wave Impact Weibull Results

Summaries of wave impact population statistics and Weibull Analyses results are listed together in Appendix C. The maximum wave impact event for each measurement location is summarized in the first column of Table 20 as differential bending strain. The remaining columns in Table 20 summarize in a general sense the statistical behavior of wave impact loading using the results of Appendix C. As with other vessels, wave impact amplitudes follow an exponential probability distribution. The Weibull distribution becomes the exponential distribution when the shape parameter, slope of line in Figure 43, equals one.

Trends in the data show some scatter and some linear relationships between speed and impact rates. For a given location between Frames 57 and 58, impact rates increase as speed increases for a head sea relative heading, see Figure 44. Locations closer to the water line tend to have a flat non-increasing trend between speed and impact rate. Locations further from the water have more scatter and tend to show an increasing trend with speed. The largest wave impacts typically occur at locations furthest from the centerline in the flat portion of the bow flare. These locations have a lower impact rates but larger impact events when they occur. This is reflected in the geometry of the area, which is flat, parallel to the water, with a zero dead rise angle. In this flat area of the cross structure damage due to wave impact loading did occur and is documented in Reference 2.

Structures Summary

The global response behavior of the HSV-X1 or any high speed wave piercing vessel is complex in nature. Examination of structural response data for the HSV-X1 has identified unique regimes or modes of structural response. Two load regimes were identified separated into low and high speed operation. Low speed operation is dominated by a displacement mode behavior and high speed operation is characterized by wave-piercing in a semi-planing mode. In the speed range of the vessel the “hump speed” could be used as the dividing line between the two regimes. This dividing line is supported by the sharp drop off in response that occurs after 33 knots, see Figure 31 through Figure 34. A subset of each load regime would be the inclusion of slamming and influence of the ride control system, see Figure 45 for a description. The identified ride control effects are most likely specific to the HSV-X1 and its hull form.

The Weibull analysis provided in Appendix B and summarized in Figure 35 provides insight to global load responses for high speed catamarans. These results suggest that ordinary wave responses for the catamaran can be estimated using a variety of existing predictive methodologies. However, additional work will be needed to define the additive responses of the global structure resulting from wave impacts.

One significant observation was the reduction in ordinary wave response (weight minus buoyancy) in the mode of operation involving wave piercing and high speed. It is also at high speed that global response is influenced by the behavior of the ride control system. This behavior was clearly seen in time histories for transverse bending response locations in the cross structure, see Figure 46. More specifically, the transverse bending time history shows direct correlation to the control signal used by the T-foils. The two signals are also similar in frequency content as seen by the PSD's in Figure 47. The influence of the ride control system for other global responses was more embedded and difficult to quantify.

Existing predictive tools for structural loads based on frequency domain calculations may require modification to account for a mixed mode loading (sea way + ride control) of the structure. Frequency domain estimates require the input of transfer functions based on wave height. Developing a transfer function for transverse bending response as a function of wave height will be difficult because of the influence of the ride control system. The ride control system effectively reduces roll and pitch motions reducing inertial loading of the primary structure. However, the mitigation of roll and pitch energy requires absorption of T-foil reactionary forces into the supporting foundation and distribution into surrounding hull structure. Functionally, the T-foils operate out-of-phase to reduce roll motion. It is that behavior which creates reactionary structural forces to develop sympathetic bending of the cross structure. Likewise, the T-Foils may use in-phase operation to reduce pitch motion. How much roll and pitch is mitigated depends on adjustment of the ride control system by the operator. Accurate estimates of structural fatigue life will require knowledge of T-foil loads and cycling. Again, only specific portions of the structure would be adversely affected by the T-Foil cyclic loading and the number of cycles associated with T-foil loading could be small over the life of the ship relative to the seaway loading environment. Typically, cumulative damage calculations for monohulls in use by the Navy assume 10^8 cycles over 30 years.

A strong bi-modal response of the catamaran hull form from a multi-directional seaway was observed in the analysis of the Newport Octagon Data. Data from this type of test condition would be difficult to correlate with analytical predictions or model tests. Since fatigue life calculations require adequate formulation of structural response complex multi-modal behavior could be difficult to formulate from the limited trials data. A good use of model testing would be to define structural response over a range of modal periods for a given wave height. Furthermore, parametric model test could be performed whereby the relationship between hull separation and waterline length are optimized to reduce adverse bi-modal motions resulting in unusual structural response. This behavior may be inconsequential for a high-speed vessel but could be problematic for low speed loitering operations.

The current design of the 96 m Hull 050 involves the optimization of transverse framed structure to reduce weight. This process produced lightweight structure required for a high-speed catamaran design. In some areas of the structure, the optimization process produced transverse frames with poor local strength. This was exhibited by the failures of the transverse frames in the bow region as a result of wave impacts. Interestingly, the plate-tbar combinations never failed in the bow region. It may be that the design process accounts for a high slam pressure but does not account for the larger than expected area over which the pressure acts. As a design impact pressure is applied over an increasing area, the required global structure, i.e. transverse frames, must be increasingly strengthened, thus becoming heavier. For light-weight high-speed craft there must be trade offs or compromises to accept some local plate dishing under extreme loadings while maintaining water tight integrity. The follow-on work described below will help to optimize performance for local and global structure of future Naval HSVs.

Follow-on Work

Strain to load conversions for both global response and local wave impact response will be calculated in two separate follow-on projects. This will allow for the estimation of extreme loads statistics, fatigue life estimates and loads from which design criteria may be developed. This work will support future design efforts for open-ocean unrestricted high speed catamaran vessels. Global response strain to load sensitivities will be determined under the HSV-2 program sponsored by NAVSEA 05 in FY03 and FY04. Wave impact pressures will be converted from differential strain to load under the ONR 6.2 program “Wave Impact and Slamming” in FY03 work.

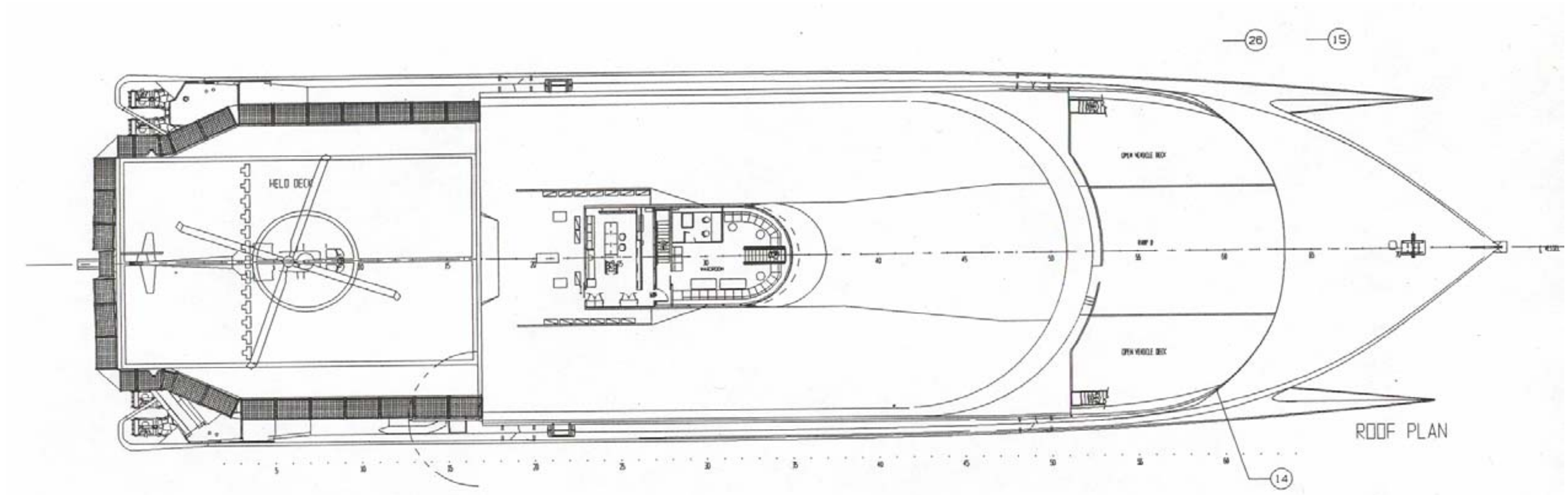


Figure 1. Plan view of HSV-X1

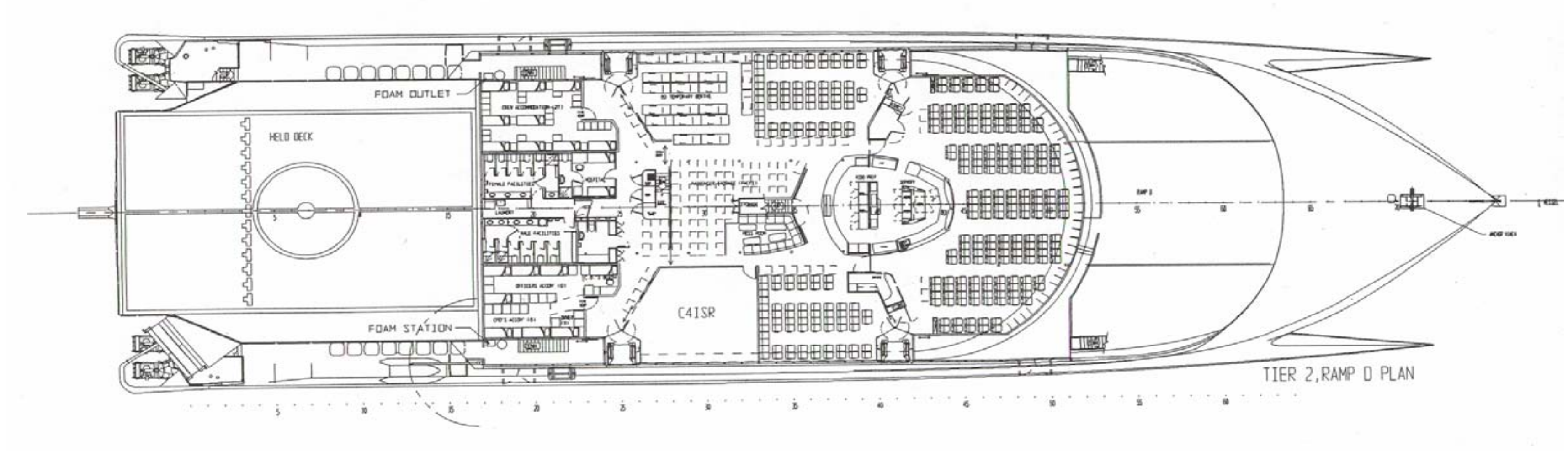


Figure 2. Plan view of HSV-X1, Passenger Deck

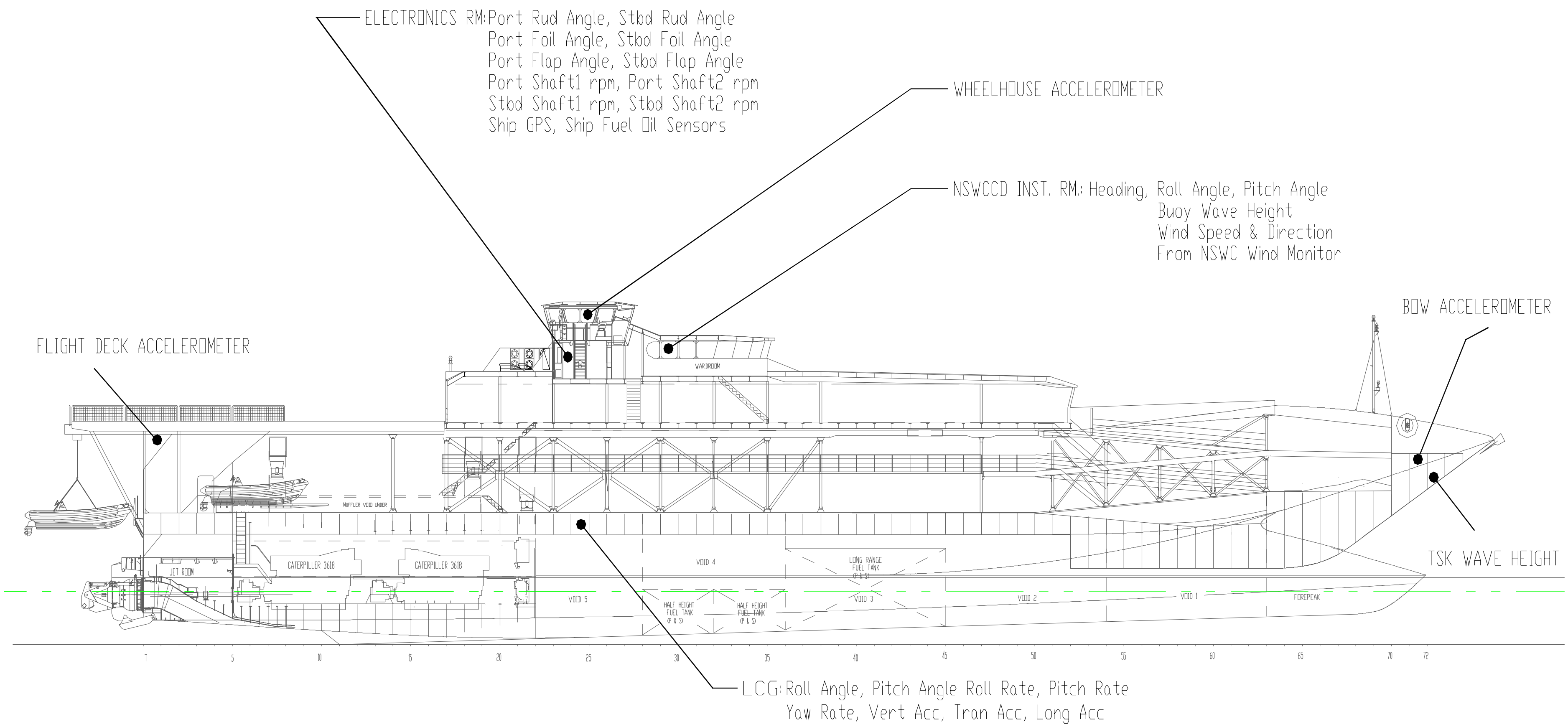


Figure 3. Profile View of HSV-X1

Highest Allowable Speed (knots)	Significant Wave Height (m)		Significant Wave Height (ft)	
50	0.0	1.8	0.0	5.9
45	1.8	2.3	5.9	7.5
40	2.3	2.9	7.5	9.5
35	2.9	3.8	9.5	12.5
32	3.8	4.3	12.5	14.1
30	4.3	5.0	14.1	16.4
Seek Shelter at Slow Speed	5.0	And Above	16.4	And Above

Operational Limits for INCAT 050 as listed on Bridge Plaque

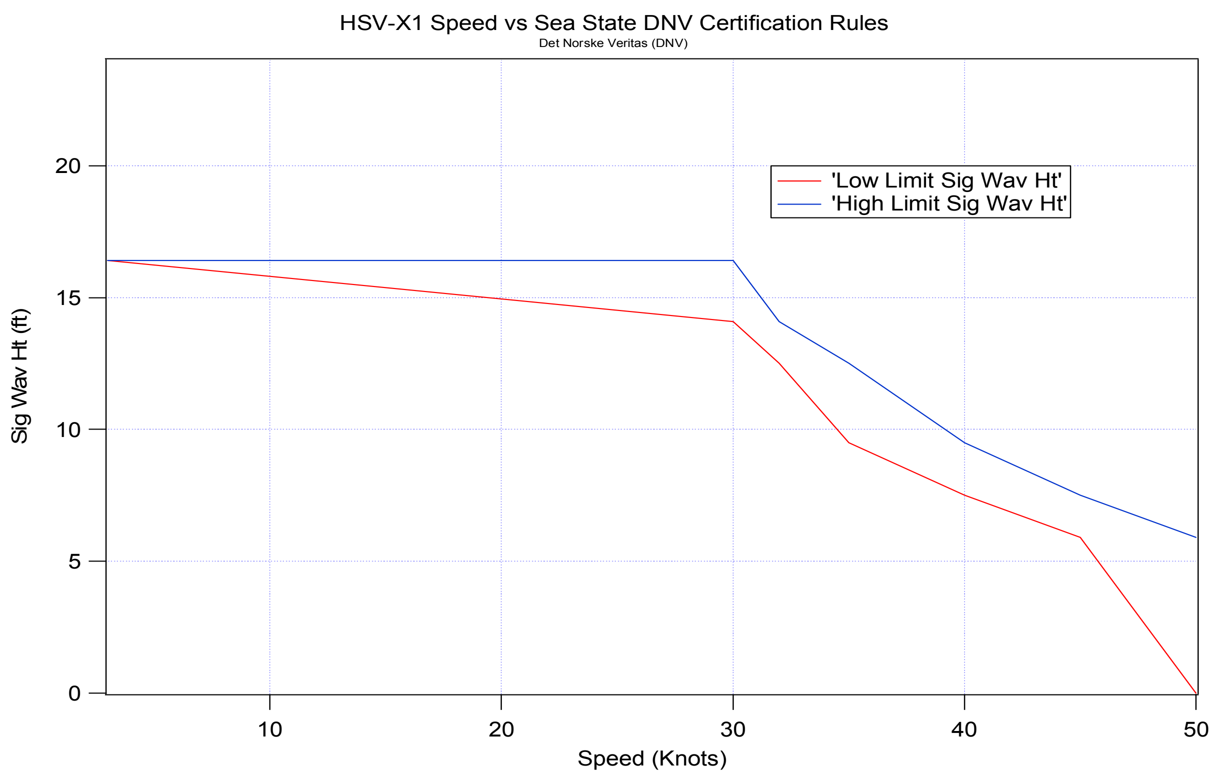


Figure 4. HSV-X1 Speed and Wave Height Operational Limits

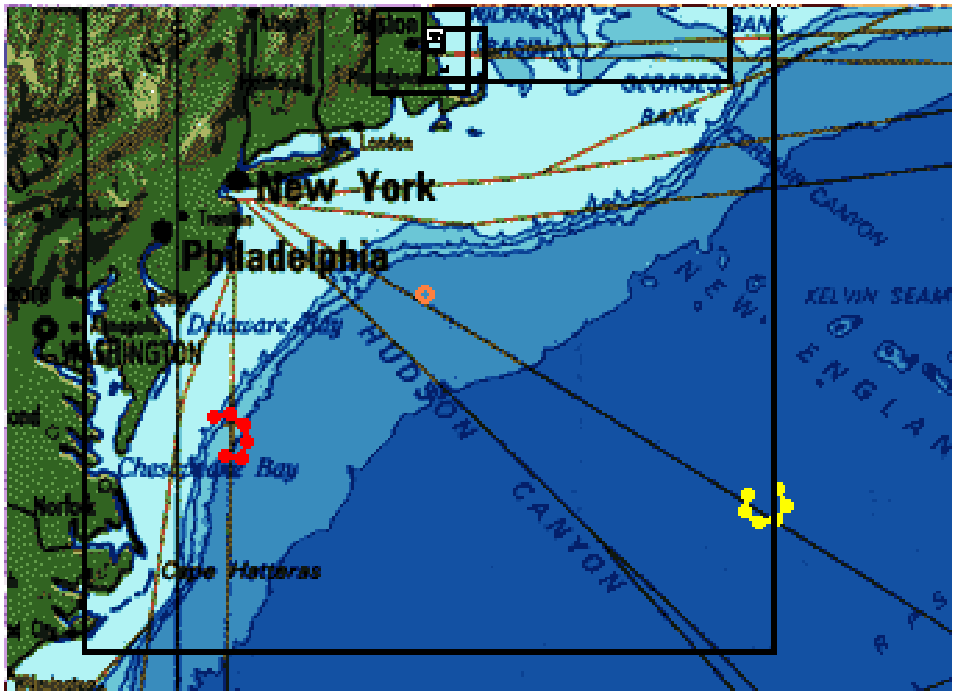


Figure 5. HSV-X1 Tracks of Seakeeping Octagon and Newport Octagons 1 and 2.

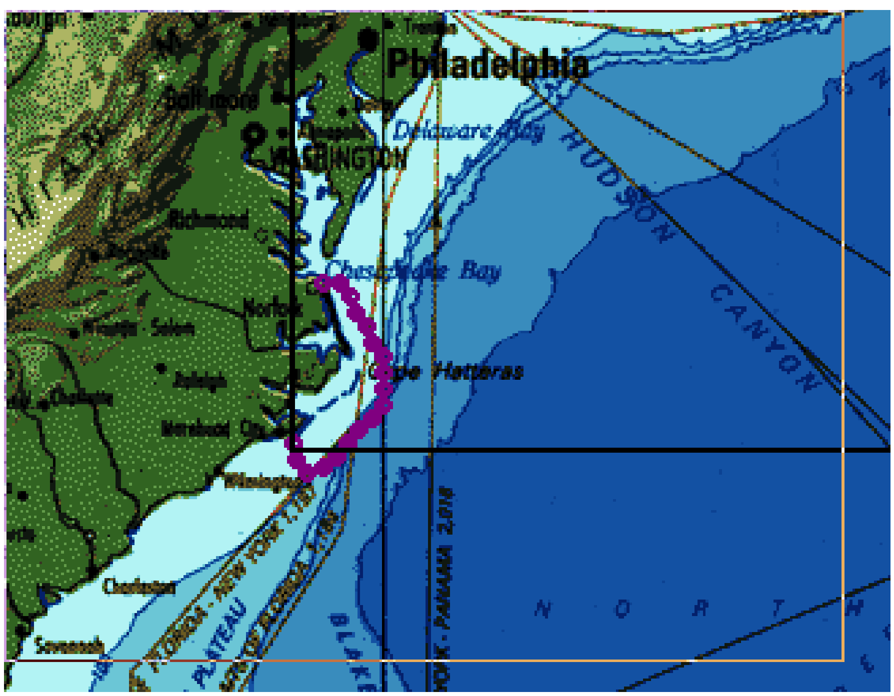


Figure 6. HSV-X1 Track of 24 Hour Load Out South LOE.

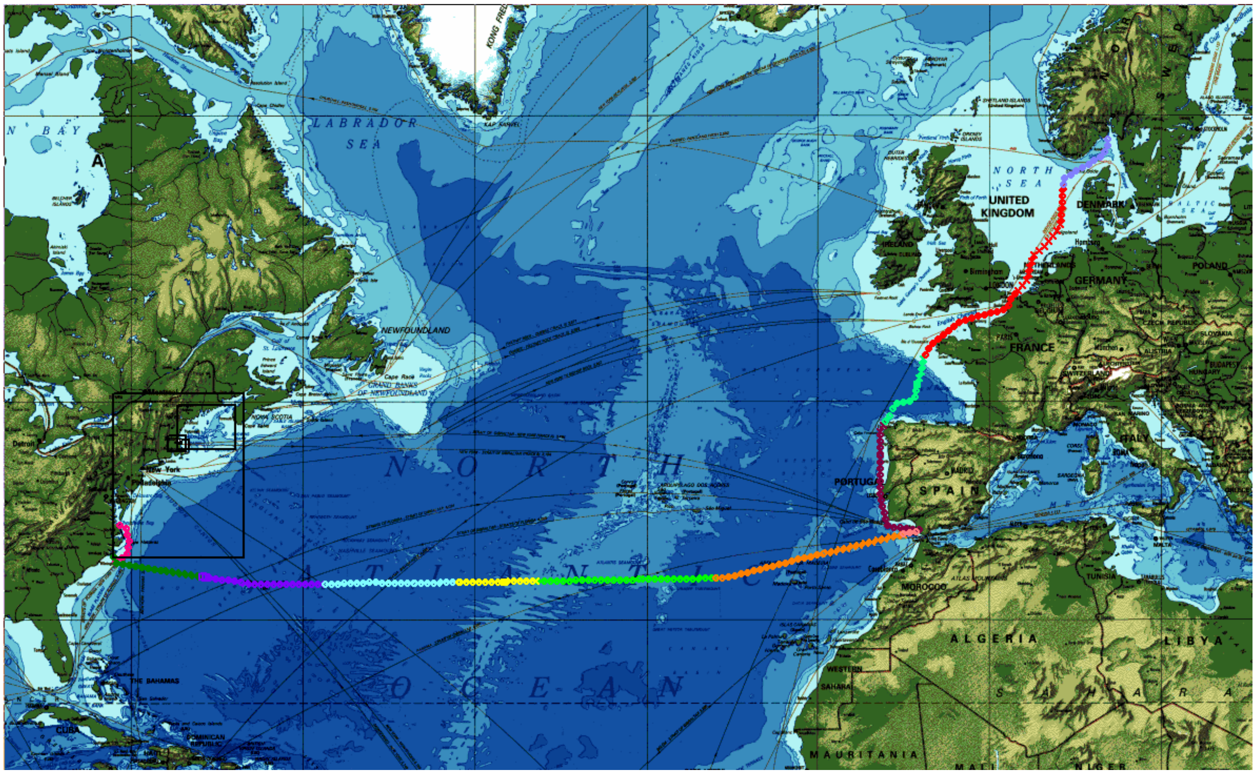


Figure 7. HSV-X1 Track of Transatlantic Crossing – February 2002.

Figure 8. HSV-X1 Tracks of Baltic Octagons 1, 2, 3, and 4.

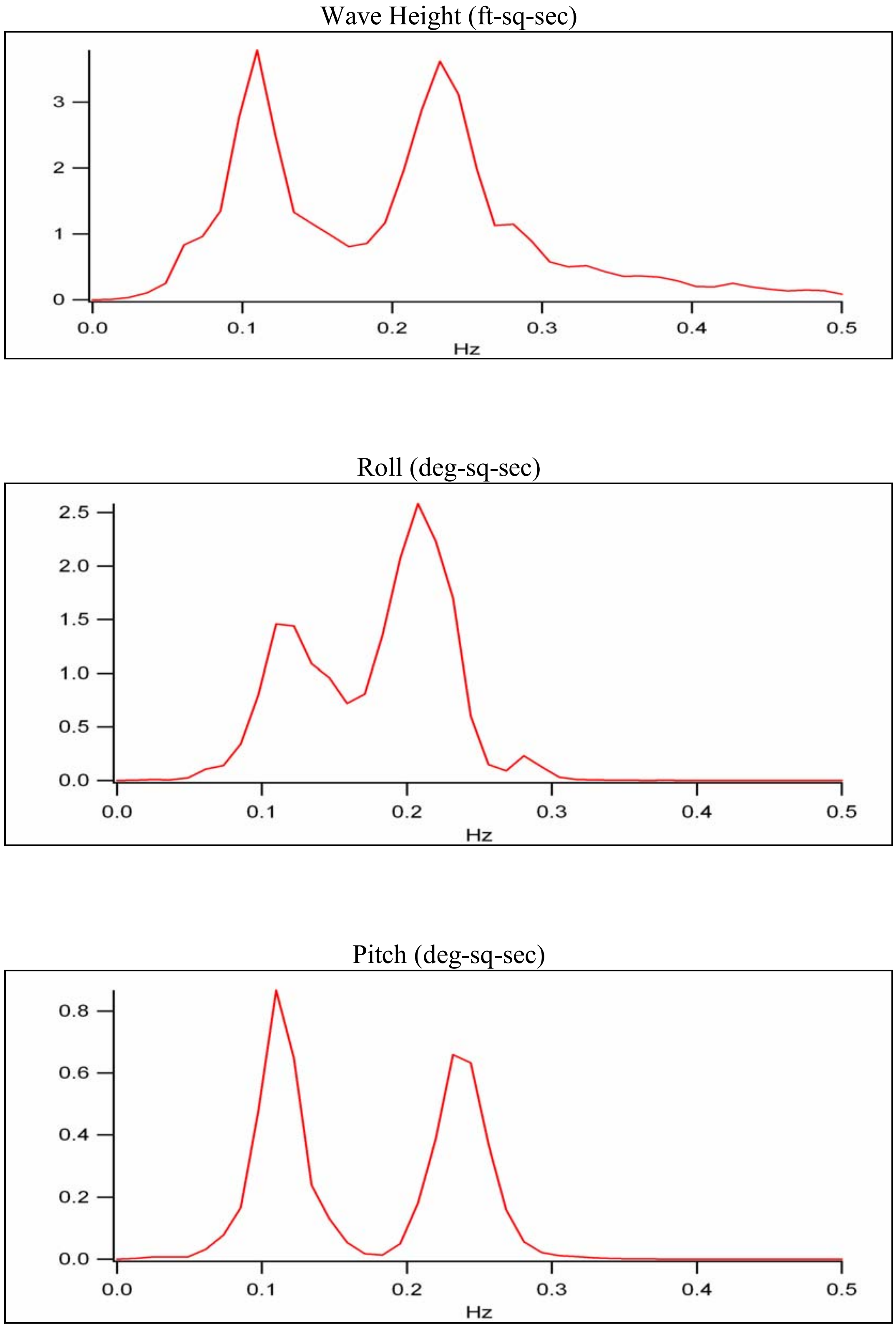


Figure 9. Wave Height, Roll Angle, and Pitch Angle Double Spectra of DIW Condition

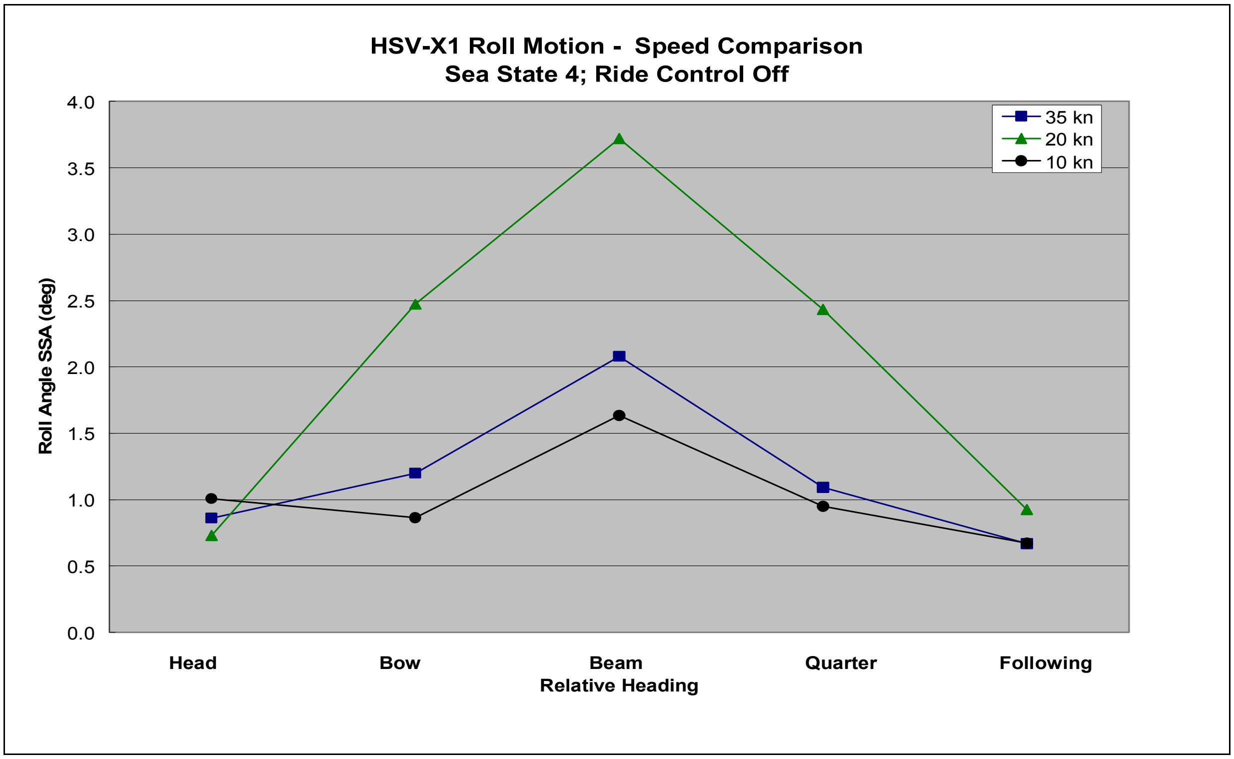


Figure 10. HSV-X1 Roll Motion – Speed Comparison

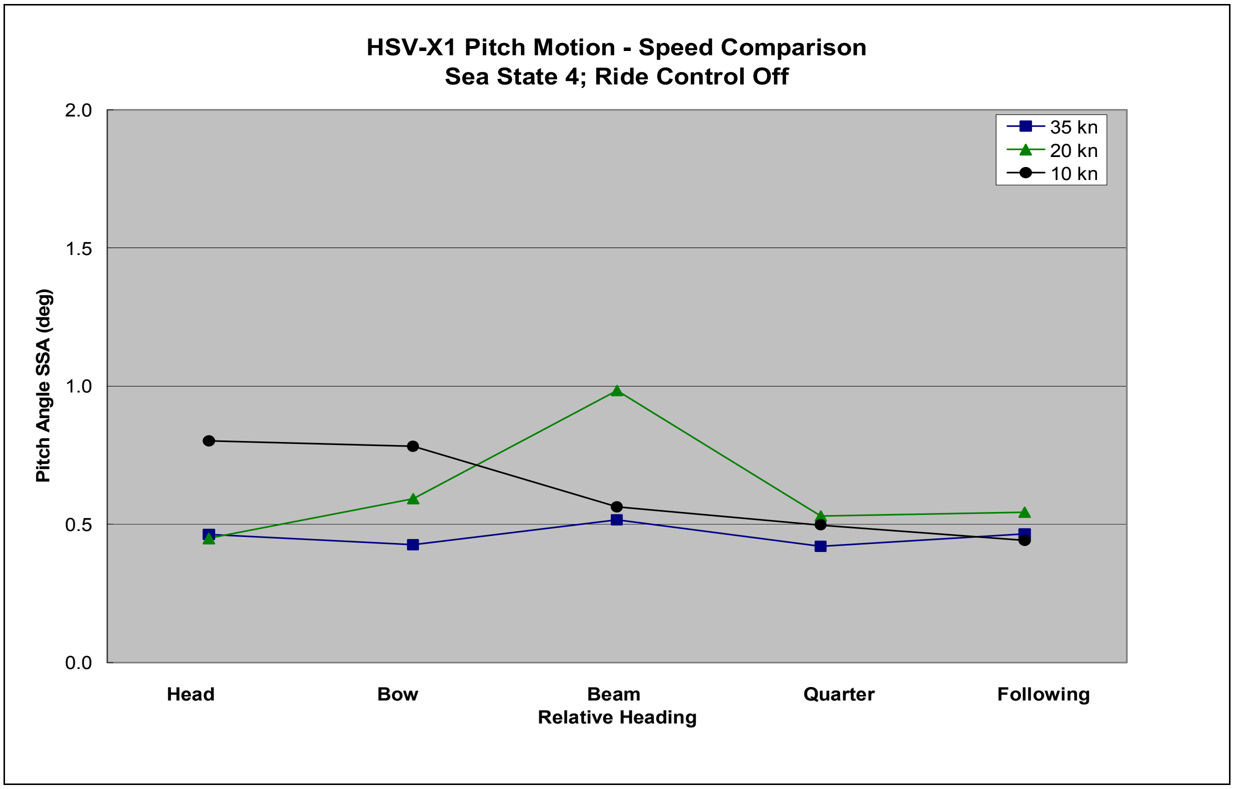


Figure 11. HSV-X1 Pitch Motion – Speed Comparison

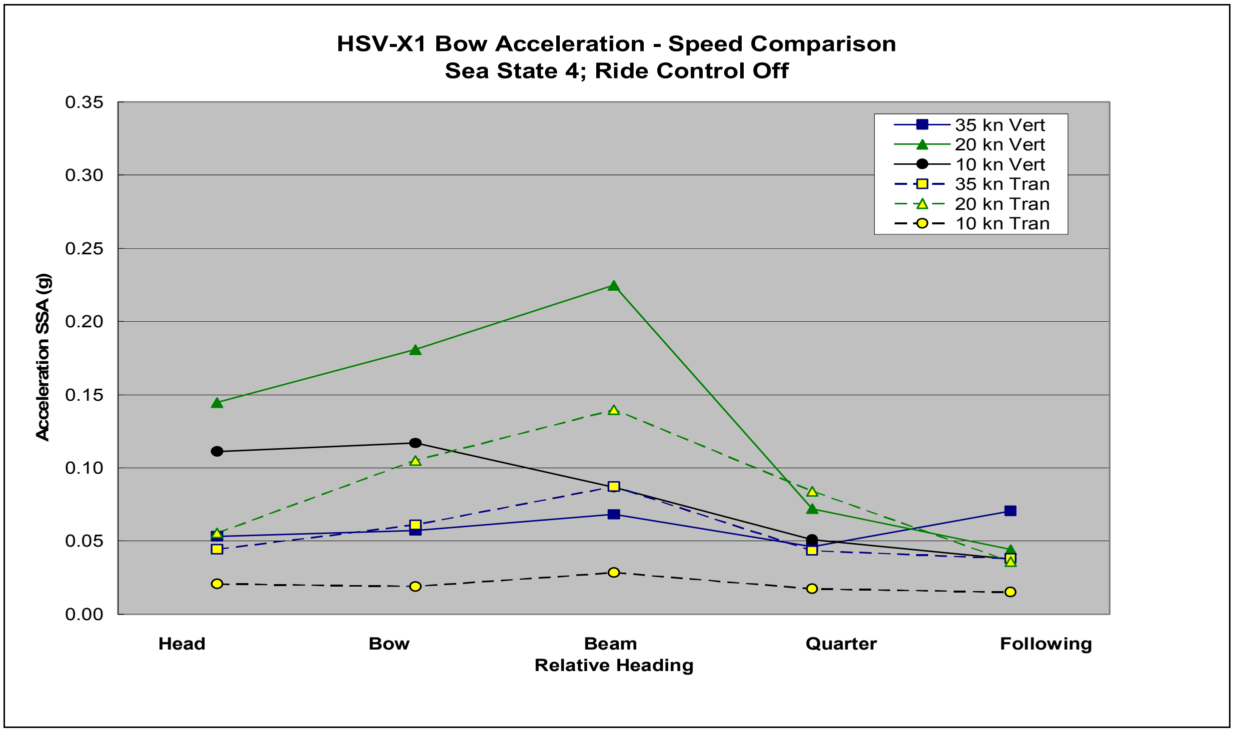


Figure 12. HSV-X1 Bow Acceleration – Speed Comparison

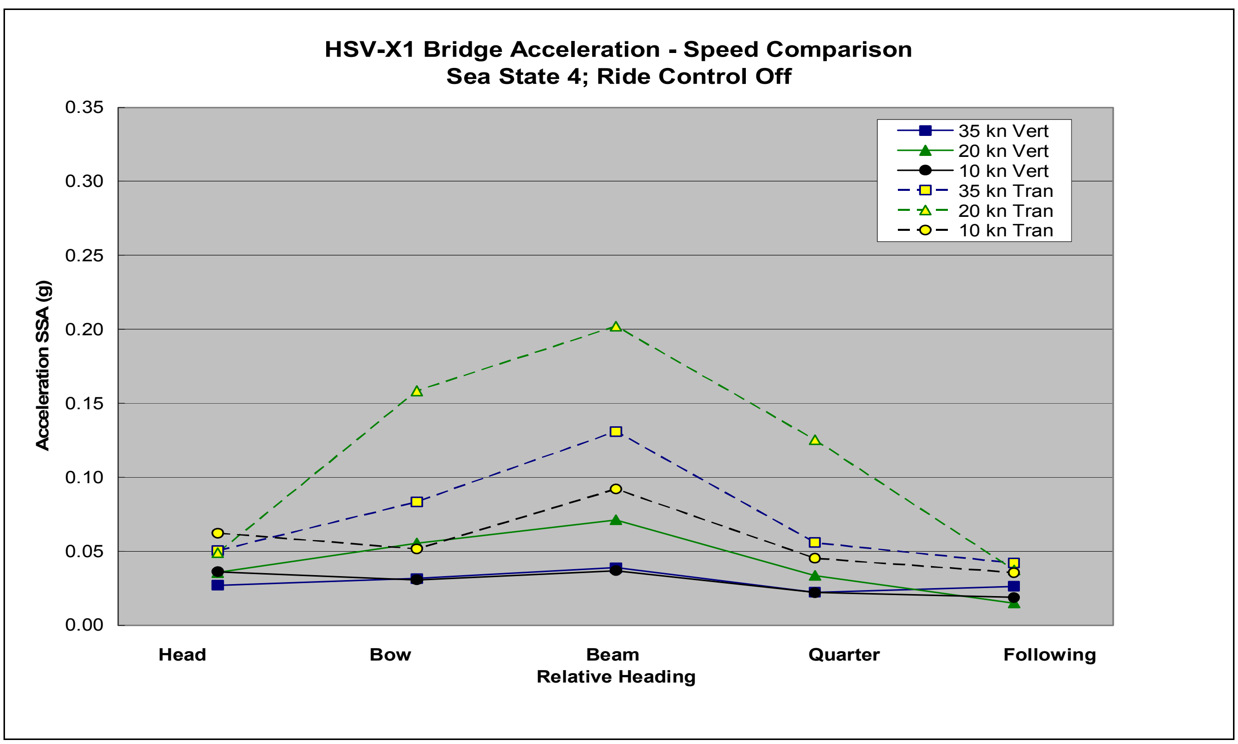


Figure 13. HSV-X1 Bridge Acceleration – Speed Comparison

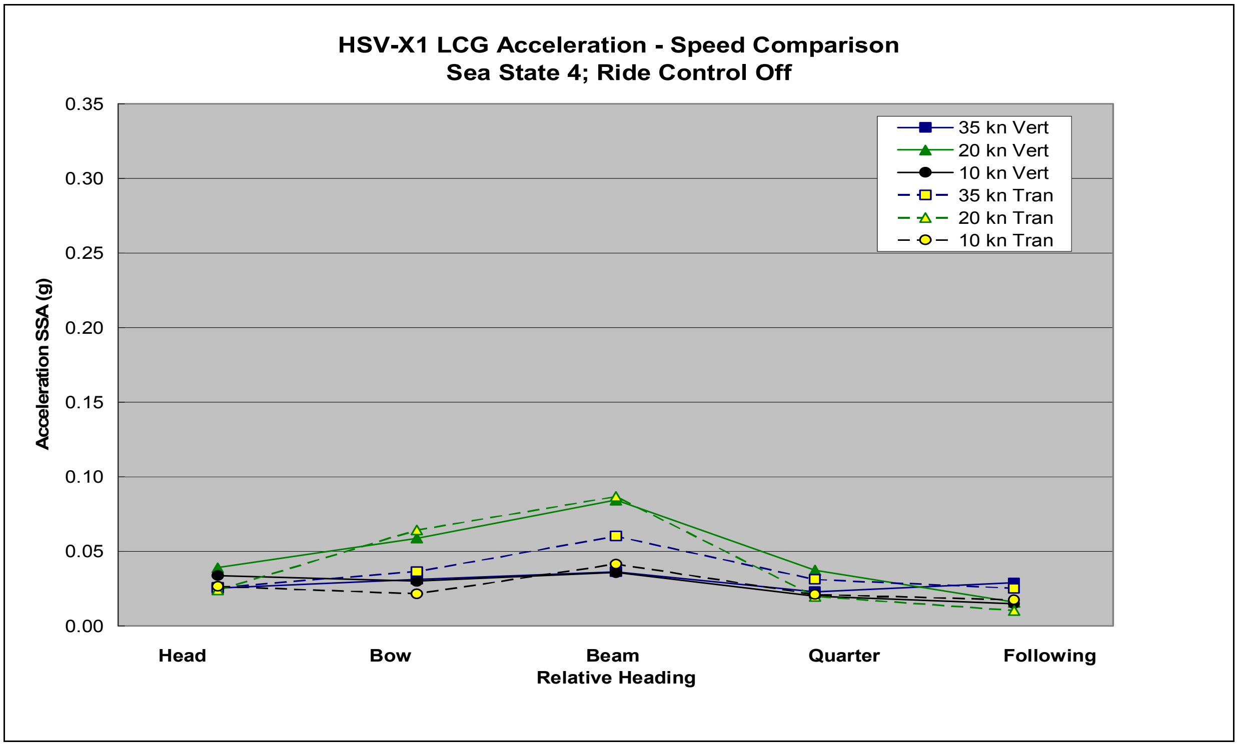


Figure 14. HSV-X1 LCG Acceleration – Speed Comparison

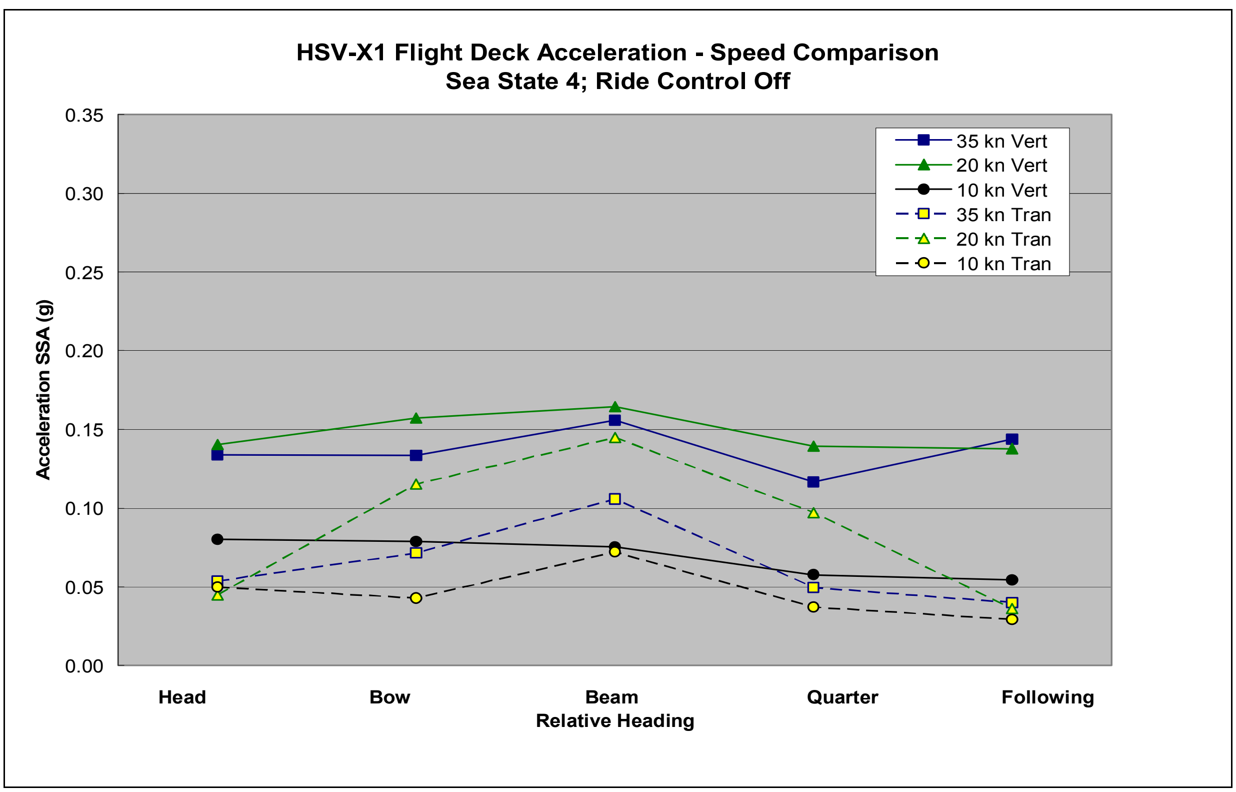


Figure 15. HSV-X1 Flight Deck Acceleration – Speed Comparison

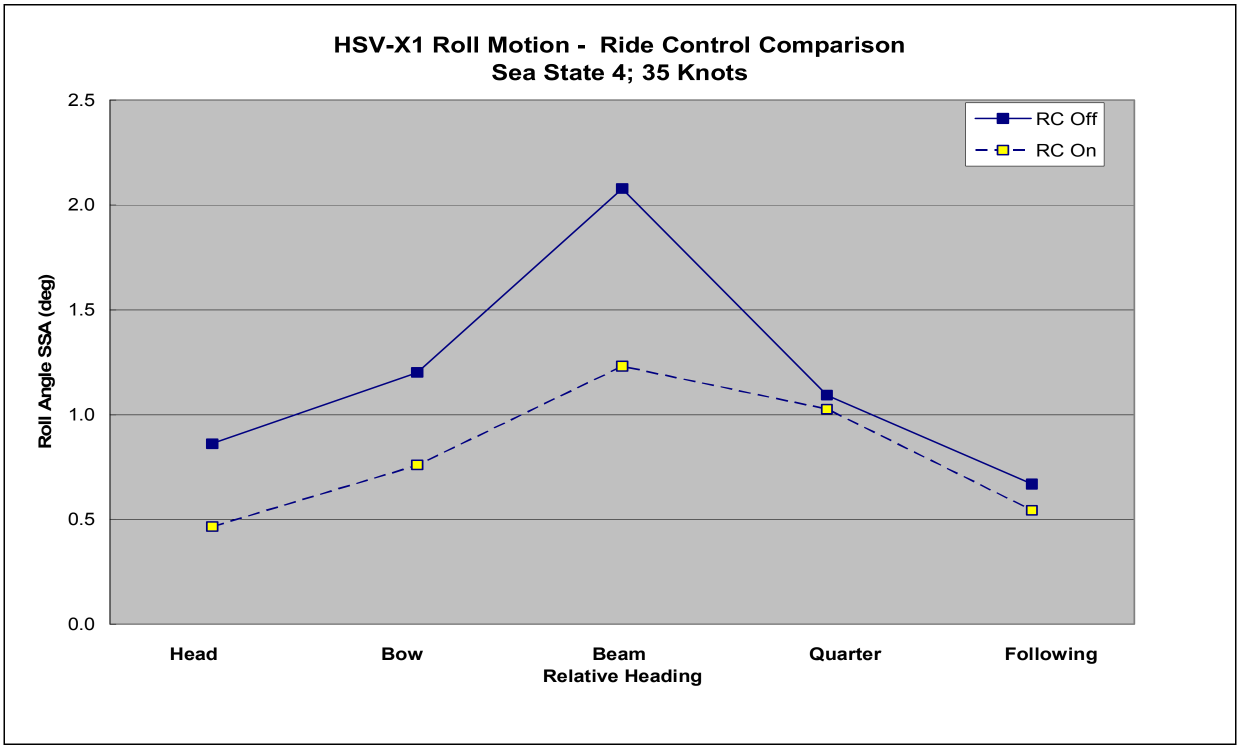


Figure 16. HSV-X1 Roll Motion – Ride Control Comparison

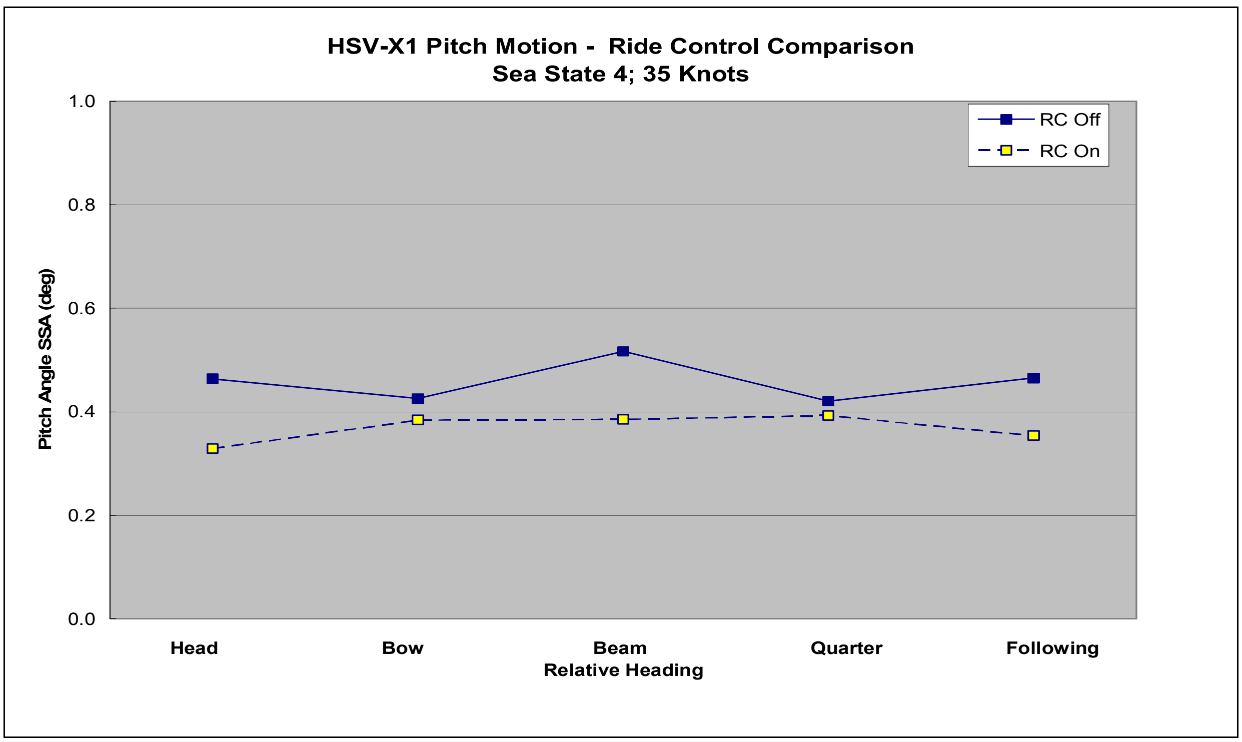


Figure 17. HSV-X1 Pitch Motion – Ride Control Comparison

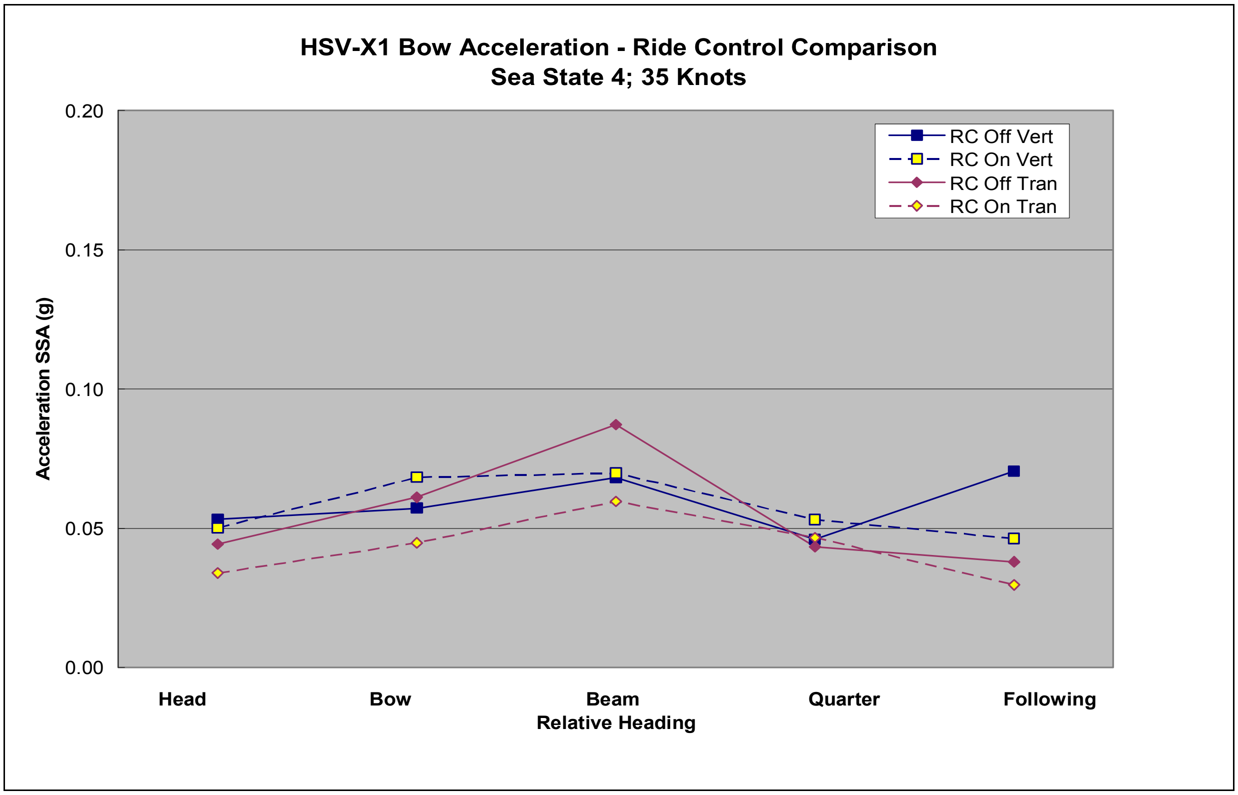


Figure 18. HSV-X1 Bow Acceleration – Ride Control Comparison

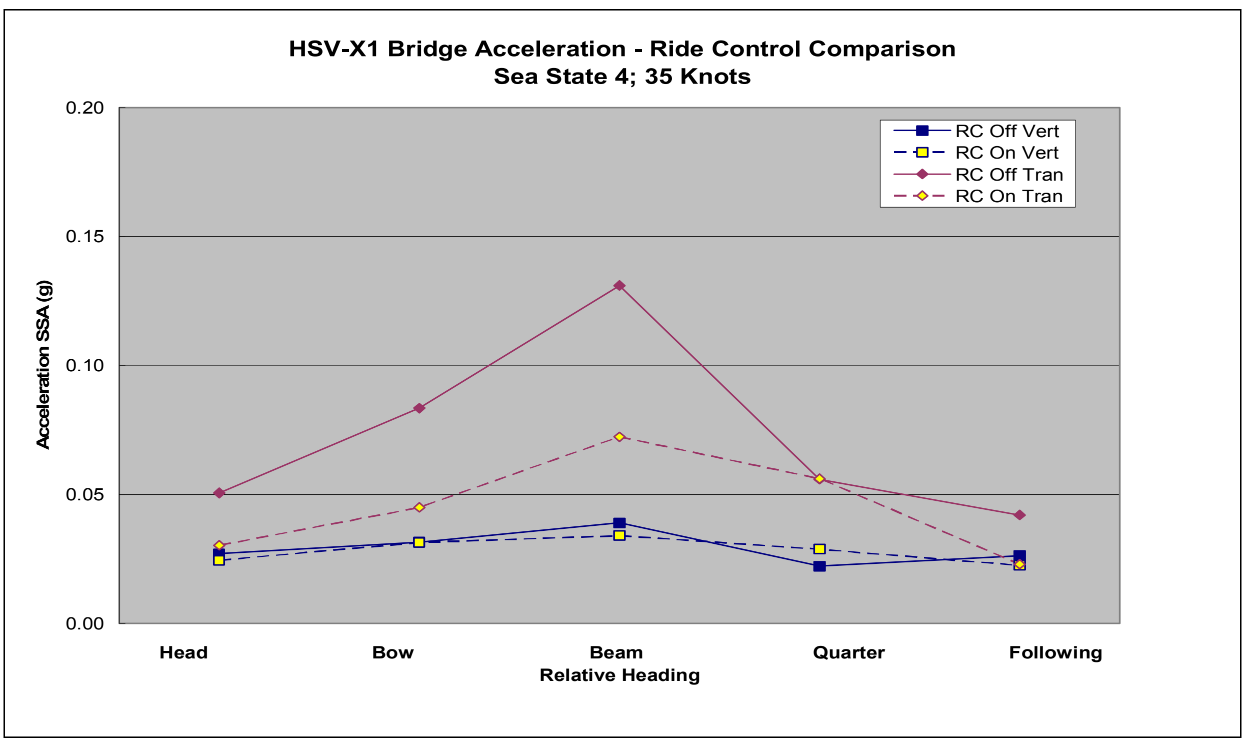


Figure 19. HSV-X1 Bridge Acceleration – Ride Control Comparison

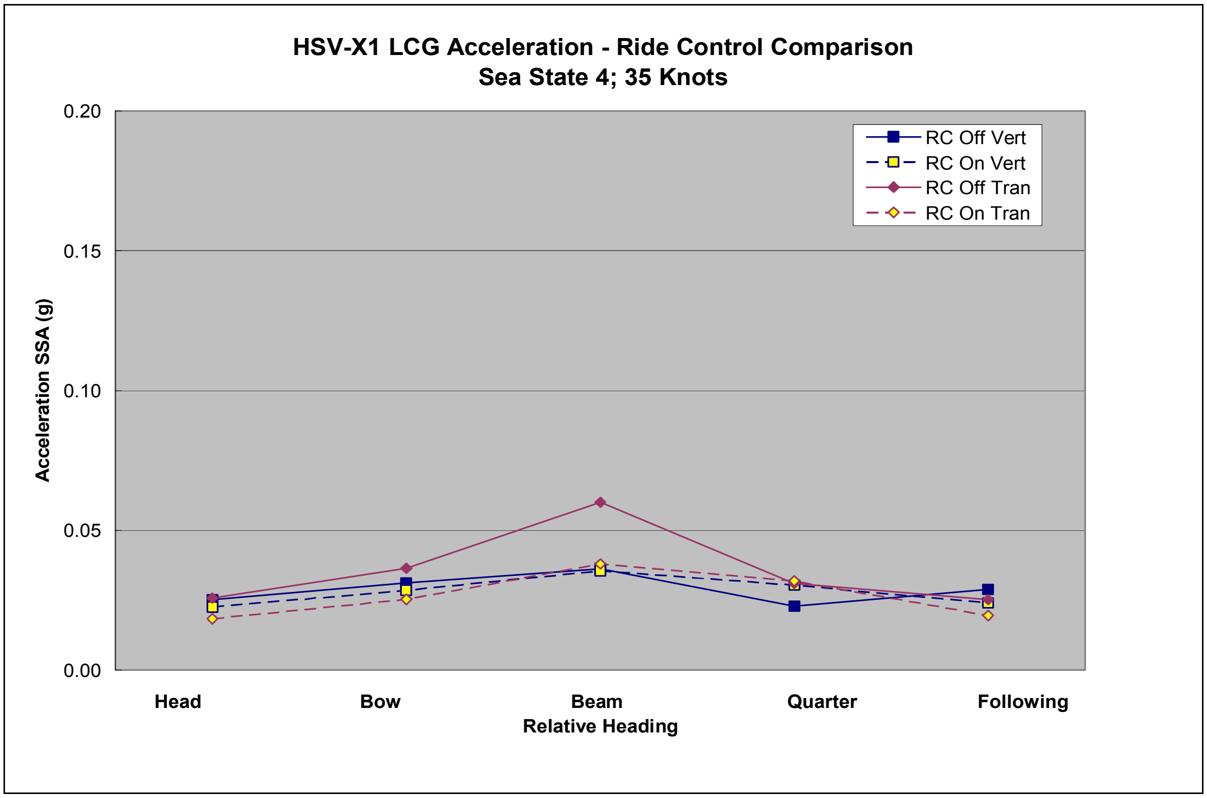


Figure 20. HSV-X1 LCG Acceleration- Ride Control Comparison

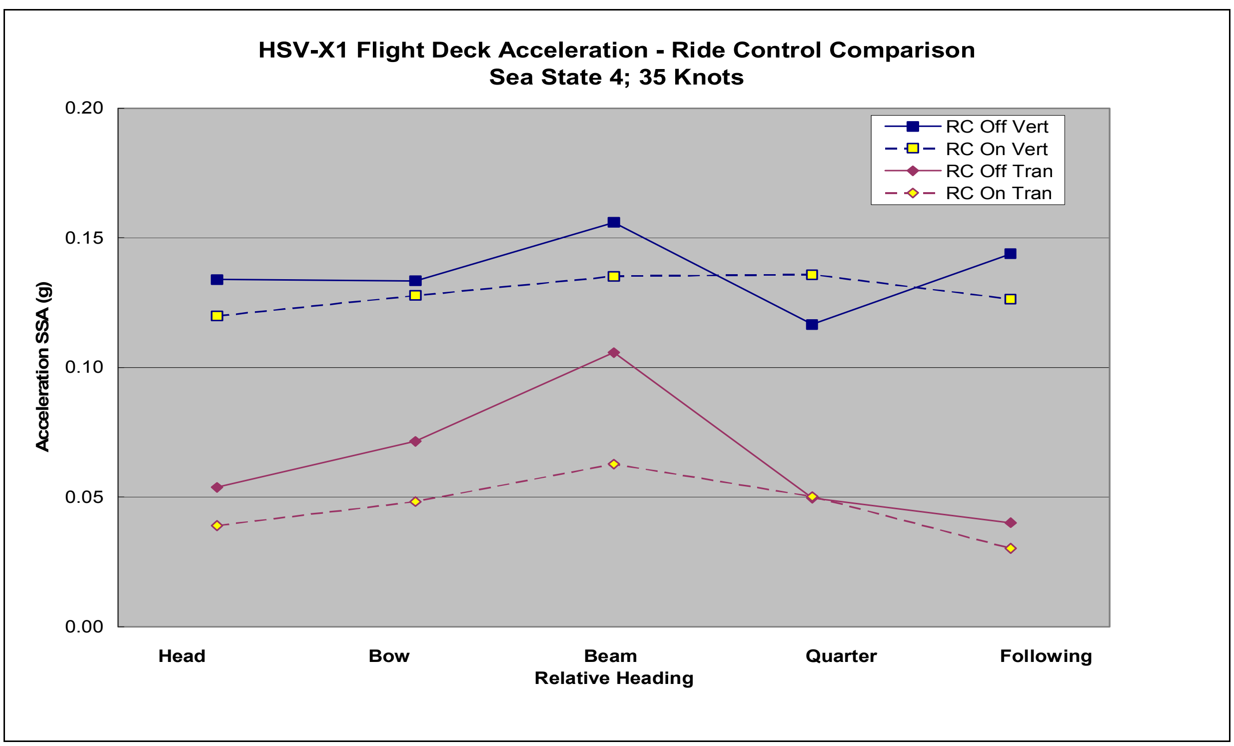


Figure 21. HSV-X1 Flight Deck Acceleration – Ride Control Comparison

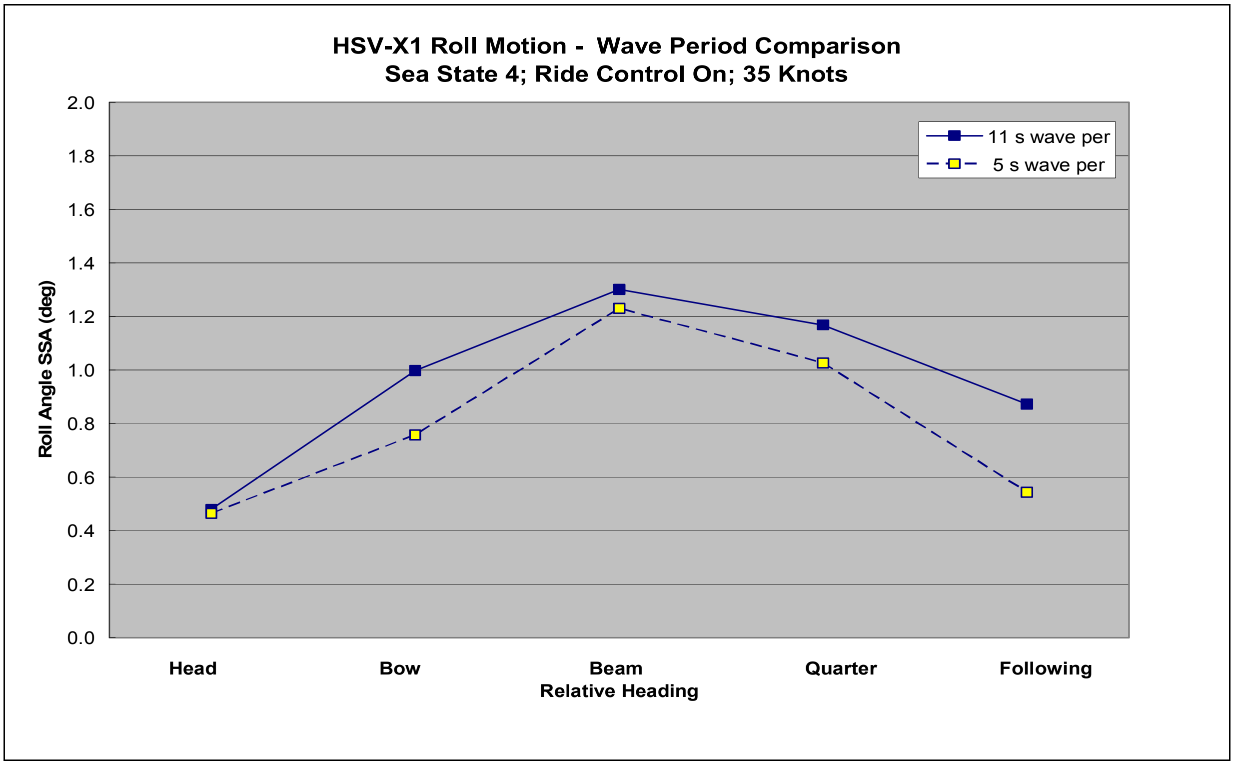


Figure 22. HSV-X1 Roll Motion – Wave Period Comparison

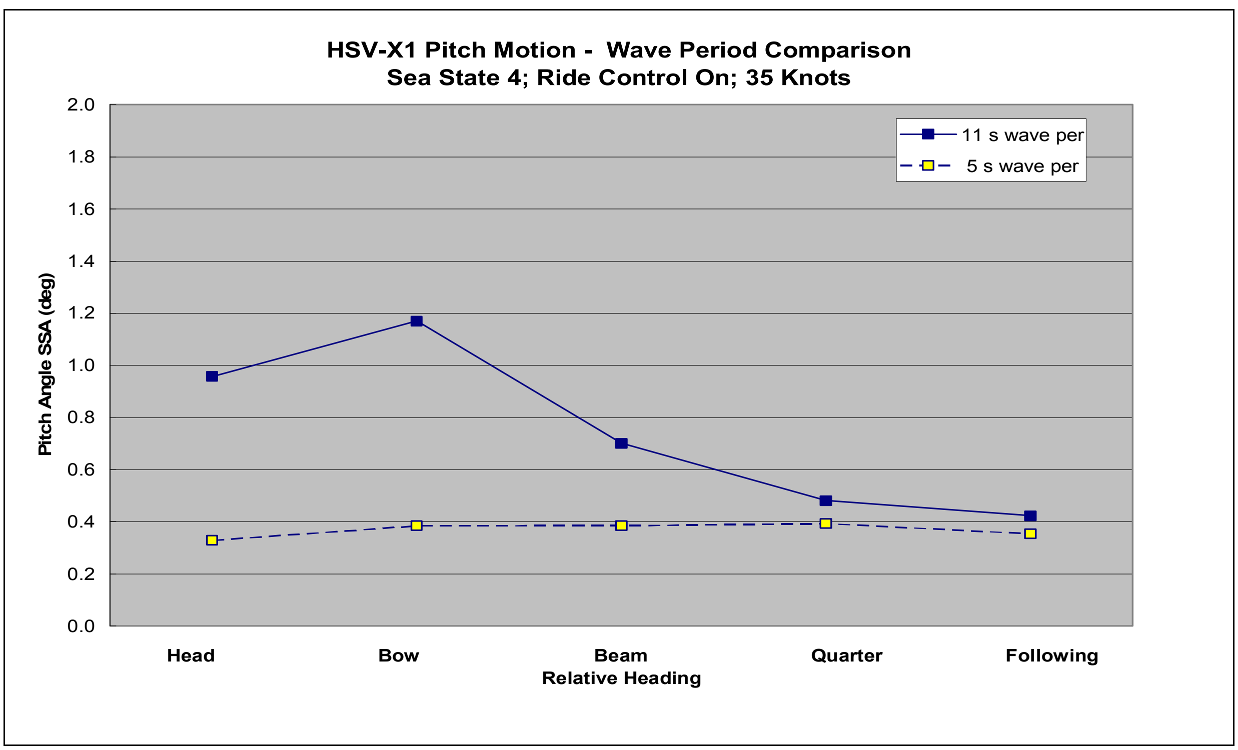


Figure 23. HSV-X1 Pitch Motion – Wave Period Comparison

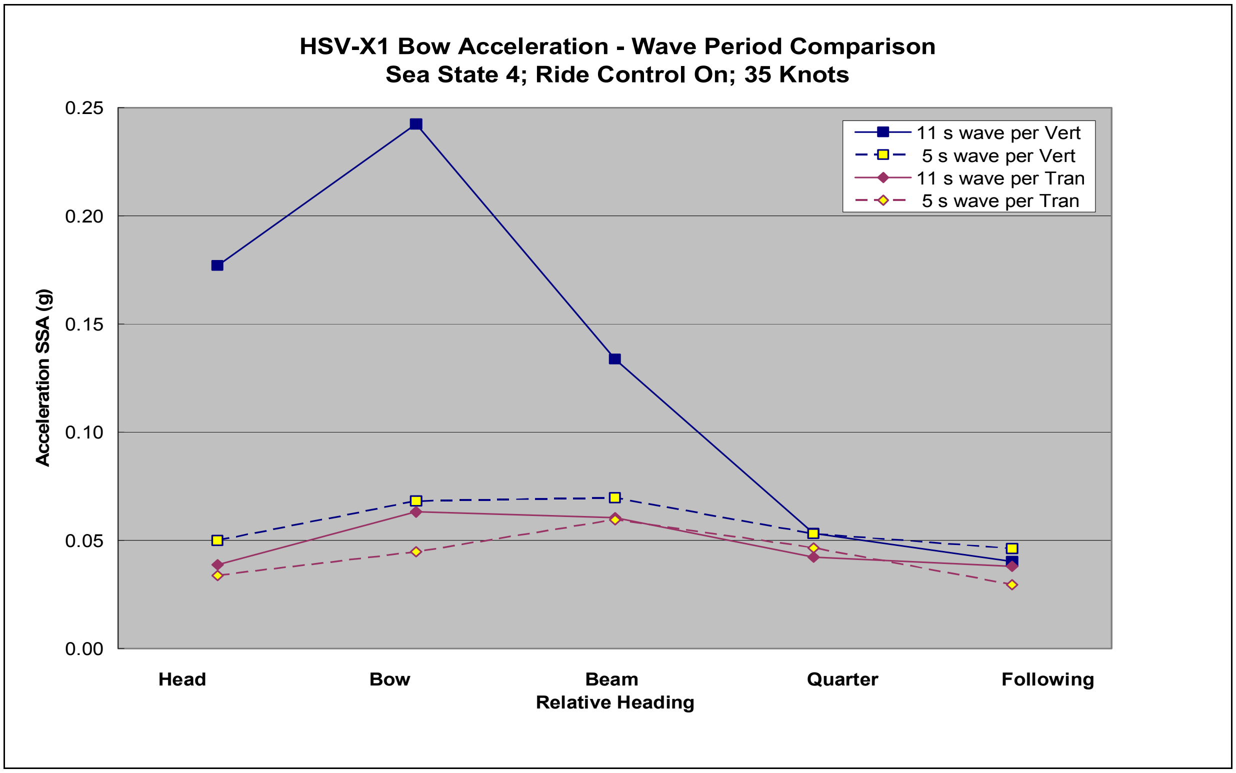


Figure 24. HSV-X1 Bow Acceleration – Wave Period Comparison

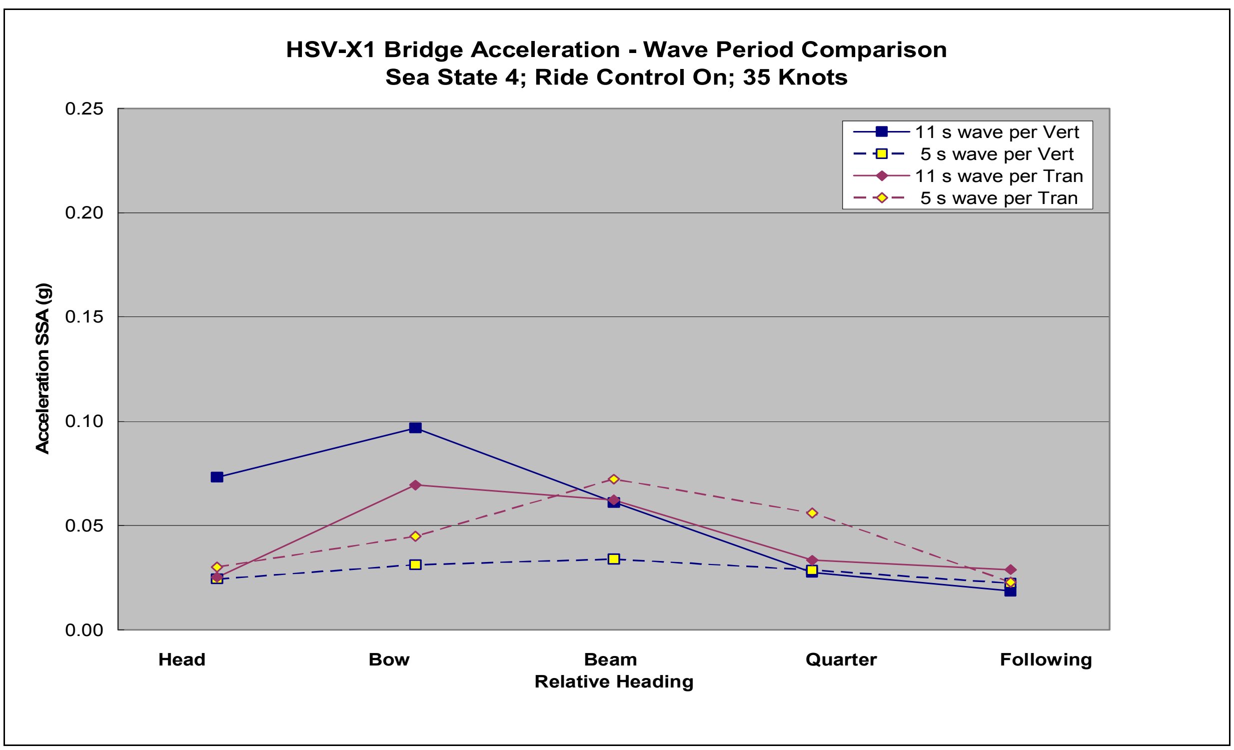


Figure 25. HSV-X1 Bridge Acceleration – Wave Period Comparison

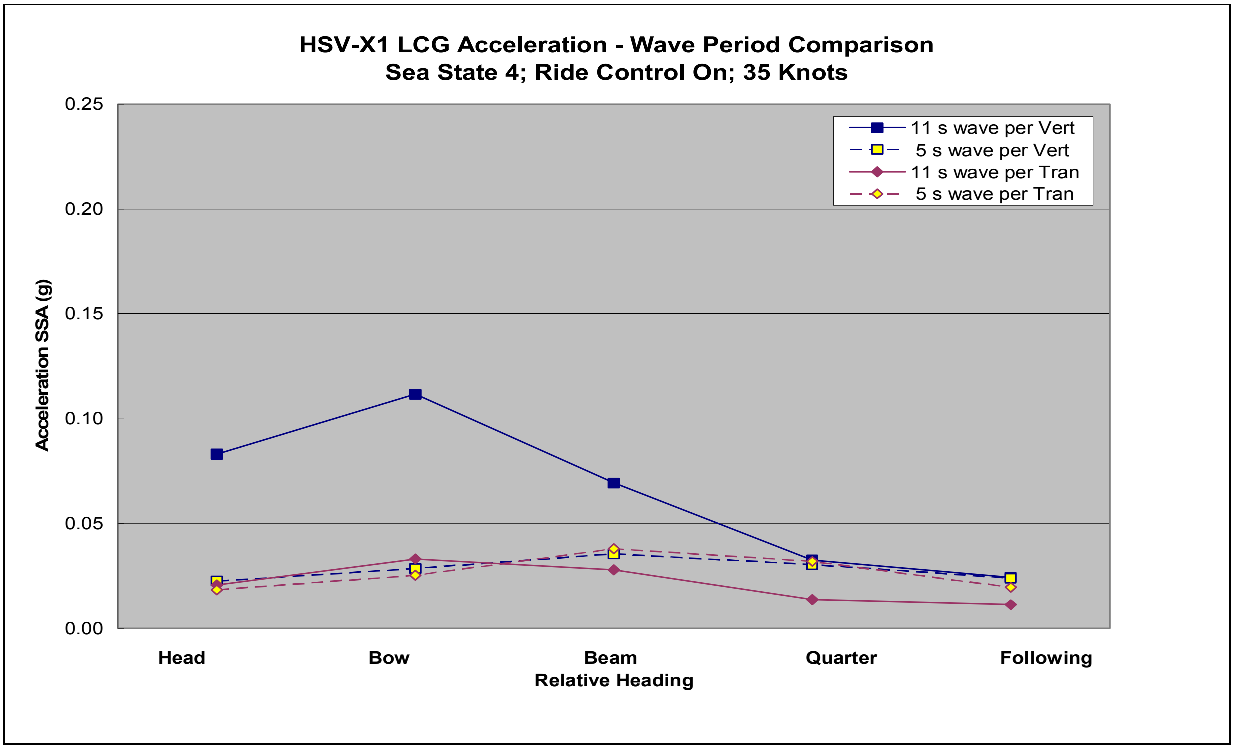


Figure 26. HSV-X1 LCG Acceleration – Wave Period Comparison

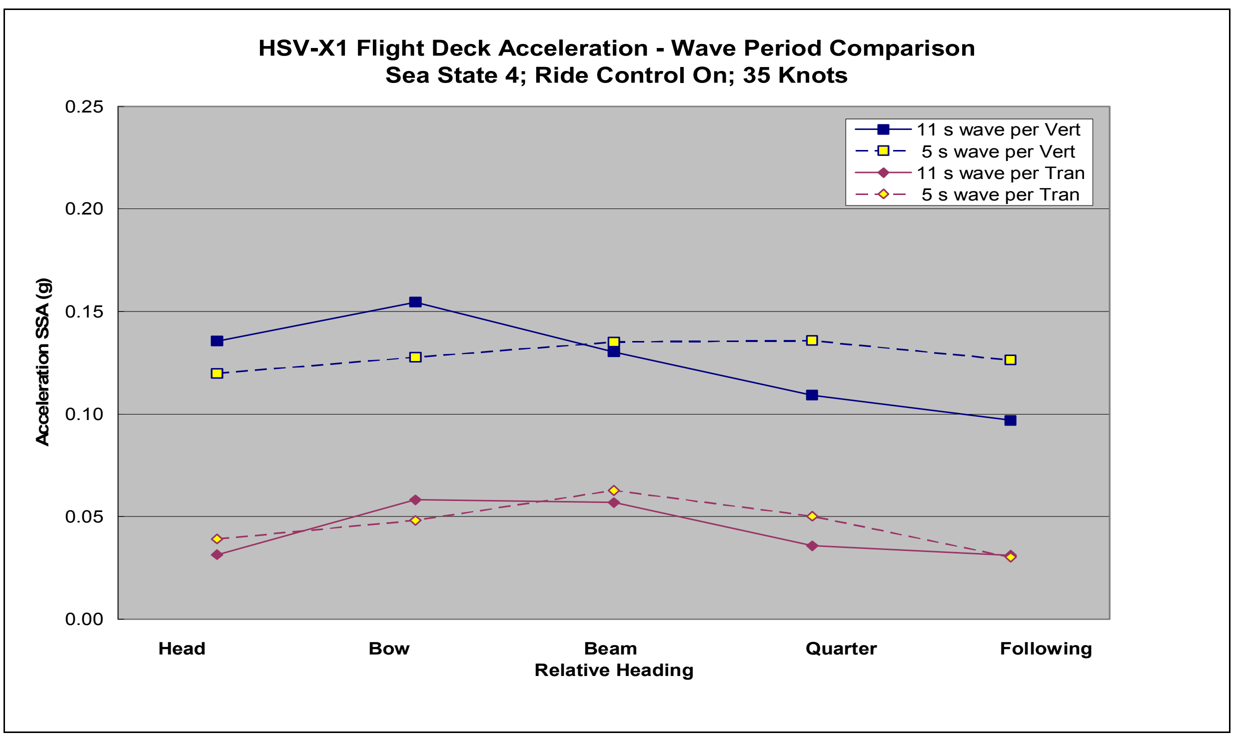


Figure 27. HSV-X1 Flight Deck Acceleration – Wave Period Comparison

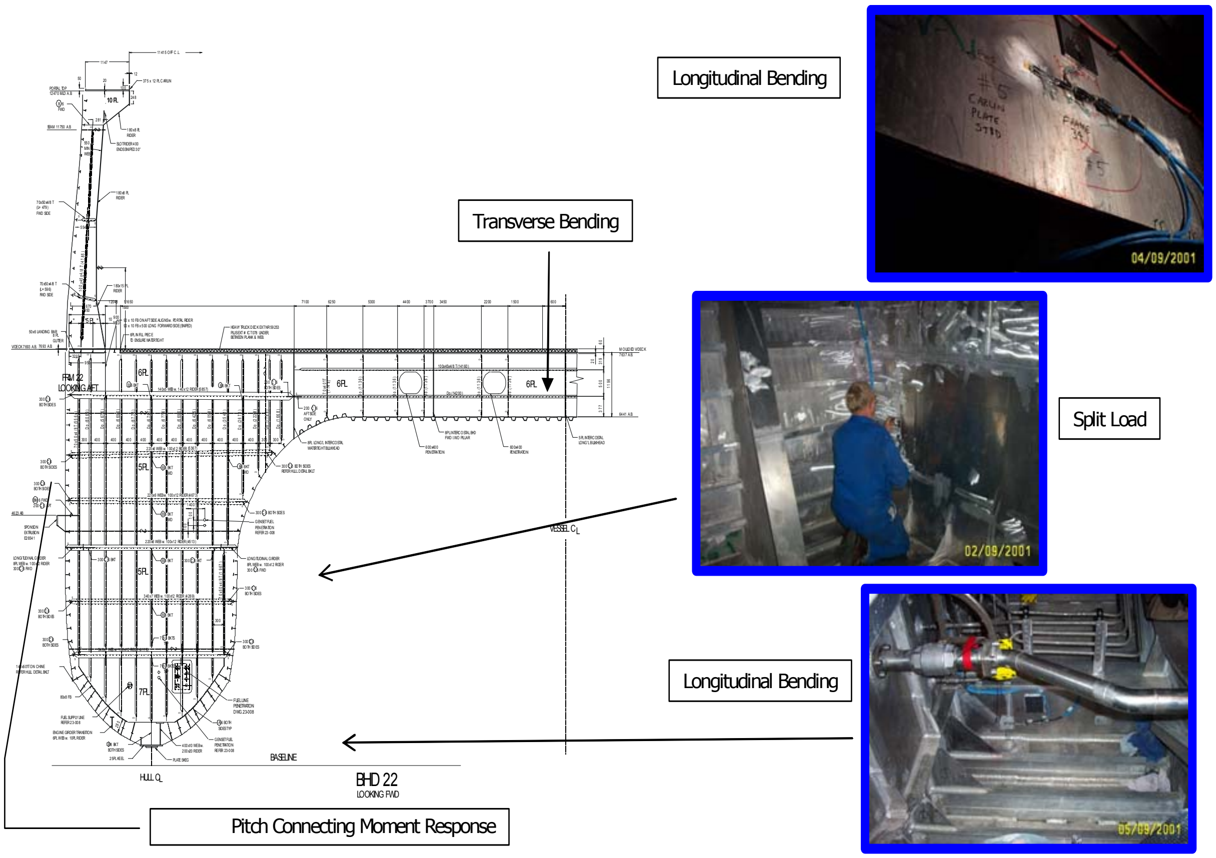


Figure 28. Typical Global Response Strain Gage Locations

Strain Gage Instrumentation on Longitudinal T-Bar for Wave Impacts

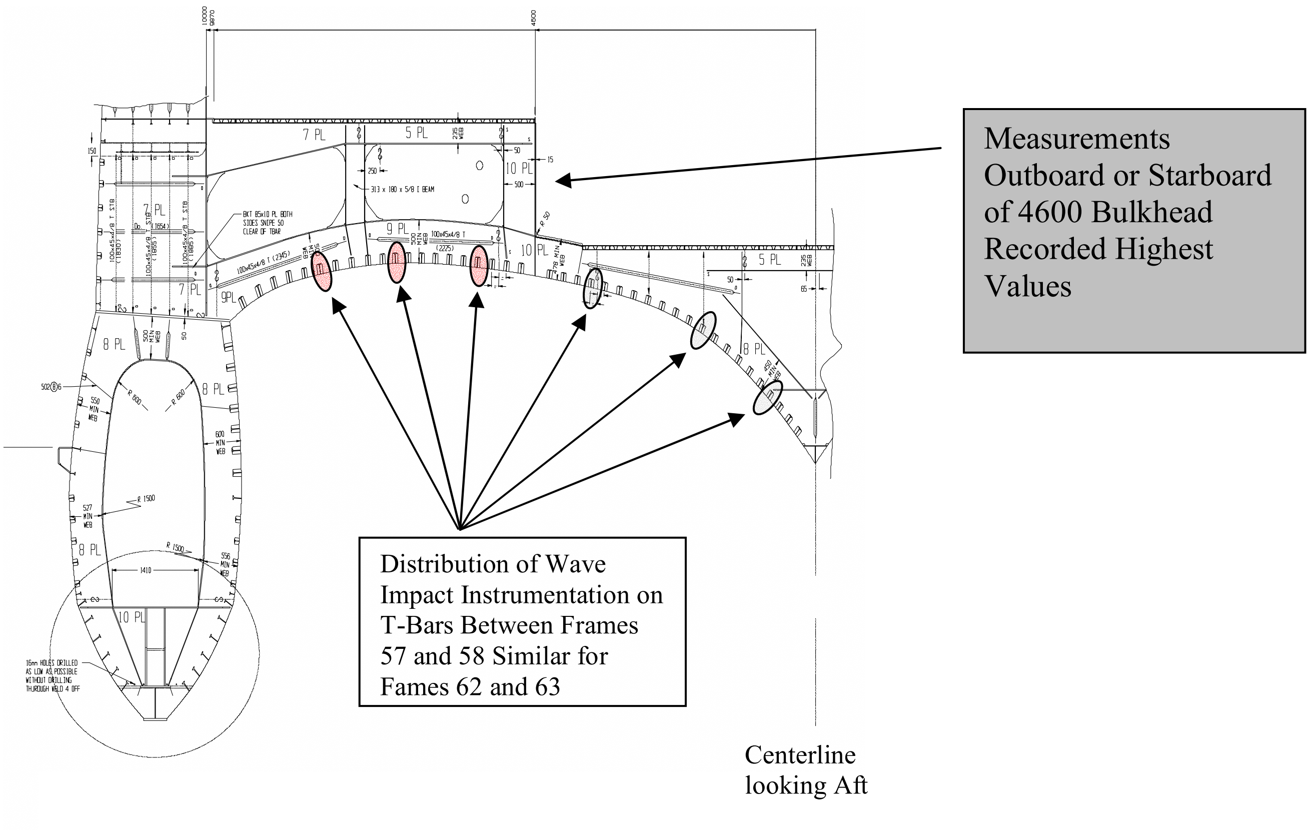


Figure 29. Cross Section Of Frame 57 With Wave Impact Instrumentation

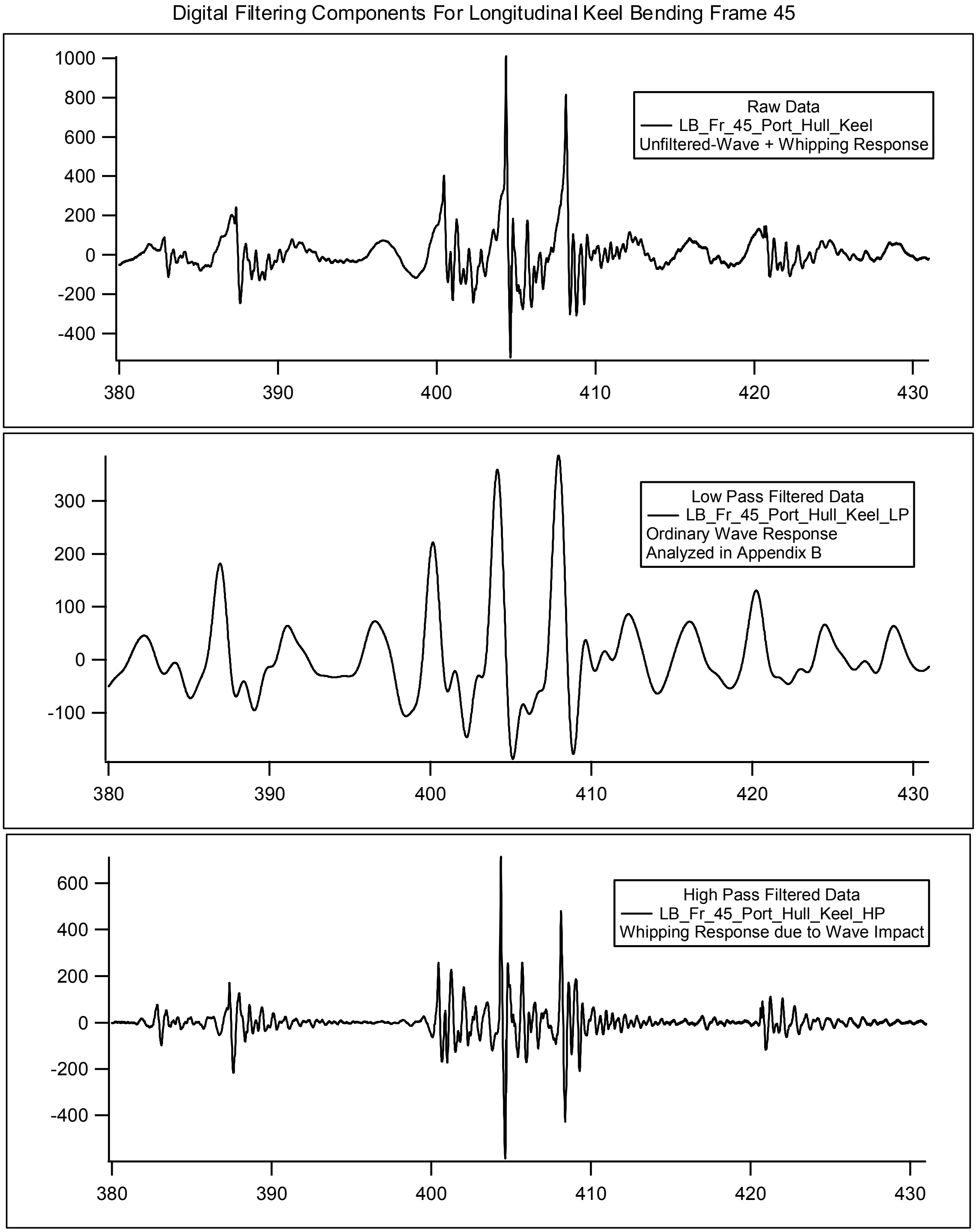


Figure 30. Components of Global Response

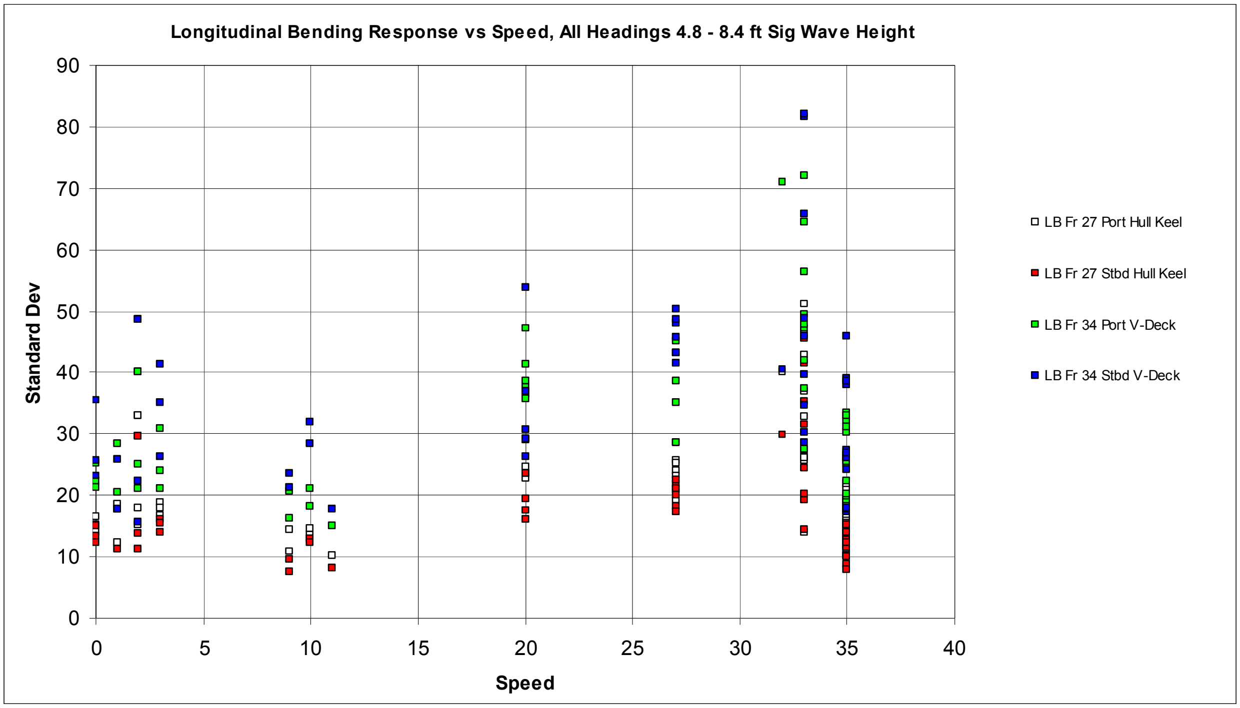


Figure 31. Trend in Longitudinal Bending Response vs Speed

Figure 32. Trend Split Load vs Speed

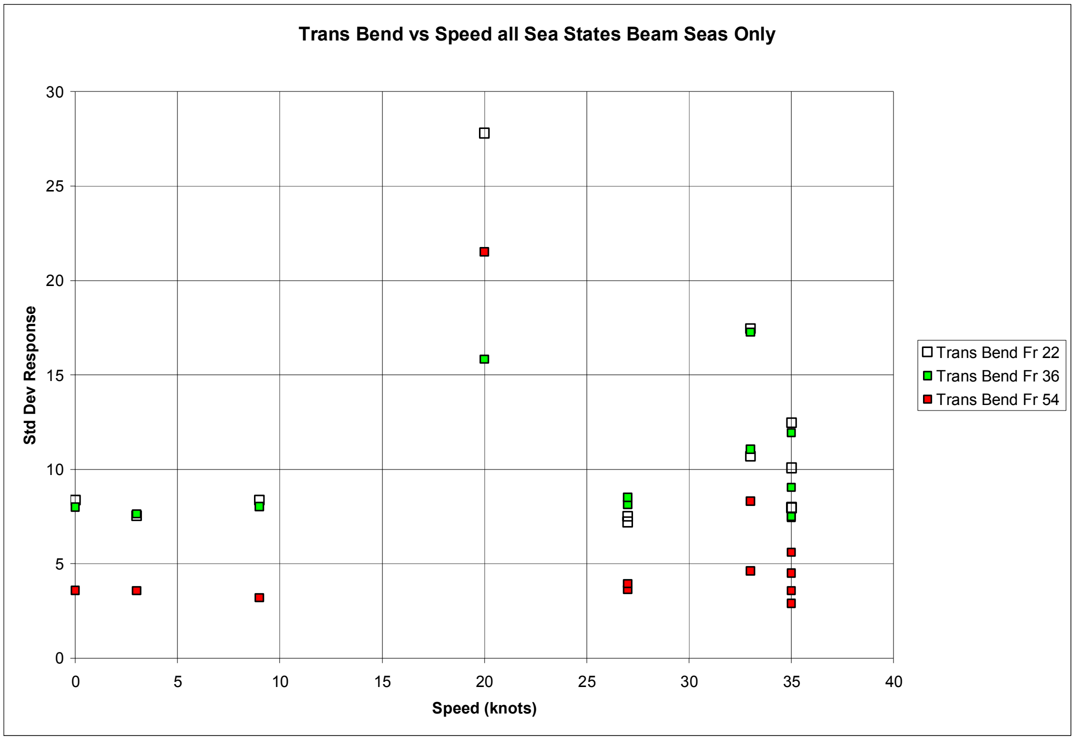


Figure 33. Transverse Bending vs Speed

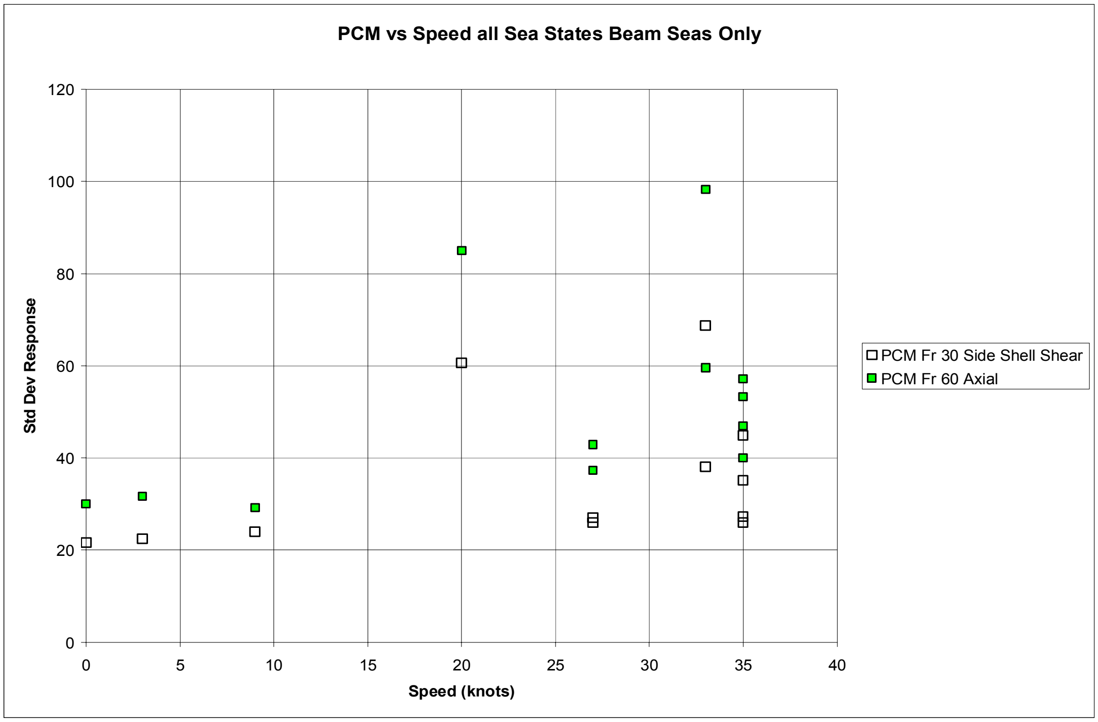
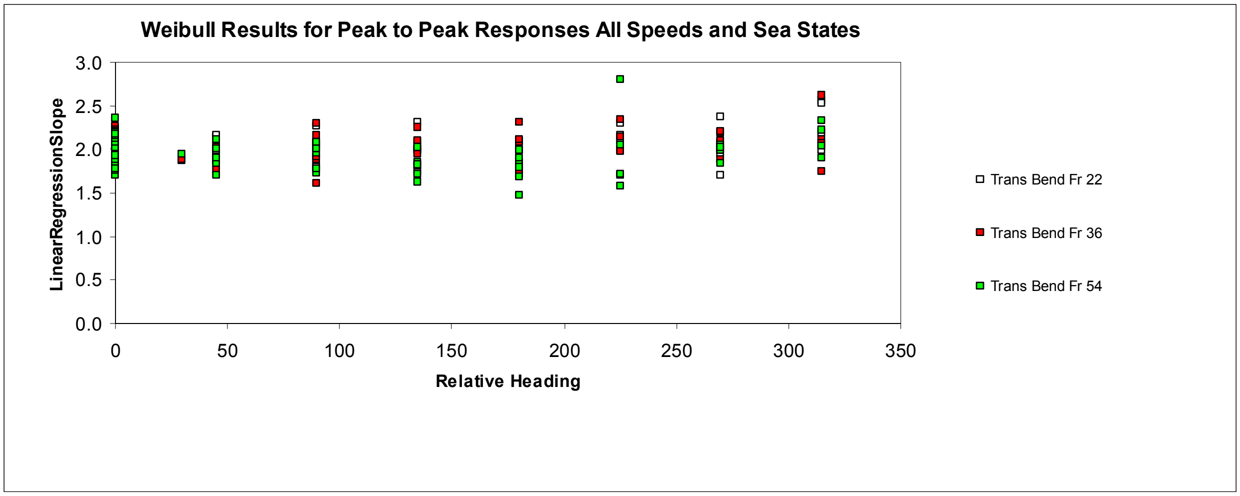
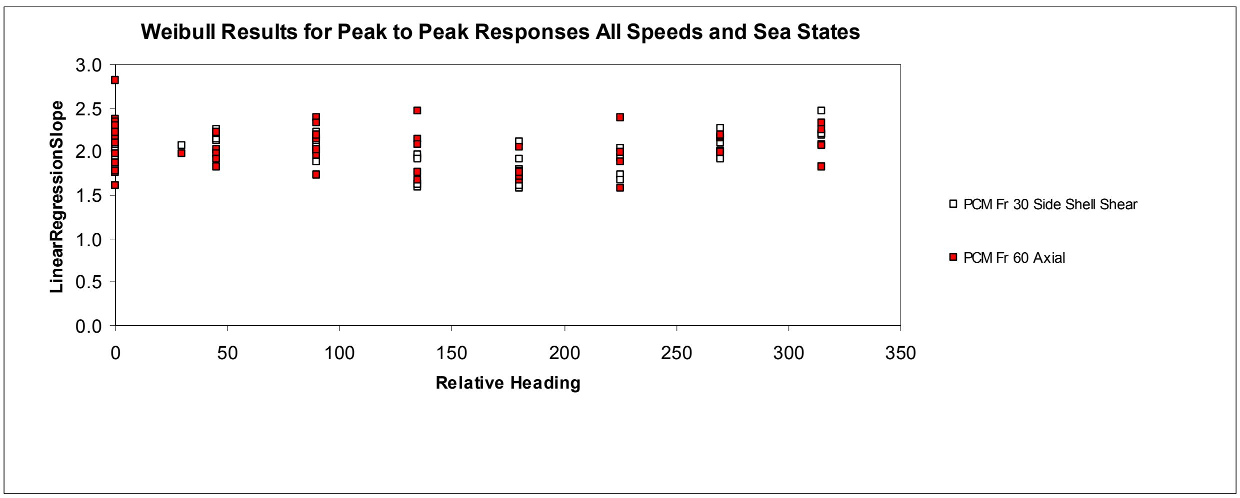


Figure 34. Pitch Connecting Response vs Speed





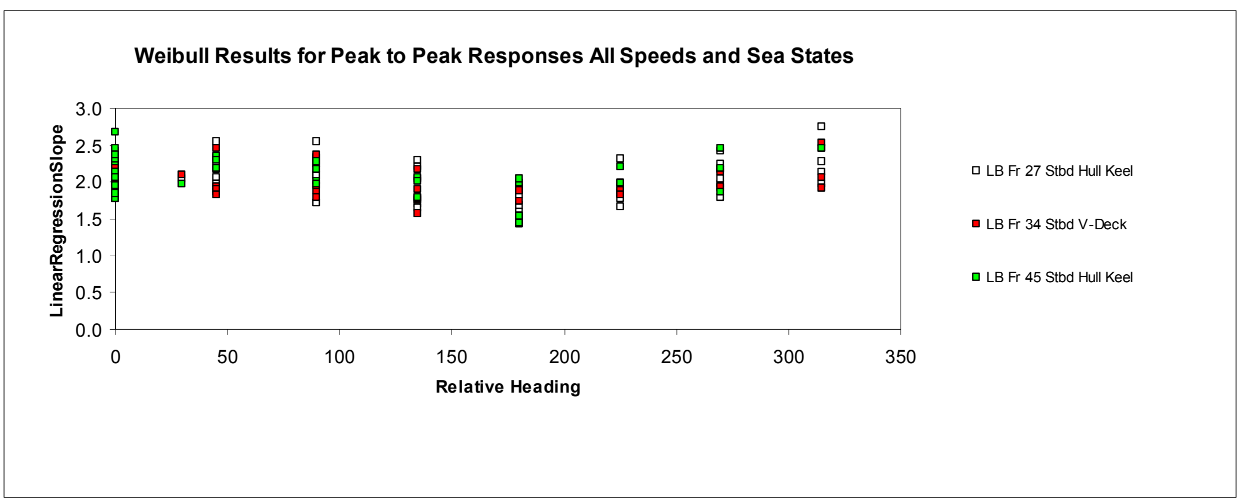


Figure 35. Trend in Weibull Shape Parameter vs Heading

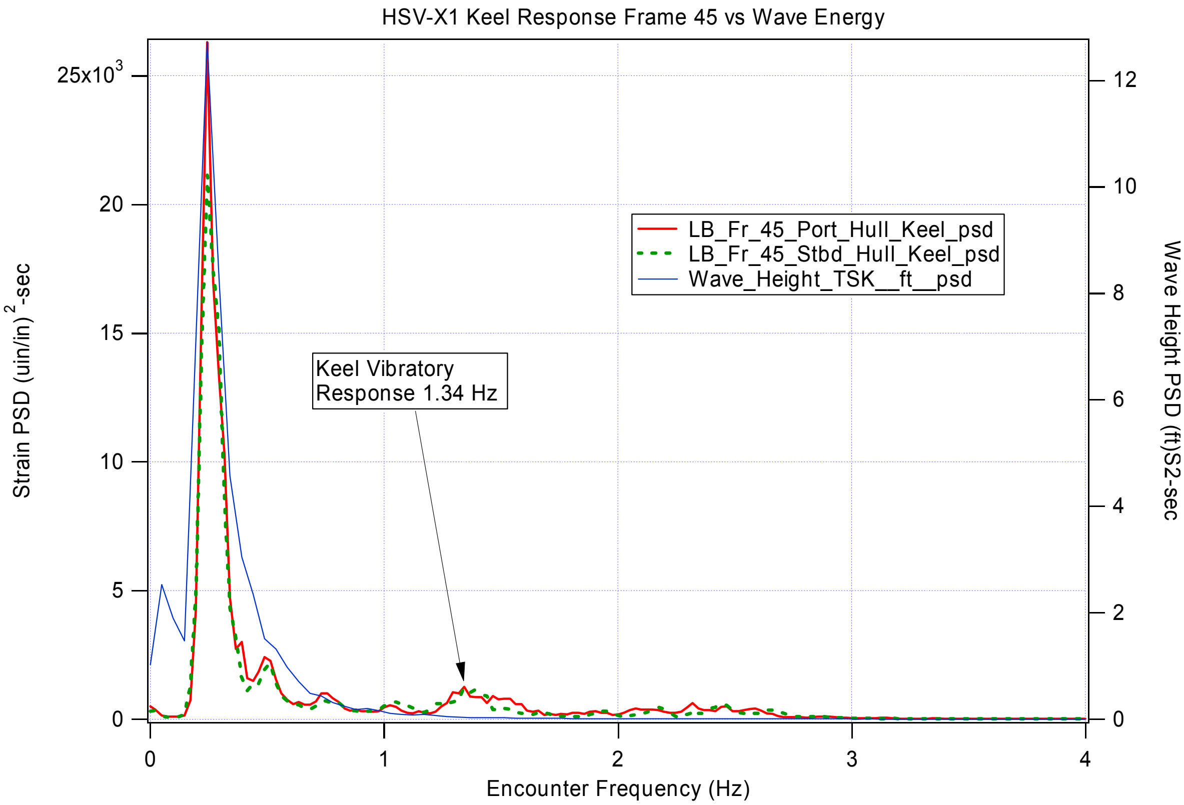


Figure 36. Keel Response PSD vs Wave Energy

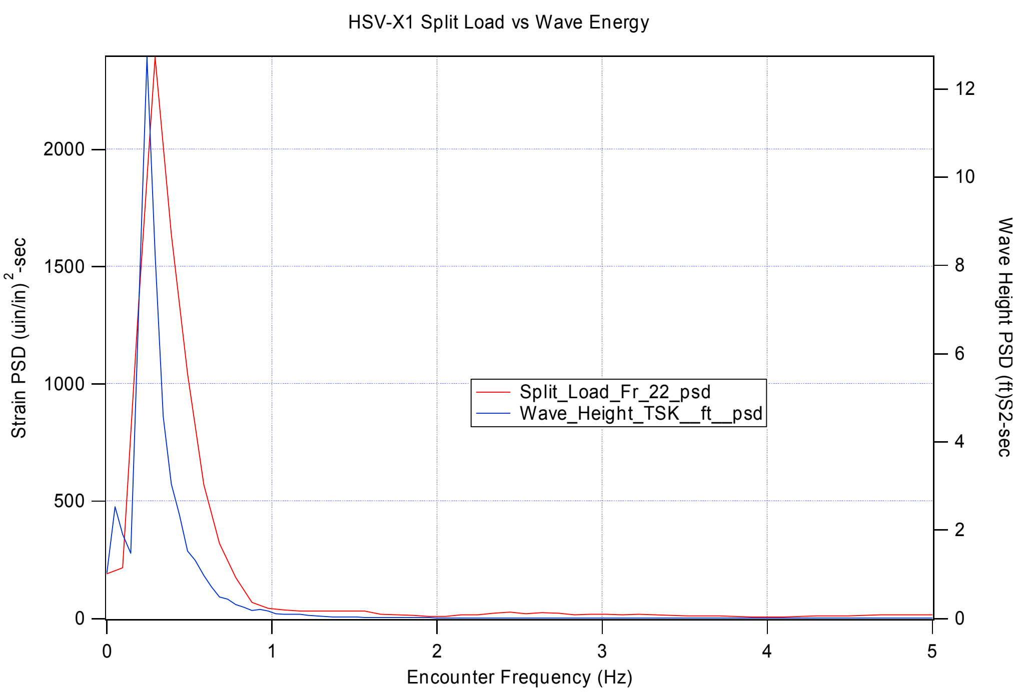


Figure 37. Split Load Response vs Wave Energy

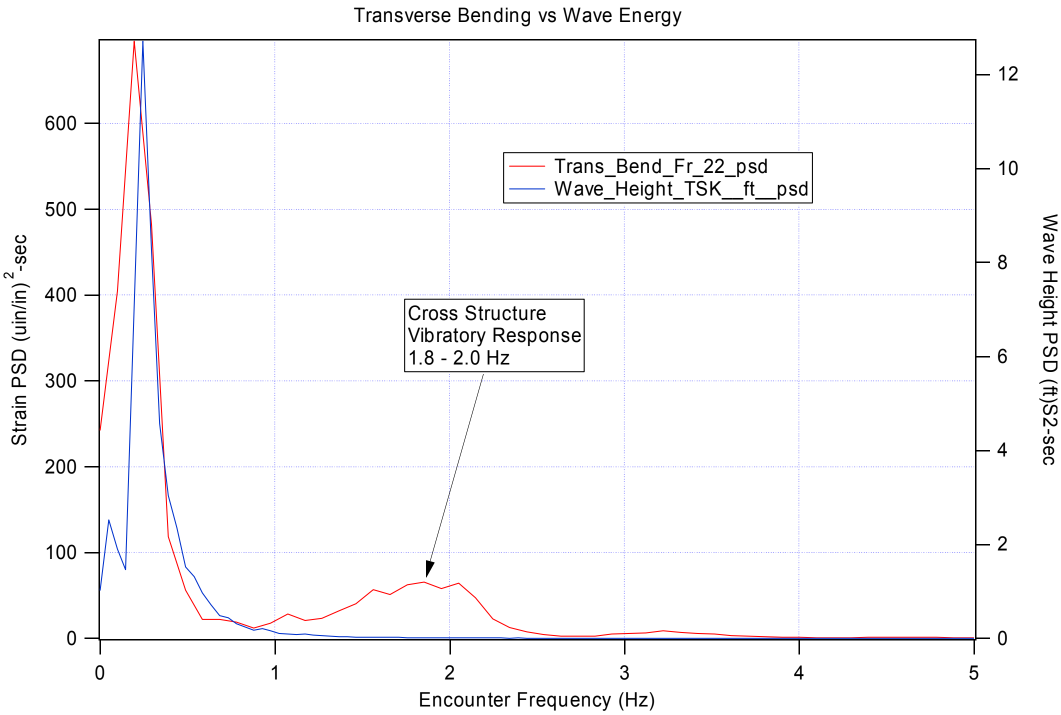


Figure 38. Transverse Bending Response vs Wave Energy

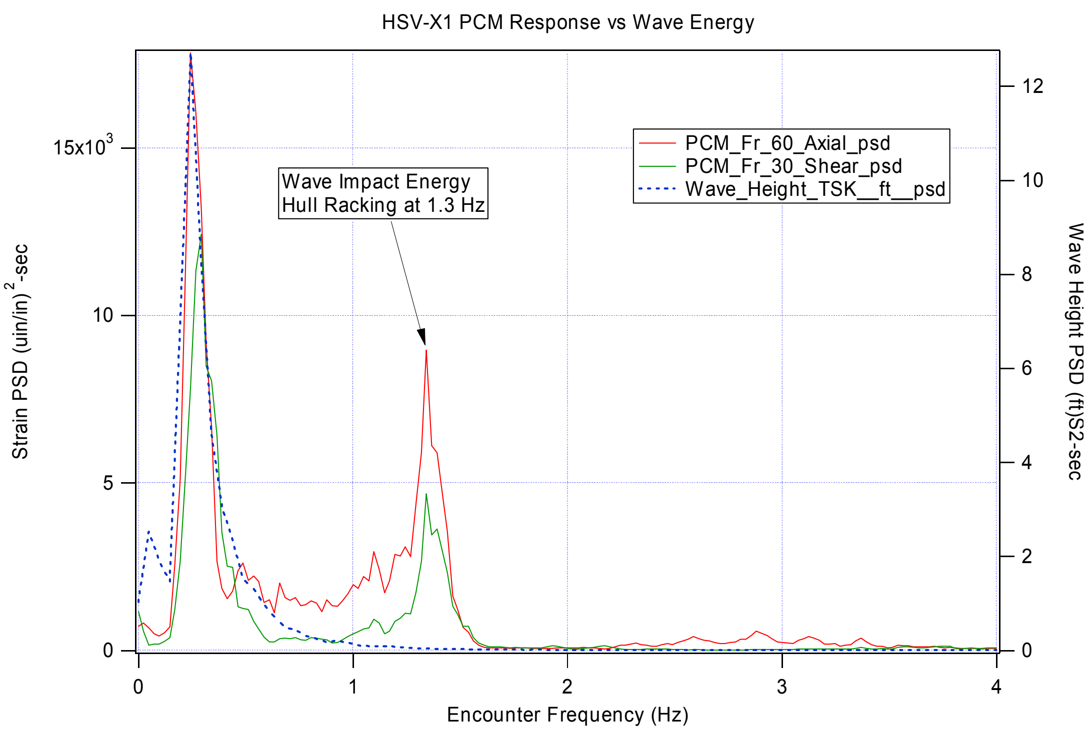


Figure 39. PCM Response vs Wave Energy

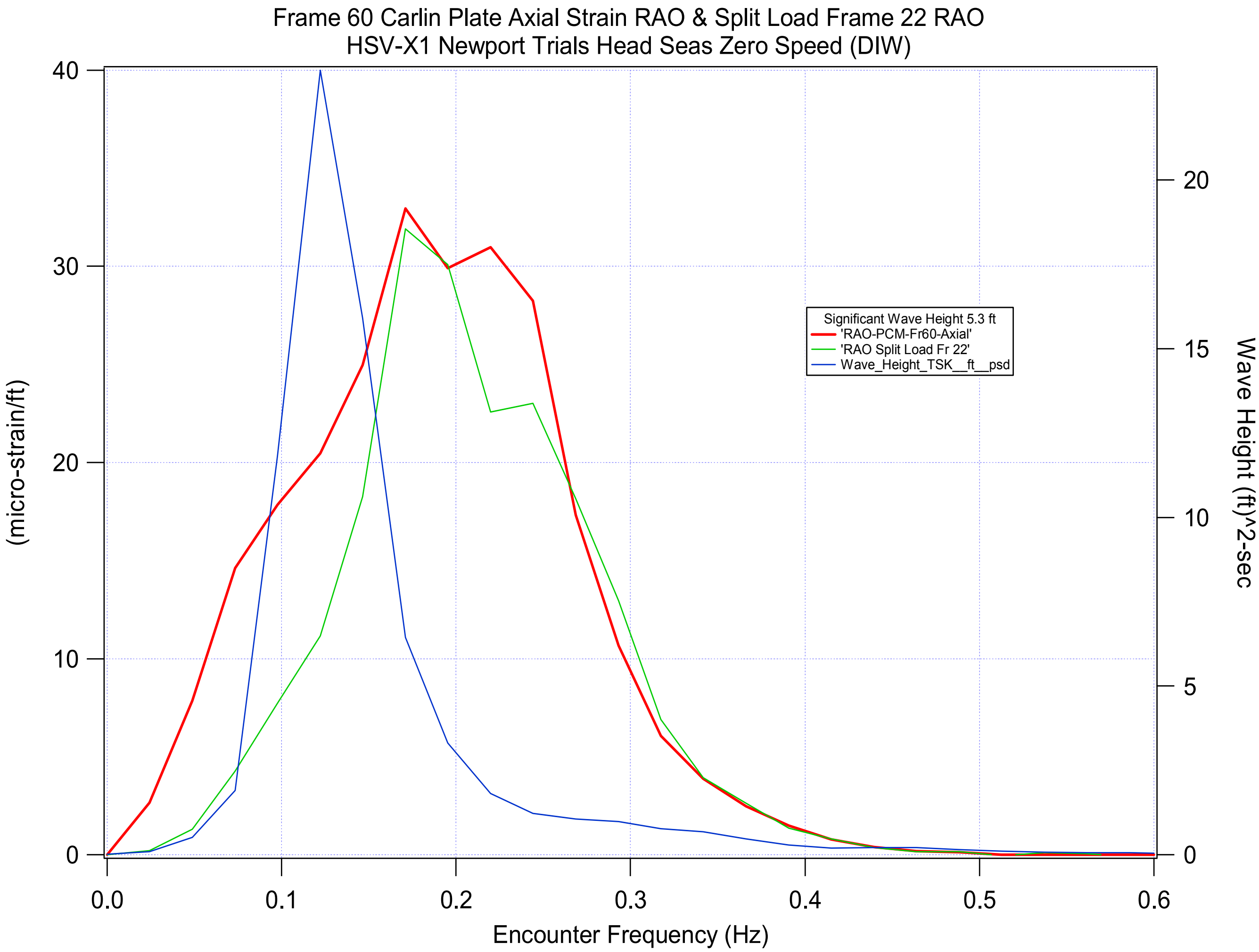


Figure 40. Response Amplitude Operator as Strain for PCM and Split Load

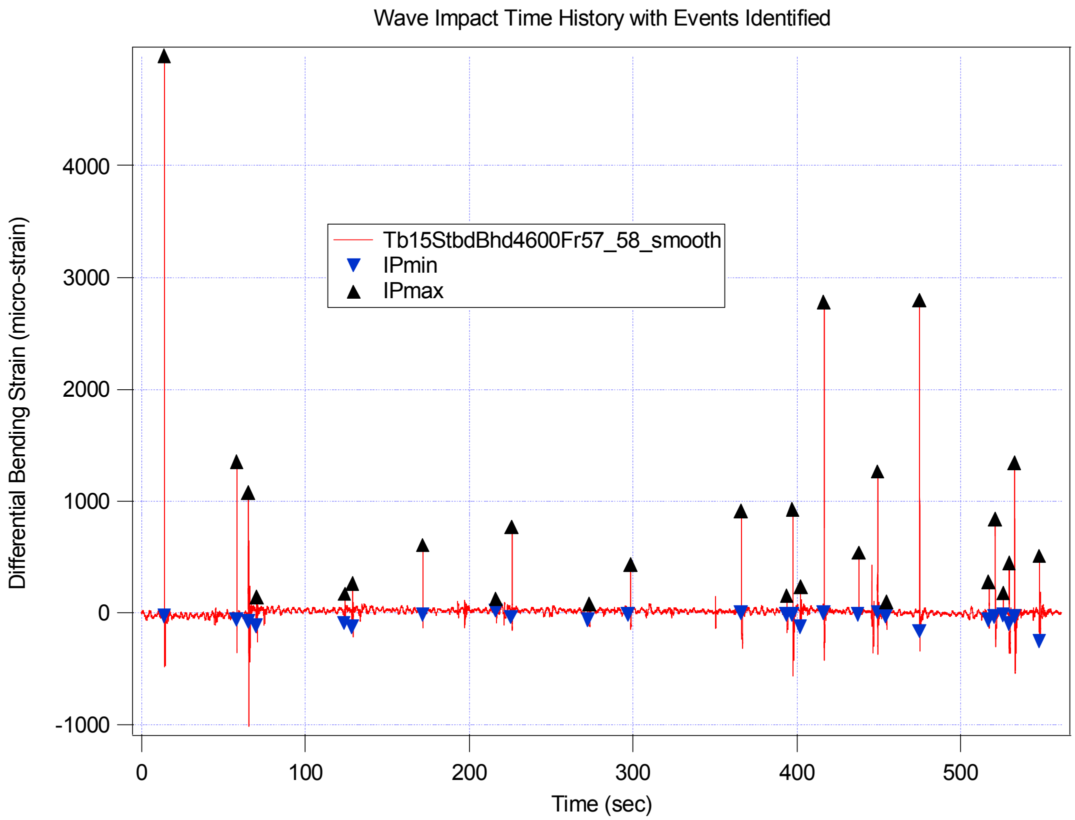


Figure 41. Condensed Wave Impact Time History for T-Bar 15 Between Frames 57 and 58

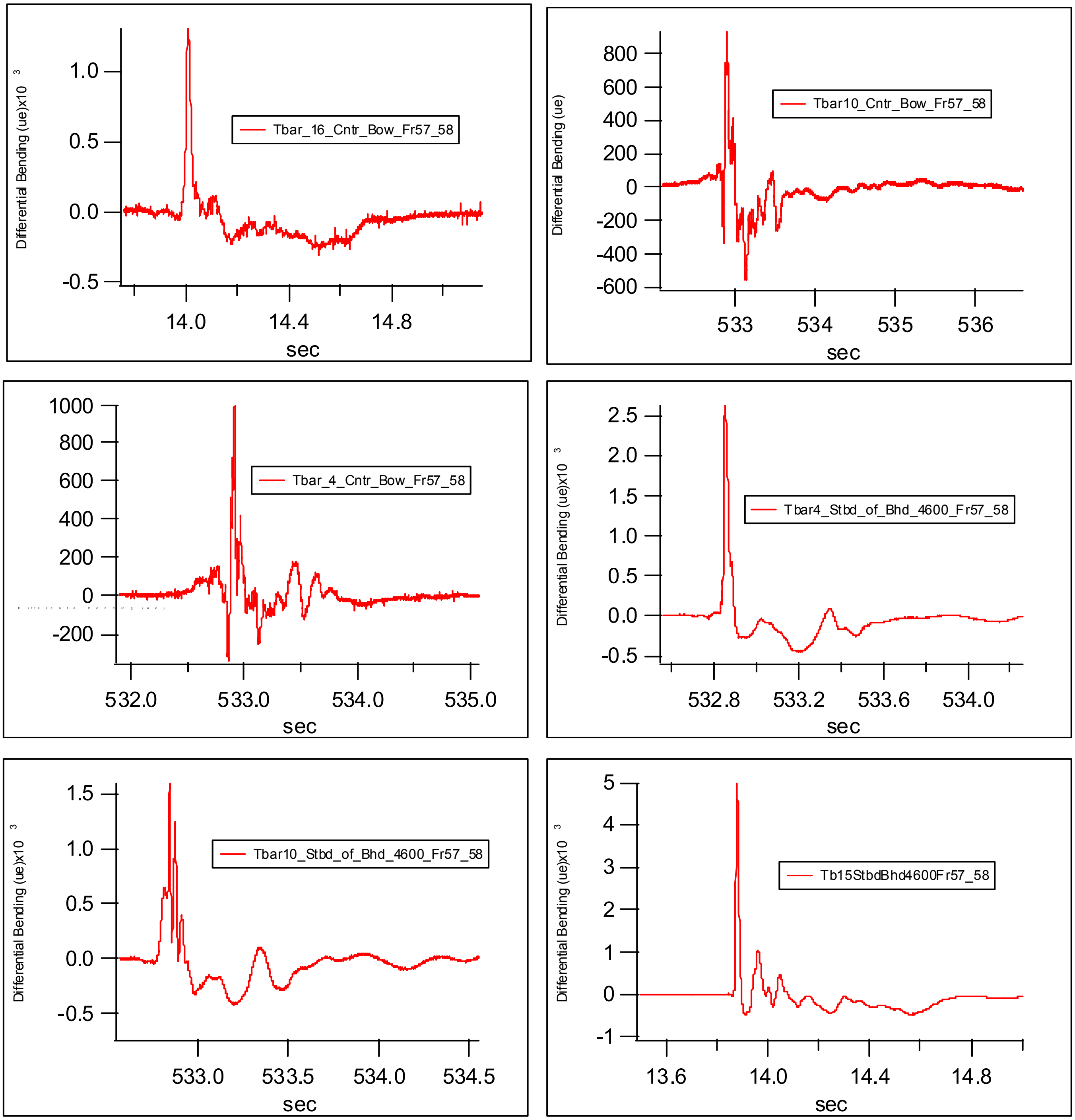


Figure 42. Typical Wave Impact Events for T-Bars between Frames 57 and 58

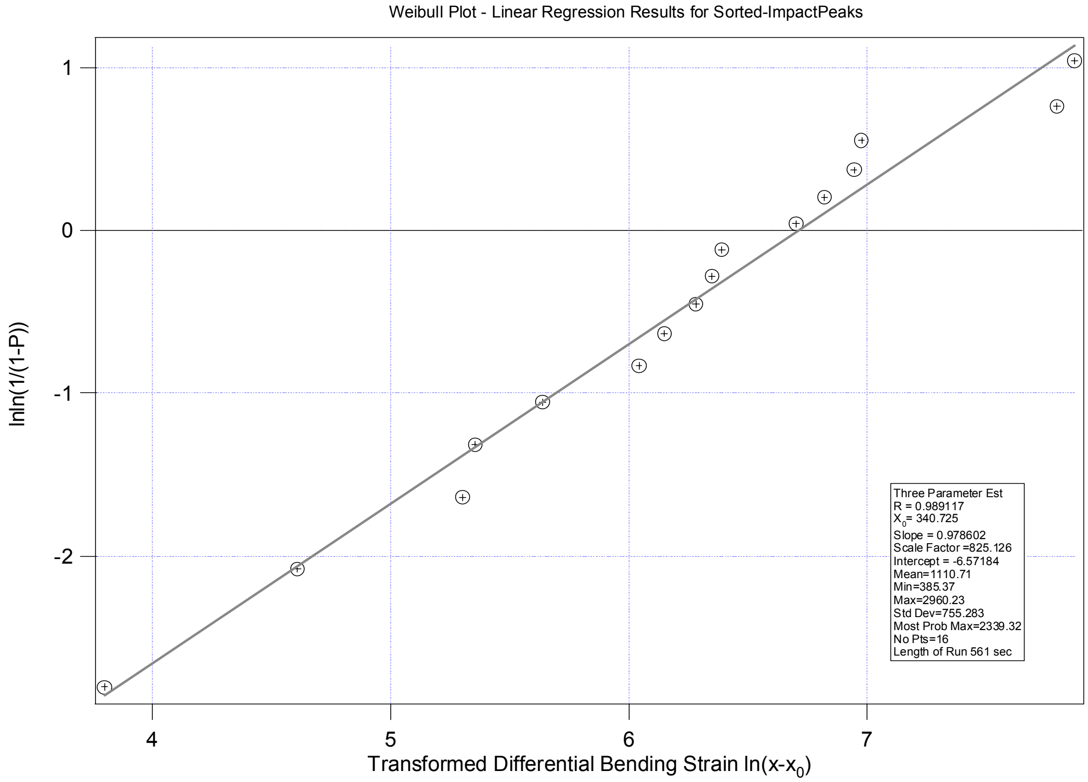


Figure 43. Weibull Analysis Results for Wave Impact Events on T-Bar 15 between Frames 57 and 58

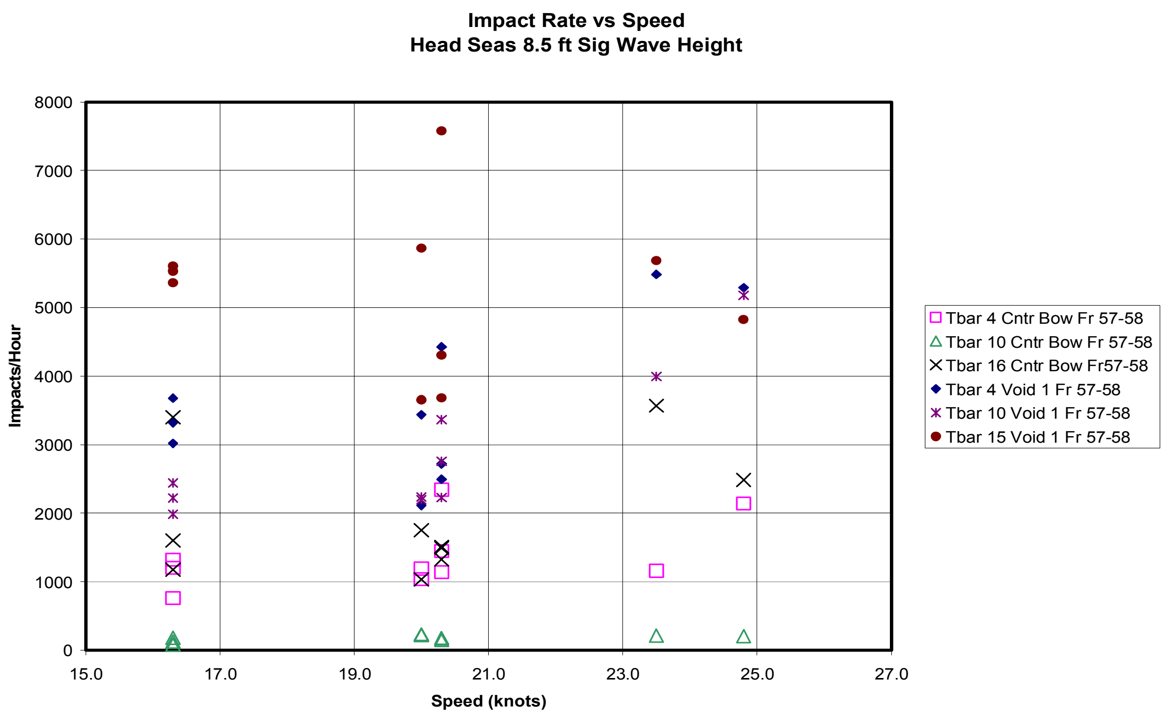


Figure 44. Impact Rates for the Frame 57-58 Wave Impact Measurements

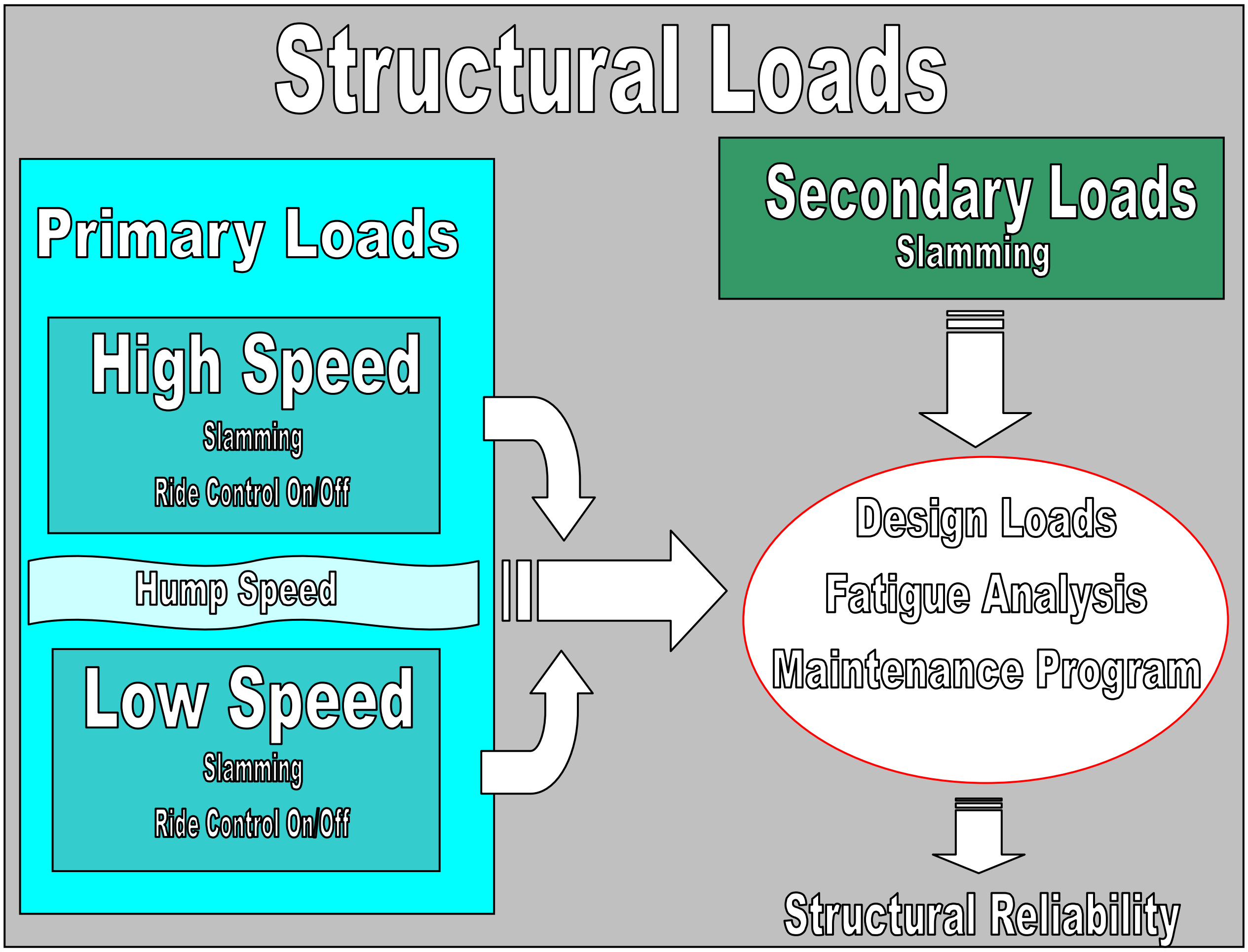


Figure 45. Structural Response and Design Loads

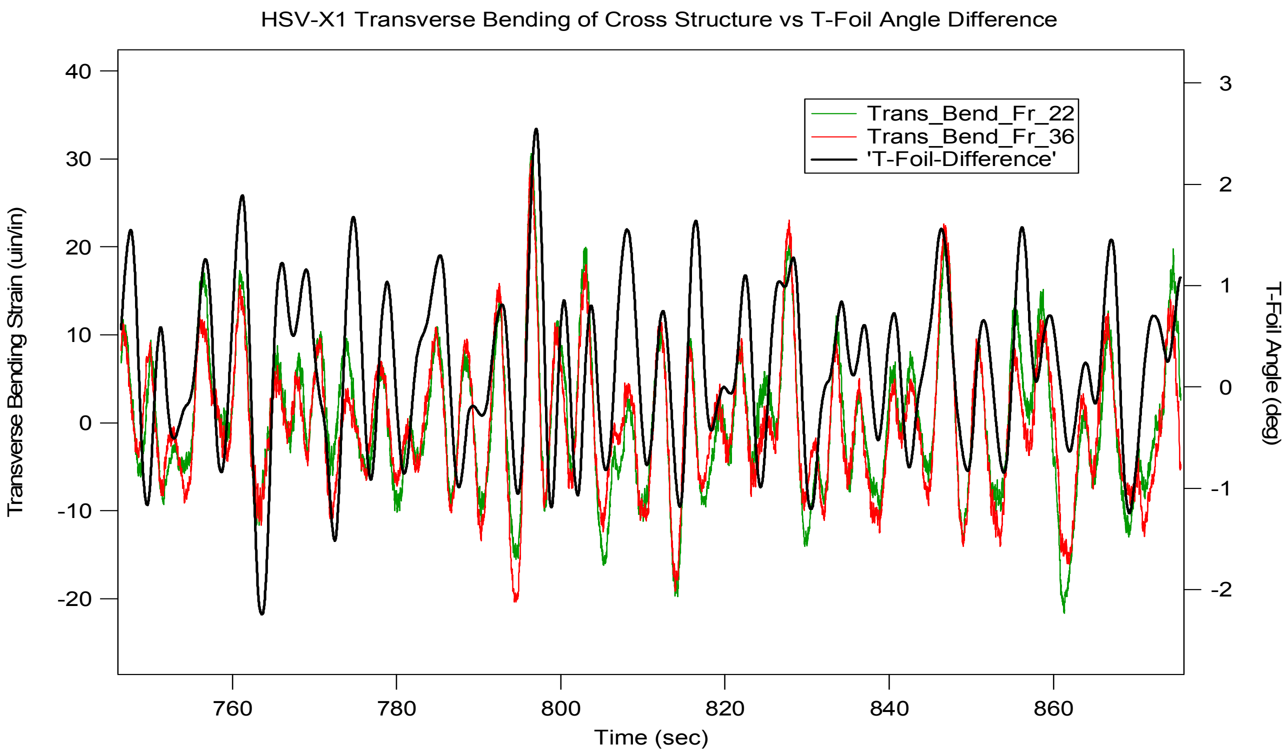


Figure 46. Transverse Bending Response Related to T-Foil Angle

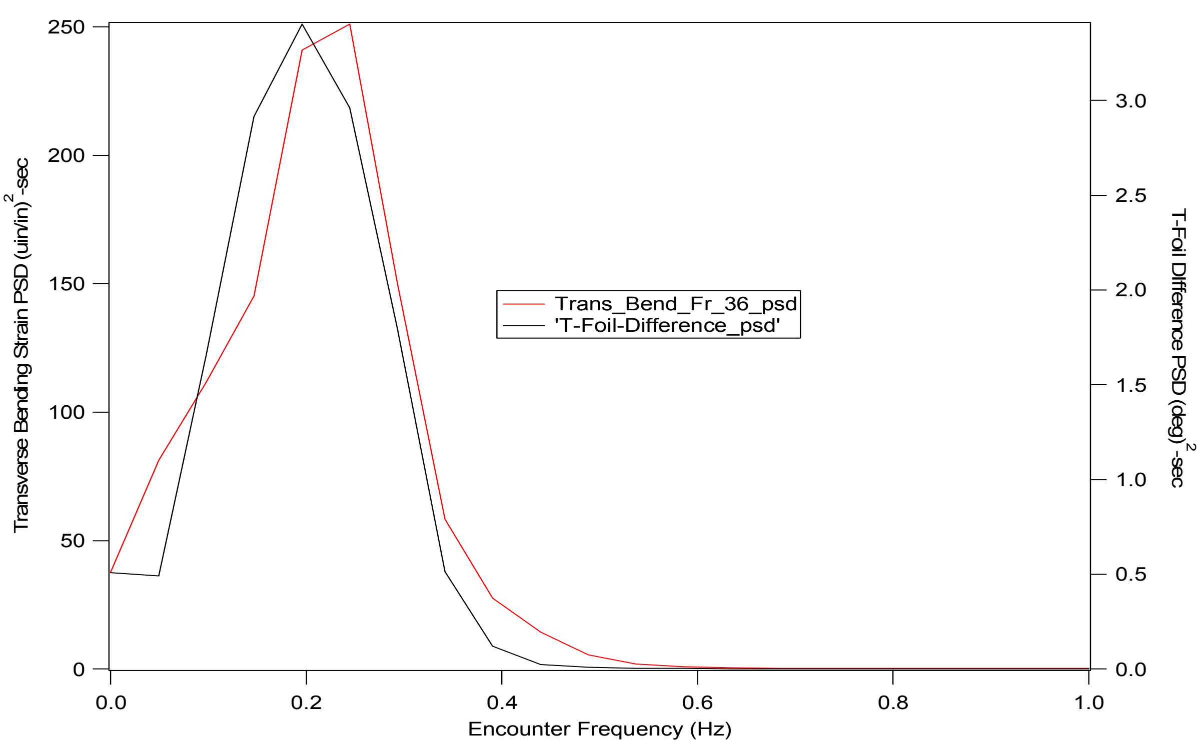


Figure 47. Transverse Bending Spectra vs T_Foil Difference Spectra

Table 1. HSV-X1 Joint Venture Ship Particulars

Dimensions

Length		Beam		Draft
95.47 m	Overall	26.6 m	Overall	3.67 m
86 m	Waterline	4.5 m	DemiHull	

Speed

Operational	Light Ship
38 knots	48 knots

Displacement

Dead Weight	Lightship Weight
815 Short Tons 740 Metric Tons	945 Metric Tons

Personnel

Crew	Long Term Riders	Seating
45	48	363

Liquids

Fuel Tanks	Long Range Tanks	Water Tank
175,000 Liters	392,000 Liters	11,300 Liters

Table 2. Seakeeping and Structural Measurement Milestones

+

LOE /Operation / Event		Date	Reference
Instrumentation		Aug-Sept 2001	1
Helicopter Flight Deck Certification Trials		30 Oct – 31 Oct 2001	
Seakeeping Operations in Sea State 3 and 4		30 Oct 2001	2
Load Out Trials	Little Creek – Morehead Morehead – Blount Island	27 Nov 2001- 29 Nov 2001	3
	24 Hour Load Out to Morehead City	09 Jan – 11 Jan 2002	
TA-NS-Baltic	Trans Atlantic Operations	04 Feb 2002 – 16 Feb	4
	North Sea & Baltic Operations	01 Mar 2002 – 07 Mar	
Newport Trials (Dedicated Trials)		20 Nov 2002 – 22 Nov	5

Table 3. HSV-X1 Vessel Condition

HSV-X1 Vessel Condition

		Fuel Load		DRAFT (Meter)				Static Heal and Trim (deg)		
Date	Time	Short	Long	Prt Fwd	Prt Aft	Stbd Fwd	Stbd Aft	Roll Angle	Pitch Angle	Comments
10/29/2001	9:00:00			3.67	3.39	3.71	3.44			
10/30/2001	8:37:00	78%	78%	3.65	3.39	3.61	3.42	0.174	0.220	In Port Draft Taken With Ramp Up
10/31/2001	see 11/1									Vessel at Sea
11/1/2001	7:45:00			3.41	3.42	3.41	3.48			In Port Draft Taken With Ramp Deployed
11/28/2001	10:00			3.85	3.45		3.5	-0.170	0.246	
11/28/2001	16:40			4.05	3.7		3.7	-0.167	0.298	Loaded 8 AAV's
11/28/2001	19:36									7.872 Inch Draft on 186 in Short Tones
1/9/2002	23:59	95%	95%							
1/10/2002	18:33	(-10 hour transit)		4.1	3.7	3.9	3.7			Loaded Car Deck with USMC Equipment
2/5/2002	1300			3.83	3.83	3.67	3.85			
2/6/2002	11:52	99%	99%					-0.281	0.479	11 155 Howitzers Equipment and Fork Truck
2/6/2002	1235	100%	100%	3.52	3.55	3.59	3.55	-0.250	0.519	11 155 Howitzers Equipment and Fork Truck
2/12/2002	1050			3	4.5	3.9	4.36			Pre-Fueling
2/13/2002	100			3.52	3.7	3.67	3.65			Post-Fueling
2/16/2002	21:15							-0.492	-0.046	Ramp Down Engine on
2/16/2002	21:35			NA	3.8	3.55	3.55	-0.499	-0.056	Ramp Down Engine on
2/16/2002	22:20							-0.500	-0.061	Ramp Down Engine on
2/17/2002	0:00			3.4	3.5	3.55	3.5			
3/1/2002	8:30		100%							Zero at Pier
3/1/2002	12:50		100%							Zero at Pier Engines Running
3/1/2002	16:11		100%							Zero at Pier (Filters maybe off)
3/5/2002	10:30			3.4	3.4	3.4	3.4	-0.072	-0.097	Zero at Pier
3/6/2002	12:45							-0.205	0.412	Zero at Pier
3/7/2002	14:20							-0.191	0.414	Zero a Pier

Table 4. Slow System Channel Summary of Seakeeping Measurements

No.	Channel ID	Units	Description	Source	Location
24	Roll Angle 1	degrees	LCG Motions Package Roll	NSW CCD	Cross Structure Centerline Frame 31
25	Pitch Angle 1	degrees	LCG Motions Package Pitch	NSW CCD	Cross Structure Centerline Frame 32
26	Roll Rate	degrees	LCG Motions Package Roll Rate	NSW CCD	Cross Structure Centerline Frame 33
27	Pitch Rate	degrees	LCG Motions Package Pitch Rate	NSW CCD	Cross Structure Centerline Frame 34
28	Yaw Rate	degrees	LCG Motions Package Yaw Rate	NSW CCD	Cross Structure Centerline Frame 35
29	Vert Bridge Acc	g's	Bridge Acceleration Package	NSW CCD	Bridge Frame 25
30	Tran Bridge Acc	g's	Bridge Acceleration Package	NSW CCD	Bridge Frame 25
31	Long Bridge Acc	g's	Bridge Acceleration Package	NSW CCD	Bridge Frame 25
32	Vert LCG Acc	g's	LCG Motions Package	NSW CCD	Cross Structure Frame 31
33	Tran LCG Acc	g's	LCG Motions Package	NSW CCD	Cross Structure Frame 31
34	Long LCG Acc	g's	LCG Motions Package	NSW CCD	Cross Structure Frame 31
35	Vert Flt Deck Acc	g's	Flight Deck Acceleration Package	NSW CCD	Helicopter Deck Frame 27
36	Tran Flt Deck Acc	g's	Flight Deck Acceleration Package	NSW CCD	Helicopter Deck Frame 27
37	Long Flt Deck Acc	g's	Flight Deck Acceleration Package	NSW CCD	Helicopter Deck Frame 27
38	Vert Bow Acc	g's	Bow Acceleration Package	NSW CCD	Center Hull Frame 73
39	Tran Bow Acc	g's	Bow Acceleration Package	NSW CCD	Center Hull Frame 73
40	Wave Height TSK	feet	Wave Height Package	NSW CCD	Center Hull Frame 70
41	Rel Bow Motion TSK	feet	Wave Height Package	NSW CCD	Center Hull Frame 70
42	Vert Bow Acc TSK	g's	Wave Height Package	NSW CCD	Center Hull Frame 70
43	Wind Speed	knots	Wind Bird	NSW CCD	Mast Frame 25
44	Wind Direction	degrees	Wind Bird	NSW CCD	Mast Frame 25
45	Port Rudder Ang	degrees	Port Rudder Function	Ship System	Signal From Electronics Room
46	Stbd Rudder Ang	degrees	Starboard Rudder Function	Ship System	Signal From Electronics Room
47	SO Bucket Pos	Percent	Bucket Function Zero is Full Ahead	Ship System	Signal From Electronics Room
48	SI Bucket Pos	Percent	Bucket Function Zero is Full Ahead	Ship System	Signal From Electronics Room
49	PO Bucket Pos	Percent	Bucket Function Zero is Full Ahead	Ship System	Signal From Electronics Room
50	PI Bucket Pos	Percent	Bucket Function Zero is Full Ahead	Ship System	Signal From Electronics Room
51	SO Shaft	rpm	Shaft rpm	Ship System	Signal From Electronics Room
52	SI Shaft	rpm	Shaft rpm	Ship System	Signal From Electronics Room
53	PO Shaft	rpm	Shaft rpm	Ship System	Signal From Electronics Room
54	PI Shaft	rpm	Shaft rpm	Ship System	Signal From Electronics Room
55	Stbd T Foil Ang	degrees	T-Foil Function	Ship System	Signal From Electronics Room
56	Port T Foil Ang	degrees	T-Foil Function	Ship System	Signal From Electronics Room
57	Stbd Tab Ang	Percent	Tab Function	Ship System	Signal From Electronics Room
58	Port Tab Ang	Percent	Tab Function	Ship System	Signal From Electronics Room
59	Port Out Fuel	liters/hour	Engine Fuel Consuption Rate	Ship System	Port Void 5
60	Port In Fuel	liters/hour	Engine Fuel Consuption Rate	Ship System	Port Void 5
61	Stbd Out Fuel	liters/hour	Engine Fuel Consuption Rate	Ship System	Starboard Void 5
62	Stbd In Fuel	liters/hour	Engine Fuel Consuption Rate	Ship System	Starboard Void 5
63-66	Torque	ft-lbs	Shaft Torque before Water Jets	NSW CCD	Port & Stbd Jet Room

Table 5. Digital Channel Data from KVH Gyro

Number	Channel ID	Units	Description	Source	Location
D1	Heading	degrees	Magnetic Heading	NSWCCD	Passenger Deck Frame 24
D2	roll	degrees	Roll 2	NSWCCD	Passenger Deck Frame 24
D3	Pitch	degrees	Pitch 2	NSWCCD	Passenger Deck Frame 24

Table 6. Digital Channel Data From GPS

Number	Channel ID	Units	Description	Source	Location
D4	Latitude	degrees	GPS	Ship System	Electronics Room
D5	Longitude	degrees	GPS	Ship System	Electronics Room
D6	Speed	knots	GPS	Ship System	Electronics Room
D7	Course over ground	degrees	GPS	Ship System	Electronics Room
D8	Time	GPS Local	GPS	Ship System	Electronics Room

Table 7. Slow System Channel Summary of Structural Measurements

Number	Channel ID	Units	Description	Source	Location
1	LB_Fr_27_Port_Hull_Keel	micro-strain	Longitudinal Bending Strain	NSWCCD	Frame 27 Port Void 5
2	LB_Fr_34_Port_V_Deck	micro-strain	Longitudinal Bending Strain	NSWCCD	Frame 34 Port Void 3
3	LB_Fr_45_Port_Hull_Keel	micro-strain	Longitudinal Bending Strain	NSWCCD	Frame 45 Port Void 2
4	LB_Fr_27_Stbd_Hull_Keel	micro-strain	Longitudinal Bending Strain	NSWCCD	Frame 27 Stbd Void 5
5	LB_Fr_34_Stbd_V_Deck	micro-strain	Longitudinal Bending Strain	NSWCCD	Frame 34 Stbd Void 3
6	LB_Fr_45_Stbd_Hull_Keel	micro-strain	Longitudinal Bending Strain	NSWCCD	Frame 45 Stbd Void 2
7	Split_Load_Fr_22	micro-strain	Shear Strain in Transverse Bulkhead	NSWCCD	Frame 22 Stbd Void 5
8	Split_Load_Fr_36	micro-strain	Shear Strain in Transverse Bulkhead	NSWCCD	Frame 36 Stbd Void 4
9	Split_Load_Fr_54	micro-strain	Shear Strain in Transverse Bulkhead	NSWCCD	Frame 54 Stbd Void 2
10	Trans_Bend_Fr_22	micro-strain	Bending Strain in Transverse Bulkhead	NSWCCD	Frame 22 Stbd Void 5
11	Trans_Bend_Fr_36	micro-strain	Bending Strain in Transverse Bulkhead	NSWCCD	Frame 36 Stbd Void 4
12	Trans_Bend_Fr_54	micro-strain	Bending Strain in Transverse Bulkhead	NSWCCD	Frame 54 Stbd Void 2
13	PCM_Fr30_Side_Shell	micro-strain	Pitch Connecting Shear Strain	NSWCCD	Frame 31 Stbd Void 4
14	PCM_Fr60_Axial	micro-strain	Pitch Connecting Strain	NSWCCD	Frame 60 CarlinPlate
15	Stbd_Bow_LB	micro-strain	Transverse Bending Stbd Hull	NSWCCD	Frame 63
16	Stbd_Bow_VB	micro-strain	Vertical Bending Stbd Hull	NSWCCD	Frame 63 Stbd Hull Keel
17	HD_Channel_Stiff_1	micro-strain	Helo Deck Channel Stiffener Bending Strain	NSWCCD	SH60B Wheel Load Area
18	HD_Plt_Long_1	micro-strain	Helo Deck Plate Longitudinal Strain	NSWCCD	SH60B Wheel Load Area
19	HD_Plt_Trans_1	micro-strain	Helo Deck Plate Transverse Strain	NSWCCD	SH60B Wheel Load Area
20	HD_Channel_Stiff_2	micro-strain	Helo Deck Channel Stiffener Bending Strain	NSWCCD	SH60B Wheel Load Area
21	HD_Plt_Long_2	micro-strain	Helo Deck Plate Longitudinal Strain	NSWCCD	SH60B Wheel Load Area
22	HD_Plt_Trans_2	micro-strain	Helo Deck Plate Transverse Strain	NSWCCD	SH60B Wheel Load Area
23	HD_Channel_Stiff_3	micro-strain	Helo Deck Channel Stiffener Bending Strain	NSWCCD	SH60B Wheel Load Area

Table 8. High-Speed Wave Impact Channel List

No.	Channel ID	Units	Description	Source	Location
1	Tbar_4_Cntr_Bow_Fr57_58	Micro-strain	Wave Impact	NSWCCD	Center Bow
2	Tbar10_Cntr_Bow_Fr57_58	Micro-strain	Wave Impact	NSWCCD	Center Bow
3	Tbar_16_Cntr_Bow_Fr57_58	Micro-strain	Wave Impact	NSWCCD	Center Bow
4	Tbar4_Stbd_of_Bhd_4600_Fr57_58	Micro-strain	Wave Impact	NSWCCD	Starboard Void 1
5	Tbar10_Stbd_of_Bhd_4600_Fr57_58	Micro-strain	Wave Impact	NSWCCD	Starboard Void 1
6	Tbar15_Stbd_of_Bhd_4600_Fr57_58	Micro-strain	Wave Impact	NSWCCD	Starboard Void 1
7	Tbar4_Cntr_Bow_Fr65_66	Micro-strain	Wave Impact	NSWCCD	Center Bow
8	Tbar10_Cntr_Bow_Fr65_66	Micro-strain	Wave Impact	NSWCCD	Center Bow
9	Tbar15_Cntr_Bow_Fr65_66	Micro-strain	Wave Impact	NSWCCD	Center Bow
10	Tbar4_Stbd_of_Bhd_4600_Fr62_63	Micro-strain	Wave Impact	NSWCCD	Starboard Void 1
11	Tbar15_Stbd_of_Bhd_4600_Fr62_63	Micro-strain	Wave Impact	NSWCCD	Starboard Void 1

Table 9. **TSK Measured Waves**

Octagon and LOE Natural Significant Wave Heights and Modal Periods

Date	Time	Run	Ship Speed (kn)	Natural Sig Wave Ht (ft)	Natural To (sec)	Natural T_2 (sec)
30-Oct-01	19:38	0	2	4.8	11.7	4.2
Seakeeping						
30-Oct-01	23:08	7	2	5.7	10.2	5
24 Hr Load Out South						
9-Jan-02	5:25	8	4.2	6.7	6.3	-
2-Mar-02	8:16	0	1	4.8	4.8	-
Baltic Octagon 1						
2-Mar-02	11:24	7	1	5.1	5.1	-
Baltic Octagon 2						
2-Mar-02	14:10	13	2	7.2	5.9	-
Baltic Octagon 3						
2-Mar-02	16:59	20	33*	8.4	6.3	-
3-Mar-02	13:27	1	2	5.4	5.5	-
Baltic Octagon 4						
3-Mar-02	16:07	4	3	5	4.6	-
20-Nov-02	6:51	1	3	5.2	9.1	7
Newport Octagon 1						
20-Nov-02	11:36	9	3	4.8	8.2	7
Newport Octagon 2						
22-Nov-02	8:32	45	2	4.4	5.1	-

* Beam Seas (3 and 33 knots)

Table 10. HSV-X1 Run Matrix

Run Time in Min Required Spectra: 10% Random, 10% Bias	**Relative Wave Heading**				
	Head	**Bow**	**Beam**	**Quarter**	**Follow**
SS3 (NATO)	(1.6 to 4.1 feet Significant Height, 5.0 to 14.8 second period)				
35 knots (unrestricted)					
Ride Control On	O	O	O	O	O
Ride Control Off	O	O	O	O	O
Steerage (~0 knots)					
Ride Control Off	O				
SS4 (NATO)	(4.1 to 8.2 feet Significant Height, 6.1 to 15.2 second period)				
35 knots (unrestricted)					
Ride Control On	3-Mar	3-Mar	3-Mar	3-Mar	3-Mar
Ride Control On	30-Oct	30-Oct	30-Oct	30-Oct	30-Oct
Ride Control On					16-Feb
Ride Control Off	2-Mar	2-Mar	2-Mar	2-Mar	2-Mar
Ride Control Off	16-Feb	16-Feb			
Steerage (~0 knots)					
Ride Control Off	16-Feb 30-Oct 2-Mar 3-Mar				
Dead In Water (DIW)					
Ride Control Off			16-Feb		
20 knots					
Ride Control Off	*2-Mar*	*2-Mar*	*2-Mar*	*2-Mar*	*2-Mar*

Run Time in Min Required Spectra: 10% Random, 10% Bias	**Relative Wave Heading**				
	Head	**Bow**	**Beam**	**Quarter**	**Follow**
SS5 (NATO)	(8.2 to 13.1 feet Significant Height, 8.3 to 15.5 second period)				
35 knots (restricted 12.5 ft)					
Ride Control On	O	O			
Ride Control Off	2-Mar	2-Mar	2-Mar	2-Mar	2-Mar
Ride Control Off		10-Jan	10-Jan	10-Jan	
Steerage (~0 knots)					
Ride Control Off	10-Jan 2-Mar	O	O	O	O
Dead In Water (DIW)					
Ride Control Off			O		
20 knots					
Ride Control Off	*10-Jan*	*10-Jan*			*11-Jan*

(green)	Full Octagon - Wind Driven Seas
(yellow)	Supporting Data - Slams, Loads, Speed Limits
O	Supporting Data - Not Yet Complete
	Eliminated from Test Program
Italic	*Added to Test Program*

Table 11. HSV-X1 Baltic Octagons 1 and 2, and Newport Octagon 2 SSA Values – Speed Comparison

Sea State 4 HSV-X1 Significant Single Amplitude Values Ride Control OFF

Relative Heading	Speed (kn)	Roll Angle (deg)	Pitch Angle (deg)	Bridge Acceleration Vert (g)	Bridge Acceleration Tran (g)	Bridge Acceleration Long (g)	LCG Acceleration Vert (g)	LCG Acceleration Tran (g)	LCG Acceleration Long (g)	Flight Deck Accel Vert (g)	Flight Deck Accel Tran (g)	Flight Deck Accel Long (g)	Bow Acceleration Vert (g)	Bow Acceleration Tran (g)	Enc Sig Wave Ht (ft)
Baltic Octagon 1															4.8*
Head	35	0.86	0.46	0.027	0.051	0.015	0.025	0.026	0.010	0.134	0.054	0.054	0.053	0.044	3.1
Bow	35	1.20	0.43	0.031	0.083	0.016	0.031	0.036	0.011	0.133	0.071	0.054	0.057	0.061	3.1
Beam	35	2.08	0.52	0.039	0.131	0.018	0.036	0.060	0.012	0.156	0.106	0.063	0.068	0.087	4.5
Quartering	35	1.09	0.42	0.022	0.056	0.012	0.023	0.031	0.009	0.117	0.050	0.054	0.046	0.043	3.5
Following	35	0.67	0.47	0.026	0.042	0.019	0.029	0.025	0.014	0.144	0.040	0.056	0.071	0.038	1.8
															5.1*
Baltic Octagon 2															5.1*
Head	20	0.73	0.45	0.036	0.049	0.038	0.039	0.024	0.013	0.140	0.045	0.067	0.145	0.055	4.8
Bow	20	2.47	0.59	0.056	0.158	0.045	0.059	0.064	0.015	0.157	0.115	0.071	0.181	0.105	4.6
Beam	20	3.72	0.98	0.071	0.202	0.053	0.084	0.087	0.017	0.164	0.145	0.068	0.225	0.140	7.2
Quartering	20	2.43	0.53	0.034	0.125	0.017	0.037	0.020	0.010	0.139	0.097	0.065	0.072	0.084	6.6
Following	20	0.93	0.54	0.015	0.037	0.012	0.016	0.010	0.010	0.138	0.036	0.066	0.044	0.036	5.6
															7.2*
Newport Octagon 2															4.4*
Head	10	1.01	0.80	0.036	0.062	0.029	0.034	0.026	0.011	0.080	0.050	0.029	0.111	0.021	3.6
Bow	10	0.86	0.78	0.031	0.052	0.030	0.030	0.022	0.011	0.079	0.043	0.030	0.117	0.019	3.7
Beam	10	1.64	0.56	0.037	0.092	0.023	0.036	0.042	0.009	0.075	0.072	0.026	0.087	0.028	4.2
Quartering	10	0.95	0.50	0.022	0.045	0.013	0.020	0.021	0.008	0.058	0.037	0.024	0.051	0.017	5.0
Following	10	0.67	0.44	0.019	0.036	0.010	0.015	0.017	0.008	0.055	0.029	0.024	0.038	0.015	5.4

* Designates natural significant wave height measured prior to or following seakeeping runs.

Table 12. HSV-X1 Baltic Octagon 3 and Newport Octagon 1 SSA Values

Sea State 4/5 HSV-X1 Significant Single Amplitude Values Ride Control OFF

Relative Heading	Speed (kn) / Sea State	Roll Angle (deg)	Pitch Angle (deg)	Bridge Acceleration Vert (g)	Bridge Acceleration Tran (g)	Bridge Acceleration Long (g)	LCG Acceleration Vert (g)	LCG Acceleration Tran (g)	LCG Acceleration Long (g)	Flight Deck Accel Vert (g)	Flight Deck Accel Tran (g)	Flight Deck Accel Long (g)	Bow Acceleration Vert (g)	Bow Acceleration Tran (g)	Enc Sig Wave Ht (ft)
Baltic Octagon 3															8.4*
Head	33 / 5	0.67	0.64	0.066	0.062	0.050	0.064	0.031	0.016	0.157	0.062	0.056	0.196	0.069	4.7
Bow	33 / 5	2.30	0.56	0.062	0.163	0.039	0.059	0.067	0.014	0.145	0.123	0.057	0.155	0.105	4.5
Beam	33 / 5	4.30	1.07	0.119	0.238	0.067	0.130	0.105	0.026	0.205	0.166	0.072	0.288	0.178	7.4
Quartering	33 / 5	1.54	0.57	0.029	0.069	0.018	0.031	0.042	0.012	0.130	0.062	0.057	0.065	0.058	5.2
Following	33 / 5	1.03	0.81	0.020	0.038	0.018	0.022	0.029	0.014	0.133	0.042	0.056	0.054	0.039	4.5
															-
Newport Octagon 1															5.2*
Head	27 / 4	1.59	1.29	0.080	0.079	0.079	0.098	0.037	0.024	0.155	0.059	0.058	0.322	0.032	4.2
Bow	27 / 4	1.94	1.26	0.086	0.099	0.075	0.101	0.047	0.023	0.156	0.078	0.057	0.308	0.037	4.8
Bow	27 / 4	1.40	1.14	0.075	0.072	0.071	0.093	0.034	0.022	0.144	0.051	0.055	0.291	0.031	3.8
Beam	27 / 4	2.03	1.15	0.071	0.089	0.061	0.086	0.042	0.019	0.130	0.069	0.050	0.252	0.033	4.7
Quartering	27 / 4	1.69	0.97	0.059	0.074	0.049	0.071	0.036	0.016	0.116	0.057	0.047	0.203	0.028	4.1
Quartering	27 / 4	1.71	0.92	0.058	0.085	0.046	0.070	0.042	0.016	0.114	0.066	0.045	0.195	0.032	4.2
															4.8*

* Designates natural significant wave height measured prior to and following seakeeping runs.

Table 13. HSV-X1 Baltic Octagon 1 and Baltic Octagon2 SSA Values – Ride Control Comparison

Sea State 4 35 Knots HSV-X1 Significant Single Amplitude Values

Relative Heading	Ride Control	Roll Angle (deg)	Pitch Angle (deg)	Bridge Acceleration Vert (g)	Bridge Acceleration Tran (g)	Bridge Acceleration Long (g)	LCG Acceleration Vert (g)	LCG Acceleration Tran (g)	LCG Acceleration Long (g)	Flight Deck Accel Vert (g)	Flight Deck Accel Tran (g)	Flight Deck Accel Long (g)	Bow Acceleration Vert (g)	Bow Acceleration Tran (g)	Enc Sig Wave Ht (ft)
Baltic Octagon 1															4.8*
Head	Off	0.86	0.46	0.027	0.051	0.015	0.025	0.026	0.010	0.134	0.054	0.054	0.053	0.044	3.1
Bow	Off	1.20	0.43	0.031	0.083	0.016	0.031	0.036	0.011	0.133	0.071	0.054	0.057	0.061	3.1
Beam	Off	2.08	0.52	0.039	0.131	0.018	0.036	0.060	0.012	0.156	0.106	0.063	0.068	0.087	4.5
Quartering	Off	1.09	0.42	0.022	0.056	0.012	0.023	0.031	0.009	0.117	0.050	0.054	0.046	0.043	3.5
Following	Off	0.67	0.47	0.026	0.042	0.019	0.029	0.025	0.014	0.144	0.040	0.056	0.071	0.038	1.8
															5.1*
Baltic Octagon 4															5.4*
Head	On	0.46	0.33	0.024	0.030	0.015	0.023	0.018	0.010	0.120	0.039	0.052	0.050	0.034	3.2
Bow	On	0.76	0.38	0.031	0.045	0.019	0.029	0.025	0.010	0.128	0.048	0.054	0.068	0.045	3.6
Beam	On	1.23	0.39	0.034	0.072	0.017	0.036	0.038	0.012	0.135	0.063	0.055	0.070	0.060	4.7
Quartering	On	1.03	0.39	0.029	0.056	0.015	0.030	0.032	0.011	0.136	0.050	0.055	0.053	0.047	2.4
Following	On	0.54	0.35	0.022	0.023	0.014	0.024	0.020	0.011	0.126	0.030	0.056	0.046	0.030	1.5
															5.0*

* Designates natural significant wave height measured prior to and following seakeeping runs.

Table 14. HSV-X1 Seakeeping Octagon and Baltic Octagon 4 SSA Values – Wave Period Comparison

Sea State 4 35 Knots HSV-X1 Significant Single Amplitude Values **Ride Control ON**

Relative Heading	Wave Period (sec)	Roll Angle (deg)	Pitch Angle (deg)	Bridge Acceleration Vert (g)	Bridge Acceleration Tran (g)	Bridge Acceleration Long (g)	LCG Acceleration Vert (g)	LCG Acceleration Tran (g)	LCG Acceleration Long (g)	Flight Deck Accel Vert (g)	Flight Deck Accel Tran (g)	Flight Deck Accel Long (g)	Bow Acceleration Vert (g)	Bow Acceleration Tran (g)	Enc Sig Wave Ht (ft)
Seakeeping Octagon															4.8*
Head	11	0.48	0.96	0.073	0.025	0.041	0.083	0.021	0.016	0.135	0.031	0.056	0.177	0.039	4.2
Bow	11	1.00	1.17	0.097	0.069	0.055	0.112	0.033	0.020	0.155	0.058	0.062	0.242	0.063	4.4
Beam	11	1.30	0.70	0.061	0.062	0.031	0.069	0.028	0.014	0.130	0.057	0.056	0.134	0.061	4.5
Quartering	11	1.17	0.48	0.028	0.033	0.016	0.033	0.014	0.012	0.109	0.036	0.052	0.053	0.042	4.6
Following	11	0.87	0.42	0.019	0.029	0.013	0.024	0.011	0.013	0.097	0.031	0.048	0.040	0.038	2.7
															5.7*
Baltic Octagon 4															5.4*
Head	5	0.46	0.33	0.024	0.030	0.015	0.023	0.018	0.010	0.120	0.039	0.052	0.050	0.034	3.2
Bow	5	0.76	0.38	0.031	0.045	0.019	0.029	0.025	0.010	0.128	0.048	0.054	0.068	0.045	3.6
Beam	5	1.23	0.39	0.034	0.072	0.017	0.036	0.038	0.012	0.135	0.063	0.055	0.070	0.060	4.7
Quartering	5	1.03	0.39	0.029	0.056	0.015	0.030	0.032	0.011	0.136	0.050	0.055	0.053	0.047	2.4
Following	5	0.54	0.35	0.022	0.023	0.014	0.024	0.020	0.011	0.126	0.030	0.056	0.046	0.030	1.5
															5.0*

* Designates natural significant wave height measured prior to or following seakeeping runs.

Long Period Waves		Beginning of run	End of run
- multimodal	Hs	4.8 ft	5.7 ft
	To	11.7 sec	10.2 sec
	T_2	4.2 sec	5 sec

Short Period Waves	Beginning of run	End of run
	5.4 ft	5 ft
	5.5 sec	4.6 sec

Table 15. Details of Global Structural Strain Gage Instrumentation

No.	HULL	SPACE	ORIENTATION	FRAME	STRUCTURAL DETAILS	GLOBAL RESPONSE MEASUREMENT
1	Port	Void 5	Fwd Side	27.75	Neutral Axis of Keel on Web	Longitudinal Bending
2	Port	Vechical Deck	Inboard Surface	34	Portal Structure on Carlin Plate	Longitudinal Bending
3	Port	Void 2	Fwd Side	45.25	Keel	Longitudinal Bending
4	Stbd	Void 5	Fwd Side	27.75	Keel	Longitudinal Bending
5	Stbd	Vechical Deck	Inboard Surface	34	Portal Structure on Carlin Plate	Longitudinal Bending
6	Stbd	Void 2	Fwd Side	45.25	Port Hull Keel	Longitudinal Bending
7	Stbd	Void 5	Aft Side	22	5mm BHD Plate 4000mm AB 600 mm from inboard shell	Transverse Shear Split Load
8	Stbd	Void 4	Fwd Side	36	Centerline Stbd Hull on BHD Plate	Transverse Shear Split Load
9	Stbd	Void 2	Fwd Side	54	Centerline Stbd Hull on BHD Plate	Transverse Shear Split Load
10	Cross Structure	Void 5	Aft Side	22	Cross Structure on Transverse BHD Stbd of Centerline Intercostal Longitudinal Bulkhead	Transverse Bending
11	Cross Structure	Void 4	Fwd Side	36	Cross Structure on Transverse BHD Stbd of Centerline Intercostal Longitudinal Bulkhead	Transverse Bending
12	Cross Structure	Center Bow	Fwd Side	54	Cross Structure Transverse Frame.	Transverse Bending
13	Stbd	Void 4	Fwd Side	30.5	Half Height Side Shell above Sponson below Vehical Deck	Pitch Connecting Load (shear)
14	Stbd	Vechical Deck	Outboard Surface	59-60	Carlin Plate on Portal Top	Pitch Connecting Load Axial
15	Stbd	Void 1	Fwd Side	62-63	Port and Stbd Longitudinals Half Height below sponson	Hull Bow Vertical Bending
16	Stbd	Void 1	Fwd Side	62-63	Top and Bottom Longitudinals near Hull Center Line	Hull Bow Lateral Bending

Table 16. Details of Wave Impact Strain Gage Instrumentation

Gage No.	Measurement I.D.	Space/Void	Frame	Structurre
26	Tbar_4_Cntr_Bow_Fr57-58	Center Bow	57-58	4th Tee Bar from Center Line
27	Tbar10_Cntr_Bow_Fr57-58	Center Bow	57-58	10th Tee Bar from Center Line
28	Tbar_16_Cntr_Bow_Fr57-58	Center Bow	57-58	4th Tee Bar from Long BHD 4600
29	Tbar4 _Stbd_Void-1_Fr57-58	Bow Flare Stbd Void 1	57-58	4th Tee Bar Outboard From Long BHD 4600
30	Tbar10 _Stbd_Void-1_Fr57-58	Bow Flare Stbd Void 1	57-58	10th Tee Bar Outboard From Long BHD 4600
31	Tbar15_Stbd_Void-1_Fr57-58	Bow Flare Stbd Void 1	57-58	15th Tee Bar Outboard From Long BHD 4600
32	Tbar4_Cntr_Bow_Fr65	Center Bow	65-66	4th Tee Bar from Center Line
33	Tbar10_Cntr_Bow_Fr65	Center Bow	65-66	10th Tee Bar from Center Line
34	Tbar15_Cntr_Bow_Fr65	Center Bow	65-66	5th Tee Bar from Long BHD 4600
35	Tbar4 _Stbd_Void-1_Fr62-63	Bow Flare Stbd Void 1	62-63	4th Tee Bar Outboard From Long BHD 4600
36	Tbar15 _Stbd_Void-1_Fr62-63	Bow Flare Stbd Void 1	62-63	10th Tee Bar Outboard From Long BHD 4600

Table 17. Maximum Global Structural Response Measurements for 24-Hour load-out
(Based on 24 hour Load Out Trials)

Channel Name	SA Max	% of Navy Rule*	SA Min	% of Navy Rule*	DA Max	% of Navy Rule*
(All micro-strain)	(SA)		(SA)		(DA)	
LB Fr 27 Port Hull Keel	937	93	-799	-79	1228	61
LB Fr 34 Port V-Deck	819	81	-1005	-100	1680	83
LB Fr 45 Port Hull Keel	689	68	-1011	-100	1533	76
LB Fr 27 Stbd Hull Keel	648	64	-699	-69	1099	54
LB Fr 34 Stbd V-Deck	963	96	-1053	-104	1857	92
LB Fr 45 Stbd Hull Keel	958	95	-703	-70	1551	77
Split Load Fr 22	308	31	-255	-25	394	20
Split Load Fr 36	222	22	-227	-23	403	20
Split Load Fr 54	245	24	-169	-17	379	19
Trans Bend Fr 22	344	34	-725	-72	735	36
Trans Bend Fr 36	313	31	-203	-20	399	20
Trans Bend Fr 54	211	21	-635	-63	635	32
PCM Fr 30 Side Shell Shear	732	73	-842	-84	1291	64
PCM Fr 60 Axial	1053	104	-1277	-127	2064	102
Stbd Bow LB	731	73	-717	-71	1448	72
Stbd Bow VB	110	11	-1786	-177	1802	89
HD Channel Stiff 1	44	4	-301	-30	303	15
HD Plt Long 1	20	2	-592	-59	592	29
HD Plt Trans 1	54	5	-154	-15	161	8
HD Channel Stiff 2	44	4	-1016	-101	1021	51
HD Plt Long 2	263	26	-31	-3	267	13
HD Plt Trans 2	50	5	-161	-16	165	8
HD Channel Stiff 3	636	63	-34	-3	642	32

**Structural Design for Naval Surface Ships*
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Limits For Design Primary Stresses For Aluminum
4.5 tsi or 1,008 ue

Key for channel names

LB Fr 27 Port Hull Keel, longitudinal bending strain measurement in port hull keel at frame 27 (independent of local bending).
Split Load Fr 22, shear strain measurement in starboard hull transverse bulkhead at Frame 22.
Trans Bend Fr 22, Transverse bending strain of cross structure bulkhead at Frame 22. (independent of local bending).
PCM Fr 60 Axial, Pitch Connecting Moment Strain sensitive measurement on Carlin Plate Portal Structure Frame 60.
HD Channel Stiff 1, Helicopter Deck strain measurement on longitudinal supporting channel stiffener, part of extruded plate and channel stiffener combination.

Table 18. Octagon Structural Response Summary Statistics as Standard Deviation Part 1

	Speed (kts)	Sig Wave Ht (ft)	Rel Hdg (Deg)	Longitudinal Bending						Split Load			Transverse Bending			PCM Gages	
				Port			Starboard			Fr 22	Fr 36	Fr 54	Fr 22	Fr 36	Fr 54	Fr 30	Fr 60
				Fr 27	Fr 34	Fr* 45	Fr 27	Fr 34	Fr 45								
Baltic Octagon1	1	4.8	0	12.3	20.5		11.2	17.8	13.1	29.0	15.3	8.9	8.0	7.9	4.6	19.1	29.4
	35	3.1	0	12.7	22.4		10.3	17.4	13.2	16.8	9.1	5.9	4.8	4.0	3.3	17.8	31.9
	35	3.1	45	11.1	17.4		7.9	17.9	10.8	23.8	11.8	6.9	6.7	6.3	3.9	21.5	32.8
	35	2.5	135	16.1	26.6		11.5	26.1	14.3	36.6	17.1	8.9	10.2	9.5	4.9	34.8	41.6
	35	3.6	135	13.8	19.2		10.0	26.8	12.8	28.6	14.9	7.3	7.0	6.2	3.7	30.7	32.9
	35	4.6	90	15.5	33.3		13.7	38.0	18.6	30.5	14.0	9.8	12.5	11.9	5.6	27.3	57.1
	35	1.8	180	15.6	18.9		12.7	39.1	14.9	26.7	13.3	6.2	5.4	4.6	2.8	27.7	31.6
	1	5.1	0	18.7	28.4		17.7	25.9	18.0	29.9	15.1	8.7	6.7	6.0	3.8	24.7	29.0
Baltic Octagon2	20	4.9	0	24.7	38.7		19.5	29.3	22.2	23.5	13.2	9.2	4.1	4.5	3.7	28.5	37.2
	20	4.6	45	23.5	47.1		17.5	26.3	18.8	30.5	16.9	11.9	10.6	10.8	6.5	30.7	70.0
	20	6.7	135	22.8	35.6		16.0	30.6	19.9	43.4	22.4	14.1	13.6	13.0	6.6	48.3	56.9
	20	5.9	180	29.1	37.6		23.7	37.0	25.8	32.4	18.4	9.4	6.2	5.1	3.5	38.9	36.8
	20	7.3	90	36.6	41.4		28.9	53.9	29.6	47.2	23.2	15.9	27.8	15.8	21.5	60.6	84.9
	2	7.2	0	33.1	40.2		29.7	48.6	34.0	29.8	16.3	8.2	8.8	9.2	3.5	32.3	33.7
	32	5.2	30	40.1	71.1		29.9	40.6	30.5	28.9	17.0	11.0	9.2	11.0	5.5	43.9	85.6
	33	4.7	0	32.9	49.4		27.3	39.7	30.1	22.0	12.9	8.1	5.5	6.4	3.4	32.8	42.8
Baltic Octagon3	33	4.5	45	26.0	47.9		19.3	28.6	20.6	28.3	14.5	10.6	9.9	9.7	5.2	32.2	66.1
	33	5.3	135	26.3	37.4		20.3	34.7	20.9	39.3	20.3	10.2	9.4	8.2	4.5	49.0	53.9
	33	4.6	180	36.9	47.1		31.6	46.0	30.8	32.3	18.9	7.5	6.3	5.8	2.9	40.5	39.9
	33	7.5	90	25.6	42.0		24.5	65.8	36.4	51.4	23.6	16.6	17.5	17.3	8.3	68.7	98.3
	33	8.4	90	42.9	64.6		35.4	48.8	36.0	35.1	19.9	11.1	10.7	11.1	4.6	38.0	59.6
	33	7.2	0	51.3	72.0		45.6	81.7	56.4	35.3	20.1	12.6	12.3	14.0	6.9	56.2	76.9
	33	7.8	0	46.1	56.3		41.6	82.0	53.9	36.5	18.7	12.1	11.5	12.7	5.7	55.9	70.2
	33	5.6	45	14.0	27.5		14.5	30.4	20.9	31.9	16.5	9.4	9.8	9.4	4.9	26.8	47.0

Note: Longitudinal Bending Gage at Fr45 Port Keel was not working.

Table 19. Octagon Structural Response Summary Statistics as Standard Deviation Part 2

	Speed (kts)	Sig Wave Ht (ft)	Rel Hdg (Deg)	Longitudinal Bending						Split Load			Transverse Bending			PCM Gages	
				Port			Starboard										
				Fr 27	Fr 34	Fr 45	Fr 27	Fr 34	Fr 45	Fr 22	Fr 36	Fr 54	Fr 22	Fr 36	Fr 54	Fr 30	Fr 60
Baltic Octagon4	35	3.2	0	12.7	18.1		10.2	17.7	13.5	17.3	9.4	5.7	3.1	2.9	2.5	17.7	17.6
	35	1.5	180	11.9	18.7		8.8	26.1	11.6	15.2	8.0	4.0	3.6	3.3	2.5	15.6	16.7
	35	2.4	135	18.7	25.4		15.1	27.4	14.9	30.3	15.1	7.6	7.8	7.3	3.6	30.2	33.3
	35	4.8	90	19.1	30.3		14.7	38.7	18.7	37.9	17.4	9.4	10.1	9.0	4.5	44.8	53.2
	3	5.0	0	18.7	21.1		14.0	26.3	18.4	27.9	15.4	9.2	7.6	7.3	4.2	22.6	30.2
	slow	43.7	135	21.2	25.2		17.3	24.8	15.4	32.9	17.0	11.8	20.2	14.2	14.1	22.9	44.1
Newport Octagon1	3Kts Sterage	5.2	0	17.9	31.0	20.5	15.4	35.0		22.0	10.7	7.7	7.5	7.6	3.6	22.4	31.6
	DIW	5.3	0	16.5	25.3	18.7	15.1	35.4		23.4	10.8	8.1	8.4	8.0	3.6	21.6	30.0
	35	4.2	0	21.1	32.2	23.1	19.6	46.0		20.8	10.7	7.5	6.3	7.0	3.3	29.4	42.5
	27	4.7	45	23.2	35.0	25.7	20.1	45.7		22.8	11.4	8.8	7.2	8.5	3.9	27.1	42.9
	27	4.8	90	25.3	43.3	28.0	22.6	48.7		26.4	13.9	9.6	8.4	9.8	4.4	32.7	47.3
	27	4.3	135	25.7	45.1	28.3	21.9	48.0		23.9	12.9	8.5	7.2	9.1	3.6	30.6	44.4
	27	3.8	180	24.0	38.6	25.3	21.0	50.3		21.4	10.6	7.0	6.6	8.3	3.3	27.8	41.0
	27	4.2	90	19.2	28.6	21.4	17.3	41.5		23.0	11.9	8.1	7.5	8.1	3.6	26.0	37.3
	3Kts Sterage	4.8	0	16.7	24.0	18.5	16.1	41.3		23.3	10.5	8.3	12.2	7.8	6.2	20.6	28.8
	27-9	4.7	135	20.9	28.7	22.4	18.2	43.3		20.4	10.4	7.6	6.8	7.0	3.2	28.1	32.5
Newport DIW	drift	2.8	90	8.7	15.0	9.4	5.7	17.7		13.0	6.0	5.3	4.9	5.1	2.4	17.1	20.7
	drift	2.8	90	8.9	14.5	9.8	5.4	17.2		14.8	6.3	6.1	6.6	6.8	2.5	18.0	21.2
	drift	3.0	90	18.2	22.4	16.2	11.8	20.0		17.7	7.3	7.1	13.8	8.0	10.7	20.4	24.1
	drift	3.2	90-225	9.4	15.7	11.0	5.5	18.0		18.4	7.3	7.5	8.0	8.1	3.0	20.5	22.9
	2.8	3.0	90-225	9.4	14.2	10.3	5.5	16.6		17.5	7.6	7.4	7.1	7.4	3.0	18.4	18.9
	2.8	3.4	90-225	10.9	19.1	14.2	7.0	24.3		24.5	9.9	9.9	10.8	10.3	4.0	30.5	32.5
Newport Octagon2	Steerageway	4.4	0	14.1	21.4	15.3	12.2	25.7		21.7	10.7	7.7	9.3	6.0	3.3	20.5	26.5
	10.5	3.6	0	13.7	21.1	16.1	12.9	28.4		19.2	8.5	6.4	5.8	5.3	2.5	18.1	27.7
	10	3.7	45	14.6	18.1	15.3	12.3	32.1		18.0	9.2	5.1	4.6	4.0	2.3	21.2	23.7
	9	4.2	90	10.9	16.3	11.8	7.5	23.5		21.1	9.5	7.9	8.4	8.0	3.2	23.9	29.2
	9	5.0	135	14.3	20.6	15.7	9.6	21.2		16.1	9.3	6.1	4.7	4.4	2.3	19.7	22.3
	11.4	5.4	180	10.3	15.0	12.0	8.1	17.8		13.7	7.0	4.5	3.8	3.6	1.8	15.1	16.5

Note: Longitudinal bending gage Frame 45 Port side was repaired, starboard side longitudinal bending gage was not working during the Newport Octagons.

Table 20. Generalized Summary of Wave Impact Weibull Analysis

Frame	Gage[1] No.	Measurement Location	Largest Measured Impact[3] (uin/in)	Average Weibull Parameters[4]			Highest Impact Rate per hour
				Shape Parameter	Char Value (uin/in)	Pmax (uin/in)	
57-58	26	Tbar_4_Cntr_Bow_Fr57-58	2341	0.96	459	2273	329
	27	Tbar10_Cntr_Bow_Fr57-58	3252	1.23	777	2707	235
	28	Tbar_16_Cntr_Bow_Fr57-58	3569	1.15	1054	4573	194
	29	Tbar4 _Stbd_Void-1_Fr57-58	5484	1.03	1797	6708	240
	30	Tbar10 _Stbd_Void-1_Fr57-58	5177	1.07	1130	5874	299
	31	Tbar15_Stbd_Void-1_Fr57-58	7674	0.91	1413	8190	299
62-65	32	Tbar4_Cntr_Bow_Fr65	2805	1.46	555	298	638
	33	Tbar10_Cntr_Bow_Fr65	3354	1.28	893	4234	287
	34	Tbar15_Cntr_Bow_Fr65	3395	1.05	879	4960	127
	35	Tbar4 _Stbd_Void-1_Fr62-63	6502	0.87	1520	7853	111
	37	Tbar15 _Stbd_Void-1_Fr62-63[2]	9428	0.61	2333	17132	104

Notes:

1. Gage numbers were used to identify measurements on drawings.
2. Poor fits occurred in most data sets for Tbar15 _Stbd_Void-1_Fr62-63, impact data not represented well by Weibull distribution. This measurement location was frequently damaged needing repair.
3. Data is represented as differential bending micro-strain (uin/in) and will be converted to pressure in a follow on program.
4. Average Weibull parameters were presented to identify trends and establish an understanding of the loading process. Results of individual Weibull analyses are presented in Appendix B. Typically, wave impact loading is characterized by a Weibull Shape Parameter (or slope) close to one. The Weibull distribution is equivalent to an Exponential distribution for a Shape Parameter equal to one.

Appendix A Global Response Statistical Summaries for Raw Data

Statistical Summary for LB Fr 27 Port Hull Keel

Relative Heading	Speed	Sig Wave Height	Mean (uin/in)	Min-Mean (uin/in)	Max-Mean (uin/in)	PeakToPeak (uin/in)	Std Dev (uin/in)	Kurtosis	Mean Crossings	Max/Stdev
0	0	4.4	-966	-53	55	87	14	2.96	31203	3.91
0	1	4.8	-933	-45	44	47	12	2.86	46882	3.54
0	1	5.1	-928	-65	62	100	19	3	14907	3.33
0	2	4.8	-922	-63	55	104	18	3.17	3997	3.05
0	2	5.7	-918	-54	50	87	15	3	8588	3.28
0	2	7.2	-926	-126	111	236	33	2.83	8092	3.35
0	2	8.4	-926	-126	111	236	33	2.83	8092	3.35
0	3	5	-912	-73	71	91	19	3.32	8901	3.78
0	10	4.4	-961	-64	48	74	14	3.17	17026	3.5
0	20	7.2	-949	-109	118	155	25	3.06	12260	4.79
0	27	5	-965	-119	113	173	26	2.98	13970	4.4
0	33	8.4	-943	-132	125	257	33	2.97	3651	3.81
0	33	8.4	-923	-794	501	1296	51	10.88	10467	9.78
0	33	8.4	-926	-506	226	732	46	5.1	6320	4.91
0	35	4.95	-941	-46	45	71	13	2.98	12123	3.58
0	35	5.2	-937	-46	50	90	13	3.09	14495	3.92
0	35	5.25	-931	-61	66	95	17	2.96	2727	3.94
30	32	8.4	-940	-213	166	317	40	3.65	3721	4.14
45	20	7.2	-945	-131	945	984	24	26.9	18837	40.15
45	27	5	-972	-91	108	150	25	2.96	15509	4.27
45	33	8.4	-939	-113	94	172	26	2.95	6503	3.6
45	33	8.4	-948	-49	45	87	14	2.93	31845	3.24
45	35	5.25	-932	-72	89	161	22	3.08	2949	4.07
90	0	5.2	-961	-66	75	92	17	3.17	21043	4.53
90	3	4.8	-955	-58	57	111	18	2.7	22459	3.16
90	20	7.2	-948	-121	948	969	37	457.09	15629	25.93
90	27	5	-972	-76	86	111	23	2.96	10858	3.7
90	35	4.95	-930	-71	93	94	15	3.29	30578	6
90	35	5.2	-920	-74	66	100	19	3.02	18937	3.44
90	35	5.25	-936	-61	70	118	18	2.93	9347	3.82
135	0	5.4	-918	-41	918	919	15	1866.74	42157	60.25
135	33	8.4	-936	-105	107	108	26	3.23	21305	4.05
135	35	5	-966	-80	78	102	21	3.27	7676	3.68
135	35	5.2	-912	-74	75	77	19	3.19	18834	4.03
135	35	5.25	-935	-47	50	64	13	2.84	11037	3.69
180	11	4.4	-946	-40	36	40	10	2.94	25085	3.54
180	20	7.2	-943	-92	127	129	29	3.52	12532	4.37
180	33	8.4	-926	-126	123	128	37	2.85	10395	3.32
180	35	4.95	-922	-54	63	65	16	2.86	17458	4.06
180	35	5.2	-917	-42	43	45	12	3	30397	3.65
180	35	5.25	-924	-44	45	59	14	2.72	6853	3.32
225	3	5	-957	-81	64	129	17	3.31	12614	3.84
225	9	4.4	-947	-50	50	88	14	2.82	25490	3.48
225	20	7.2	-949	-95	77	132	23	3.1	22582	3.37
225	35	4.95	-925	-44	54	54	16	2.67	3152	3.33
225	35	4.95	-915	-51	51	53	14	2.95	33308	3.73
270	9	4.4	-955	-37	37	57	11	2.86	38011	3.4
270	27	5	-958	-65	75	95	19	2.85	18125	3.9
270	33	8.4	-928	-95	177	272	26	3.41	8556	6.93
270	33	8.4	-922	-213	156	325	43	3.11	5233	3.64
270	35	5.25	-929	-75	74	113	18	3.05	4993	4.13
315	10	4.4	-955	-57	57	96	15	3.15	18770	3.9
315	27	5	-957	-89	96	153	21	3.17	9963	4.58
315	27	5	-962	-82	86	121	24	2.82	15751	3.59
315	35	4.95	-938	-43	46	62	11	3	23296	4.17

Note: Units of Strain Shown as micro-strain (uin/in)

Statistical Summary for LB Fr 27 Stbd Hull Keel

Relative Heading	Speed	Sig Wave Height	Mean (uin/in)	Min-Mean (uin/in)	Max-Mean (uin/in)	PeakToPeak (uin/in)	Std Dev (uin/in)	Kurtosis	Mean Crossings	Max/Stdev
0	0	4.4	672	-49	42	90	12	3.01	3387	3.44
0	1	4.8	676	-36	79	92	11	4.64	5248	7
0	1	5.1	658	-58	57	111	18	3.22	3069	3.21
0	2	4.8	686	-44	48	80	14	2.91	1883	3.51
0	2	5.7	681	-37	44	78	11	3.06	3062	3.87
0	2	7.2	671	-104	109	210	30	2.82	1452	3.67
0	2	8.4	671	-104	109	210	30	2.82	1452	3.67
0	3	5	663	-45	49	92	14	3.05	1444	3.5
0	10	4.4	669	-46	53	99	13	3.22	2342	4.08
0	20	7.2	682	-78	97	160	19	3.36	1807	4.99
0	27	5	646	-82	73	143	22	2.96	2089	3.34
0	33	8.4	697	-94	90	181	27	3.11	979	3.32
0	33	8.4	679	-382	620	1002	46	8.89	1961	13.6
0	33	8.4	680	-264	482	747	42	4.93	1341	11.6
0	35	4.95	687	-30	87	98	10	4	1835	8.44
0	35	5.2	672	-38	42	71	10	3.04	3001	4.15
0	35	5.25	693	-47	49	91	14	3.02	1153	3.52
30	32	8.4	696	-185	130	267	30	3.45	1033	4.35
45	20	7.2	684	-684	91	686	18	24.56	2630	5.19
45	27	5	650	-87	70	141	23	3	1900	3.12
45	33	8.4	696	-69	64	129	19	2.86	1954	3.32
45	33	8.4	663	-46	57	87	14	3.1	5022	3.95
45	35	5.25	692	-66	65	111	18	2.83	959	3.59
90	0	5.2	651	-55	56	107	15	3.18	2224	3.75
90	3	4.8	657	-50	56	100	15	2.92	2967	3.62
90	20	7.2	695	-695	131	739	29	336.39	3010	4.52
90	27	5	665	-74	74	110	20	3.37	1436	3.7
90	35	4.95	678	-49	68	90	14	3.14	4227	4.97
90	35	5.2	669	-71	56	98	15	3.14	5275	3.78
90	35	5.25	693	-52	66	96	15	3	3024	4.31
135	0	5.4	674	-674	45	695	13	896.43	6594	3.32
135	33	8.4	690	-86	85	119	20	3.17	3307	4.16
135	35	5	667	-65	70	104	20	2.99	928	3.54
135	35	5.2	685	-52	53	81	15	3.04	4456	3.47
135	35	5.25	689	-43	43	67	12	2.93	4045	3.75
180	11	4.4	652	-28	24	43	8	2.58	2962	3.01
180	20	7.2	702	-73	66	74	24	2.58	2232	2.77
180	33	8.4	682	-105	96	183	32	2.86	1833	3.03
180	35	4.95	688	-45	52	71	13	2.97	3581	4.08
180	35	5.2	687	-31	26	50	9	2.81	5803	2.96
180	35	5.25	687	-40	48	49	12	2.91	2571	3.86
225	3	5	657	-62	61	105	16	3.21	2262	3.77
225	9	4.4	654	-35	36	67	10	3.02	4048	3.73
225	20	7.2	699	-54	83	110	16	3.14	3210	5.2
225	35	4.95	691	-39	34	64	12	2.82	426	2.99
225	35	4.95	695	-42	41	58	10	3.08	5902	4.08
270	9	4.4	661	-28	29	47	8	3.08	5196	3.83
270	27	5	648	-63	58	89	17	3.11	3154	3.39
270	33	8.4	685	-118	94	167	24	3.05	1823	3.85
270	33	8.4	681	-130	185	315	35	3.53	1007	5.23
270	35	5.25	698	-56	60	86	15	2.95	2117	4.01
315	10	4.4	663	-48	40	88	12	2.91	3142	3.27
315	27	5	644	-82	80	160	18	3.6	2839	4.4
315	27	5	650	-78	75	131	21	2.93	3185	3.55
315	35	4.95	688	-29	49	66	8	4.04	3024	6.16

Statistical Summary for LB Fr 34 Port V-Deck

Run Number	Filter State	Relative Heading	Speed	Sig Wave Height	Mean (uin/in)	Min-Mean (uin/in)	Max-Mean (uin/in)	PeakToPeak (uin/in)	Std Dev (uin/in)	Kurtosis	Mean Crossings	Max/Stdev
32	raw	0	0	4.4	796	-82	72	129	21	2.82	13641	3.36
2	raw	0	1	4.8	727	-69	71	132	21	2.79	15073	3.47
3	raw	0	1	5.1	729	-99	105	107	28	3.08	11063	3.7
48	raw	0	2	4.8	738	-83	92	131	25	3.14	5777	3.67
49	raw	0	2	5.7	741	-73	77	124	21	3	4587	3.63
9	raw	0	2	7.2	700	-139	150	262	40	2.77	5848	3.74
10	raw	0	2	8.4	700	-139	150	262	40	2.77	5848	3.74
31	raw	0	3	5	667	-85	73	121	21	3.12	5799	3.46
34	raw	0	10	4.4	782	-76	73	122	21	3.02	13410	3.45
4	raw	0	20	7.2	666	-163	178	299	39	3.1	5561	4.59
38	raw	0	27	5	786	-134	186	274	45	2.89	11759	4.13
12	raw	0	33	8.4	606	-177	194	353	49	2.85	2743	3.92
13	raw	0	33	8.4	680	-878	804	1683	72	9.46	6695	11.18
14	raw	0	33	8.4	692	-553	370	924	56	5.62	4208	6.58
21	raw	0	35	4.95	655	-72	132	170	22	3.04	4294	5.9
22	raw	0	35	5.2	648	-71	75	114	18	2.95	6961	4.13
50	raw	0	35	5.25	716	-92	96	133	26	2.85	2375	3.77
11	raw	30	32	8.4	606	-345	312	655	71	3.75	3019	4.4
7	raw	45	20	7.2	628	-628	198	706	47	3.45	7602	4.21
41	raw	45	27	5	795	-175	161	302	43	2.92	6323	3.71
19	raw	45	33	8.4	607	-175	179	329	48	3.12	4167	3.73
20	raw	45	33	8.4	806	-91	101	127	27	2.83	11509	3.68
54	raw	45	35	5.25	715	-114	774	775	31	9.4	3083	24.88
33	raw	90	0	5.2	829	-103	80	157	25	2.99	8303	3.15
45	raw	90	3	4.8	771	-101	104	151	31	2.74	11360	3.36
8	raw	90	20	7.2	624	-624	166	627	41	54.13	6068	4.01
42	raw	90	27	5	728	-123	121	210	35	2.86	5210	3.44
29	raw	90	35	4.95	626	-144	140	223	33	3.31	9909	4.21
30	raw	90	35	5.2	635	-116	109	176	30	3.02	9054	3.6
55	raw	90	35	5.25	731	-82	93	152	26	2.81	4597	3.55
1	raw	135	0	5.4	710	-710	103	742	22	144.69	9204	4.59
15	raw	135	33	8.4	634	-169	161	281	37	3.44	11350	4.3
43	raw	135	35	5	730	-117	122	178	32	3.17	3585	3.79
23	raw	135	35	5.2	596	-104	89	140	25	3.01	10120	3.49
51	raw	135	35	5.25	742	-73	1600	1619	20	279.3	8407	80.78
36	raw	180	11	4.4	789	-55	51	81	15	3.19	21037	3.4
5	raw	180	20	7.2	601	-109	142	144	38	3	7462	3.79
16	raw	180	33	8.4	633	-172	147	182	47	2.82	5495	3.12
24	raw	180	35	4.95	640	-82	61	87	19	3.04	11249	3.24
25	raw	180	35	5.2	599	-56	71	72	19	2.81	12199	3.77
52	raw	180	35	5.25	745	-80	461	463	20	5.62	8738	22.86
44	raw	225	3	5	761	-86	104	188	24	3.05	8439	4.31
46	raw	225	9	4.4	786	-63	64	101	21	2.71	14899	3.12
6	raw	225	20	7.2	601	-156	128	182	36	3.01	9036	3.59
26	raw	225	35	4.95	629	-73	103	104	27	3.97	2455	3.88
27	raw	225	35	4.95	610	-80	67	81	19	3	16057	3.47
47	raw	270	9	4.4	784	-56	67	97	16	2.88	20711	4.11
39	raw	270	27	5	700	-106	139	156	29	3.15	17529	4.87
17	raw	270	33	8.4	636	-178	218	271	42	3.73	4253	5.19
18	raw	270	33	8.4	673	-312	240	550	65	3.25	2533	3.71
53	raw	270	35	5.25	720	-105	132	212	33	2.92	4913	4.02
35	raw	315	10	4.4	779	-67	72	113	18	3.05	19436	3.97
37	raw	315	27	5	759	-108	138	246	29	2.95	11225	4.81
40	raw	315	27	5	735	-129	158	208	39	2.85	17876	4.1
28	raw	315	35	4.95	631	-69	111	111	17	3.28	11098	6.34

Statistical Summary for LB Fr 34 STBD V-Deck

Relative Heading	Speed	Sig Wave Height	Mean (uin/in)	Min-Mean (uin/in)	Max-Mean (uin/in)	PeakToPeak (uin/in)	Std Dev (uin/in)	Kurtosis	Mean Crossings	Max/Stdev
0	0	4.4	609	-85	114	193	26	3.31	1149	4.45
0	1	4.8	424	-60	61	109	18	2.82	1428	3.41
0	1	5.1	415	-86	95	153	26	3.16	1125	3.69
0	2	7.2	350	-156	164	313	49	2.93	758	3.38
0	2	8.4	350	-156	164	313	49	2.93	758	3.38
0	2	4.8	565	-67	71	125	22	2.89	621	3.18
0	2	5.7	547	-53	56	99	16	3.03	1192	3.54
0	3	5	500	-98	93	191	26	3.03	660	3.54
0	10	4.4	588	-98	94	192	28	3.12	929	3.31
0	20	7.2	339	-171	127	276	29	3.62	1135	4.33
0	27	5	478	-158	173	327	48	3.04	1407	3.6
0	33	8.4	327	-135	145	281	40	3.08	817	3.66
0	33	8.4	396	-1095	656	1751	82	12.49	1474	8.03
0	33	8.4	403	-942	385	1326	82	4.81	736	4.69
0	35	4.95	369	-82	61	121	17	3.15	1169	3.48
0	35	5.2	484	-64	62	126	18	2.99	1463	3.53
0	35	5.25	524	-79	88	161	24	3.04	735	3.64
30	32	8.4	330	-242	309	551	41	4.29	917	7.61
45	20	7.2	328	-328	101	329	26	3.31	1697	3.85
45	27	5	468	-158	173	298	49	2.93	1358	3.55
45	33	8.4	342	-127	100	199	29	2.99	1333	3.5
45	33	8.4	409	-100	110	196	30	2.95	931	3.62
45	35	5.25	519	-132	124	225	35	2.93	673	3.52
90	0	5.2	519	-117	129	246	35	3.14	932	3.65
90	3	4.8	508	-104	121	219	35	3.1	1257	3.44
90	20	7.2	322	-322	223	457	54	4.1	898	4.14
90	27	5	474	-160	187	308	46	3.2	830	4.1
90	35	4.95	391	-135	144	186	38	2.84	1223	3.78
90	35	5.2	515	-141	166	206	39	3.1	1543	4.28
90	35	5.25	516	-109	96	182	31	2.92	1424	3.08
135	0	5.4	549	-549	83	597	23	47.49	1357	3.57
135	33	8.4	363	-109	112	195	35	2.84	1309	3.24
135	35	5.2	620	-114	98	150	27	3.26	2130	3.59
135	35	5	487	-141	150	199	46	3.02	528	3.27
135	35	5.25	522	-61	82	133	20	2.97	2375	4.06
180	11	4.4	588	-54	59	108	18	2.91	936	3.3
180	20	7.2	431	-106	119	180	37	2.77	1292	3.21
180	33	8.4	382	-169	173	311	46	2.99	694	3.77
180	35	4.95	450	-99	106	127	39	2.15	933	2.71
180	35	5.2	571	-70	70	80	26	2.24	1163	2.67
180	35	5.25	544	-59	75	117	20	3.07	1703	3.78
225	3	5	570	-145	145	247	41	3.26	1093	3.5
225	9	4.4	581	-79	79	129	21	3.19	1263	3.71
225	20	7.2	376	-115	131	150	31	3.02	1902	4.27
225	35	4.95	435	-71	77	114	26	2.81	145	2.97
225	35	4.95	511	-98	107	138	27	3.25	1451	3.97
270	9	4.4	579	-82	84	161	23	3.11	1339	3.58
270	27	5	486	-130	157	240	42	2.96	1428	3.78
270	33	8.4	378	-236	255	417	66	3.06	719	3.88
270	33	8.4	382	-302	156	458	49	3.4	561	3.19
270	35	5.25	557	-100	97	156	28	3.06	1003	3.49
315	10	4.4	583	-115	105	211	32	2.89	954	3.29
315	27	5	550	-178	197	336	43	3.55	780	4.56
315	27	5	490	-190	184	316	50	2.92	1641	3.66
315	35	4.95	369	-64	69	126	18	2.94	1377	3.84

Statistical Summary for LB Fr 45 Port Hull Keel

Relative Heading	Speed	Sig Wave Height	Mean (uin/in)	Min-Mean (uin/in)	Max-Mean (uin/in)	PeakToPeak (uin/in)	Std Dev (uin/in)	Kurtosis	Mean Crossings	Max/Stdev
0	0	4.4	-762	-55	51	90	15	2.84	12095	3.32
0	1	4.8	2791	-524	289	719	110	2.73	3799	2.64
0	1	5.1	2071	-1071	303	1277	89	17.28	3856	3.4
0	2	7.2	2926	-1088	438	1192	151	3.35	1155	2.89
0	2	8.4	2926	-1088	438	1192	151	3.35	1155	2.89
0	2	4.8	-427	-61	78	126	19	3.16	4007	4.17
0	2	5.7	-452	-56	48	89	15	2.96	5819	3.18
0	3	5	3711	-1377	627	1718	325	4.46	1040	1.93
0	10	4.4	-758	-65	50	103	16	2.99	5338	3.13
0	20	7.2	1888	-1071	566	1469	258	4.8	1644	2.2
0	27	5	-779	-125	119	195	28	2.94	6992	4.22
0	33	8.4	2488	-730	992	1231	341	2.24	1417	2.91
0	33	8.4	2536	-1641	789	2361	331	4	3435	2.38
0	33	8.4	2652	-1290	557	1605	274	5.4	2524	2.03
0	35	4.95	1540	-520	911	1233	255	3.01	1383	3.58
0	35	5.2	2022	-331	1213	1393	155	9.35	2823	7.84
0	35	5.25	-453	-61	66	107	19	2.83	1439	3.52
30	32	8.4	2485	-844	954	1368	329	2.16	1533	2.9
45	20	7.2	1988	-1988	616	2054	271	4.43	2205	2.27
45	27	5	-787	-122	103	199	28	2.95	5498	3.67
45	33	8.4	2331	-662	812	1270	315	2	1944	2.58
45	33	8.4	3029	-1403	837	1673	299	3.24	1613	2.8
45	35	5.25	-454	-96	82	178	22	3.26	2663	3.69
90	0	5.2	-785	-66	65	95	19	2.84	9849	3.47
90	3	4.8	-776	-66	71	106	21	2.81	11239	3.45
90	20	7.2	2547	-2547	844	2991	306	8.47	2384	2.76
90	27	5	-788	-85	89	135	26	2.87	4980	3.48
90	35	4.95	1416	-520	1117	1342	290	3	2532	3.85
90	35	5.2	2432	-839	1668	1735	374	3.99	2996	4.46
90	35	5.25	-454	-61	61	95	18	2.82	4176	3.34
135	0	5.4	3107	-3107	841	3111	357	3.64	1516	2.35
135	33	8.4	2283	-879	921	1211	316	2.58	2328	2.92
135	35	5.2	2249	-594	1356	1868	290	5.15	2873	4.68
135	35	5	-780	-78	76	132	23	2.95	3674	3.31
135	35	5.25	-449	-59	52	78	15	2.86	6443	3.53
180	11	4.4	-741	-45	43	70	12	3.29	9155	3.55
180	20	7.2	2561	-866	649	970	153	4.25	1934	4.23
180	33	8.4	2100	-826	810	1299	281	2.29	1835	2.88
180	35	4.95	1522	-558	793	1176	242	2.25	1827	3.28
180	35	5.2	2128	-312	937	1072	137	8.71	5437	6.86
180	35	5.25	-437	-52	49	56	14	2.86	5846	3.51
225	3	5	-777	-73	70	133	19	3.25	5822	3.77
225	9	4.4	-743	-52	48	83	16	2.71	7741	3.05
225	20	7.2	2311	-1061	534	1253	208	5.99	2576	2.56
225	35	4.95	1770	-800	681	1395	349	1.96	209	1.95
225	35	4.95	1398	-502	866	1309	246	2.71	2155	3.52
270	9	4.4	-750	-42	45	60	12	2.84	20279	3.81
270	27	5	-775	-77	89	111	21	2.89	7723	4.16
270	33	8.4	1760	-758	1020	1618	399	1.78	2072	2.55
270	33	8.4	2623	-1514	422	1554	197	9.79	1293	2.14
270	35	5.25	-434	-72	79	133	20	3.05	4957	3.96
315	10	4.4	-751	-60	57	94	15	3.02	7622	3.71
315	27	5	-774	-77	101	167	22	3.02	4753	4.51
315	27	5	-776	-90	106	151	25	2.88	9571	4.18
315	35	4.95	1490	-548	885	1323	318	2.35	1606	2.78

Statistical Summary for LB Fr 45 Stbd Hull Keel

Relative Heading	Speed	Sig Wave Height	Mean (uin/in)	Min-Mean (uin/in)	Max-Mean (uin/in)	PeakToPeak (uin/in)	Std Dev (uin/in)	Kurtosis	Mean Crossings	Max/Stdev
0	0	4.4	-66	0	0	1	0	2.9	75294	4.68
0	1	4.8	-113	-46	55	91	13	3.02	7308	4.22
0	1	5.1	-130	-59	53	107	18	2.76	4331	2.92
0	2	7.2	-134	-109	98	198	34	2.75	2216	2.88
0	2	8.4	-134	-109	98	198	34	2.75	2216	2.88
0	2	4.8	-167	-52	62	96	17	2.9	4592	3.71
0	2	5.7	-160	-41	43	61	12	2.86	6539	3.49
0	3	5	-122	-60	54	109	18	2.74	2250	2.96
0	10	4.4	-66	0	0	1	0	2.9	50200	3.23
0	20	7.2	-100	-104	110	202	22	3.52	2963	4.97
0	27	5	-4743	0	0	0	0		0	
0	33	8.4	-112	-107	102	209	30	3.05	1377	3.4
0	33	8.4	-115	-446	848	1294	56	13.68	2494	15.03
0	33	8.4	-115	-282	712	994	54	5.6	1423	13.19
0	35	4.95	-103	-47	61	93	13	2.99	3137	4.61
0	35	5.2	-130	-51	42	85	13	2.89	3012	3.13
0	35	5.25	-159	-72	53	117	17	3.01	2261	3.08
30	32	8.4	-114	-167	173	328	31	3.56	1501	5.67
45	20	7.2	-94	-75	96	142	19	3.12	4522	5.09
45	27	5	-4720	-23	1755	1778	163	62.41	2	10.78
45	33	8.4	-113	-88	75	156	21	2.97	2818	3.63
45	33	8.4	-154	-74	67	129	21	2.82	3815	3.19
45	35	5.25	-163	-70	75	136	22	2.71	2473	3.47
90	0	5.2	-4743	0	0	0	0		0	
90	3	4.8	-4743	0	0	0	0		0	
90	20	7.2	-104	-107	109	211	30	2.92	2982	3.68
90	27	5	-4743	0	0	0	0		0	
90	35	4.95	-112	-78	79	110	19	3.22	5414	4.23
90	35	5.2	-126	-71	68	93	19	3.2	5974	3.65
90	35	5.25	-170	-59	61	116	17	2.95	6926	3.5
135	0	5.4	-114	-57	114	115	15	3.37	5719	7.47
135	33	8.4	-123	-67	70	117	21	2.9	4493	3.36
135	35	5.2	-116	-59	73	87	15	3.29	6929	4.86
135	35	5	-4743	0	0	0	0		0	
135	35	5.25	-182	-44	47	65	12	2.91	10116	3.82
180	11	4.4	-66	0	0	1	0	2.88	48512	3.43
180	20	7.2	-87	-81	85	86	26	2.97	4627	3.29
180	33	8.4	-128	-113	143	179	31	3.05	2998	4.65
180	35	4.95	-105	-47	51	79	15	2.82	5616	3.42
180	35	5.2	-115	-44	41	65	12	3.05	6661	3.56
180	35	5.25	-174	-43	49	73	15	2.77	6414	3.38
225	3	5	-4743	0	0	0	0		0	
225	9	4.4	-66	0	0	1	0	2.87	71564	5
225	20	7.2	-91	-74	75	126	20	3.06	4317	3.76
225	35	4.95	-99	-43	43	50	14	2.94	539	3.04
225	35	4.95	-100	-45	52	64	13	3.02	7376	4.08
270	9	4.4	-66	0	0	1	0	2.84	77556	3.65
270	27	5	-4743	0	0	0	0		0	
270	33	8.4	-123	-122	139	229	36	2.92	1891	3.82
270	33	8.4	-116	-119	283	402	36	3.79	1689	7.85
270	35	5.25	-161	-56	70	94	17	3.12	4283	4.08
315	10	4.4	-66	0	0	1	0	2.89	64396	3.53
315	27	5	-4743	0	0	0	0		0	
315	27	5	-4743	0	0	0	0		0	
315	35	4.95	-98	-45	48	86	11	3.19	4453	4.42

Statistical Summary for Split Load Fr 22

Relative Heading	Speed	Sig Wave Height	Mean (uin/in)	Min-Mean (uin/in)	Max-Mean (uin/in)	PeakToPeak (uin/in)	Std Dev (uin/in)	Kurtosis	Mean Crossings	Max/Stdev
0	0	4.4	-364	-80	89	157	22	3.27	1710	4.09
0	1	4.8	-325	-91	89	171	29	2.74	1283	3.06
0	1	5.1	-296	-90	105	184	30	2.76	1671	3.52
0	2	7.2	-308	-106	118	224	30	2.7	1616	3.96
0	2	8.4	-308	-106	118	224	30	2.7	1616	3.96
0	2	4.8	-301	-58	69	125	20	2.84	1149	3.51
0	2	5.7	-316	-51	64	108	17	2.8	1971	3.79
0	3	5	-321	-96	95	191	28	3.01	948	3.4
0	10	4.4	-348	-64	69	119	19	2.9	2175	3.58
0	20	7.2	-316	-82	107	171	23	3.16	2832	4.57
0	27	5	-333	-94	97	125	24	2.81	6209	4.05
0	33	8.4	-304	-78	95	164	22	3.01	2149	4.33
0	33	8.4	-313	-186	199	303	35	2.95	2729	5.64
0	33	8.4	-316	-132	138	256	36	2.84	1557	3.79
0	35	4.95	-302	-70	62	103	17	3.13	2405	3.68
0	35	5.2	-319	-66	68	119	17	2.89	2475	3.96
0	35	5.25	-310	-54	65	108	17	2.72	2006	3.82
30	32	8.4	-302	-132	133	215	29	3.14	1861	4.6
45	20	7.2	-315	-95	314	366	30	3.23	3020	10.3
45	27	5	-336	-101	96	183	26	3.02	5160	3.65
45	33	8.4	-299	-99	112	175	28	3.02	2564	3.95
45	33	8.4	-316	-101	110	207	32	3	1660	3.46
45	35	5.25	-305	-80	89	146	25	2.78	1882	3.62
90	0	5.2	-327	-87	92	162	23	3.07	1704	3.93
90	3	4.8	-318	-72	73	145	22	3.05	2664	3.33
90	20	7.2	-329	-134	329	378	47	4.96	2159	6.97
90	27	5	-346	-69	87	130	23	2.95	3954	3.83
90	35	4.95	-275	-101	135	189	30	3.2	3429	4.44
90	35	5.2	-312	-132	218	249	38	2.96	2933	5.74
90	35	5.25	-298	-105	112	180	28	2.95	3560	3.98
135	0	5.4	-339	-113	339	424	32	4.43	1751	10.45
135	33	8.4	-302	-123	163	228	39	2.96	2667	4.15
135	35	5.2	-343	-112	101	179	30	2.78	3786	3.33
135	35	5	-351	-69	81	110	21	3.04	3072	3.88
135	35	5.25	-291	-64	82	126	22	2.71	5005	3.76
180	11	4.4	-337	-53	53	81	14	3.01	2264	3.84
180	20	7.2	-357	-95	129	132	32	3.37	3631	3.99
180	33	8.4	-299	-123	143	175	32	3.14	2771	4.43
180	35	4.95	-315	-110	110	163	27	3.11	4011	4.12
180	35	5.2	-341	-57	63	72	15	3.01	5346	4.13
180	35	5.25	-297	-75	69	82	19	3.21	4984	3.7
225	3	5	-347	-84	78	128	23	2.99	2034	3.34
225	9	4.4	-333	-57	62	97	16	2.7	2770	3.86
225	20	7.2	-344	-127	157	226	43	2.7	2570	3.63
225	35	4.95	-335	-82	92	137	37	2.07	166	2.53
225	35	4.95	-340	-99	109	142	29	2.82	3224	3.79
270	9	4.4	-332	-69	76	132	21	3	2499	3.61
270	27	5	-331	-97	95	119	23	3.02	6315	4.15
270	33	8.4	-309	-168	261	343	51	2.98	1531	5.07
270	33	8.4	-309	-99	122	212	35	2.64	906	3.47
270	35	5.25	-298	-65	85	138	21	3.03	3093	4.1
315	10	4.4	-341	-61	67	117	18	3	2487	3.71
315	27	5	-339	-75	66	120	20	2.99	2605	3.25
315	27	5	-333	-78	84	111	21	2.93	8228	3.91
315	35	4.95	-306	-90	89	171	24	3.09	2346	3.73

Statistical Summary for Split Load Fr 36

Relative Heading	Speed	Sig Wave Height	Mean (uin/in)	Min-Mean (uin/in)	Max-Mean (uin/in)	PeakToPeak (uin/in)	Std Dev (uin/in)	Kurtosis	Mean Crossings	Max/Stdev
0	0	4.4	-139	-43	39	78	11	3.1	6056	3.66
0	1	4.8	-130	-49	53	88	15	2.84	4958	3.44
0	1	5.1	-136	-50	61	104	15	2.94	5978	4.03
0	2	7.2	-140	-56	59	110	16	3.07	4500	3.63
0	2	8.4	-140	-56	59	110	16	3.07	4500	3.63
0	2	4.8	-125	-37	37	74	10	3.12	1449	3.72
0	2	5.7	-124	-31	36	61	9	3.04	2502	4.13
0	3	5	-132	-56	66	122	15	3.39	4511	4.31
0	10	4.4	-137	-39	34	57	9	3.19	4523	3.95
0	20	7.2	-136	-44	57	99	13	3.21	4916	4.28
0	27	5	-138	-45	56	69	13	3.25	10383	4.38
0	33	8.4	-137	-41	59	96	13	3.02	3715	4.54
0	33	8.4	-139	-139	128	190	20	3.93	5962	6.37
0	33	8.4	-138	-106	91	182	19	3.21	2858	4.88
0	35	4.95	-127	-35	38	53	9	3.01	4588	4.18
0	35	5.2	-127	-32	37	67	9	3.02	5545	3.92
0	35	5.25	-121	-30	45	75	9	3.14	3425	5.3
30	32	8.4	-133	-75	103	151	17	4.04	3306	6.09
45	20	7.2	-136	-52	136	137	17	2.82	4747	8.05
45	27	5	-137	-49	60	82	14	3.07	8675	4.32
45	33	8.4	-134	-51	58	102	15	3	4841	3.99
45	33	8.4	-127	-62	64	121	17	3.14	5759	3.89
45	35	5.25	-123	-35	43	62	10	3.12	3391	4.12
90	0	5.2	-144	-38	41	67	11	3.15	6972	3.81
90	3	4.8	-146	-39	38	70	11	3.01	9716	3.55
90	20	7.2	-145	-90	145	160	23	4.12	3891	6.25
90	27	5	-137	-42	40	57	11	2.77	6368	3.53
90	35	4.95	-127	-63	60	84	14	3.08	9231	4.26
90	35	5.2	-127	-50	100	103	17	3.3	8348	5.75
90	35	5.25	-120	-43	63	73	13	3.42	6570	4.94
135	0	5.4	-129	-65	129	155	17	3.61	6591	7.69
135	33	8.4	-133	-64	120	138	20	3.75	5616	5.92
135	35	5.2	-139	-48	60	68	15	3.02	9184	3.98
135	35	5	-138	-42	38	61	11	3.08	4881	3.54
135	35	5.25	-114	-34	45	58	10	3.27	8833	4.32
180	11	4.4	-149	-25	27	33	7	3.23	4381	3.9
180	20	7.2	-155	-56	70	72	18	3.44	6887	3.82
180	33	8.4	-134	-61	76	78	19	3.01	6259	4.05
180	35	4.95	-142	-46	49	77	13	2.95	8505	3.7
180	35	5.2	-138	-28	35	37	8	2.95	12097	4.43
180	35	5.25	-125	-29	28	35	8	2.95	7103	3.54
225	3	5	-143	-34	37	72	11	2.83	7743	3.52
225	9	4.4	-143	-29	35	52	9	2.87	5005	3.71
225	20	7.2	-144	-74	78	110	22	2.74	5120	3.46
225	35	4.95	-137	-47	57	59	17	3.1	692	3.34
225	35	4.95	-143	-50	56	76	15	2.95	6534	3.77
270	9	4.4	-138	-35	40	61	10	3.19	5208	4.17
270	27	5	-140	-42	45	56	12	3.1	10095	3.81
270	33	8.4	-137	-74	94	126	24	2.95	3221	3.97
270	33	8.4	-139	-62	66	120	20	2.65	2465	3.31
270	35	5.25	-120	-34	35	64	10	3.01	5482	3.57
315	10	4.4	-140	-37	39	65	9	3.08	4771	4.2
315	27	5	-138	-33	49	68	10	3.55	9241	4.74
315	27	5	-140	-41	47	56	11	3.04	14543	4.44
315	35	4.95	-130	-42	50	76	12	2.94	5013	4.22

Statistical Summary for Split Load Fr 54

Relative Heading	Speed	Sig Wave Height	Mean (uin/in)	Min-Mean (uin/in)	Max-Mean (uin/in)	PeakToPeak (uin/in)	Std Dev (uin/in)	Kurtosis	Mean Crossings	Max/Stdev
0	0	4.4	62	-28	32	55	8	3.12	6283	4.15
0	1	4.8	48	-36	31	44	9	3.09	7221	3.44
0	1	5.1	51	-30	33	51	9	2.82	6143	3.83
0	2	7.2	49	-30	29	49	8	2.96	6776	3.5
0	2	8.4	49	-30	29	49	8	2.96	6776	3.5
0	2	4.8	50	-24	19	36	6	2.95	8812	3.18
0	2	5.7	49	-20	19	28	5	2.83	10393	3.61
0	3	5	50	-33	41	56	9	3.1	4323	4.4
0	10	4.4	59	-24	25	45	6	3.21	5490	3.99
0	20	7.2	51	-33	39	56	9	2.91	4521	4.24
0	27	5	59	-41	30	51	8	3.07	10523	3.55
0	33	8.4	53	-34	48	71	8	3.41	3509	5.86
0	33	8.4	51	-131	139	265	13	6.4	8127	10.98
0	33	8.4	50	-53	84	116	12	3.39	5337	6.9
0	35	4.95	50	-25	22	38	6	3	3844	3.71
0	35	5.2	47	-21	19	35	6	2.76	5051	3.35
0	35	5.25	51	-20	20	34	5	3.07	6057	3.76
30	32	8.4	56	-52	71	87	11	3.64	3223	6.45
45	20	7.2	55	-43	54	86	12	3.15	4455	4.51
45	27	5	60	-42	38	69	10	3.18	8406	3.95
45	33	8.4	56	-40	54	75	11	3.21	4204	5.11
45	33	8.4	51	-34	34	62	9	2.99	7468	3.63
45	35	5.25	49	-23	31	49	7	2.85	5200	4.25
90	0	5.2	62	-35	30	61	8	3.04	8310	3.76
90	3	4.8	62	-30	31	54	8	3.07	11424	4.01
90	20	7.2	49	-56	102	115	16	2.99	4295	6.42
90	27	5	63	-27	43	69	9	3.09	6296	4.93
90	35	4.95	59	-36	45	68	10	3.15	6505	4.56
90	35	5.2	52	-33	46	51	9	2.92	7531	4.83
90	35	5.25	47	-28	30	43	8	3.04	11430	3.95
135	0	5.4	54	-54	46	80	12	3.23	6543	3.89
135	33	8.4	51	-37	43	51	10	2.86	7193	4.19
135	35	5.2	51	-31	29	47	8	3.08	9945	3.86
135	35	5	65	-25	32	44	7	3.02	5071	4.26
135	35	5.25	48	-22	20	30	6	2.82	14726	3.27
180	11	4.4	55	-16	18	26	5	3.19	5480	4.09
180	20	7.2	50	-31	33	33	9	2.83	7259	3.47
180	33	8.4	53	-29	25	44	7	2.86	8135	3.29
180	35	4.95	52	-23	24	37	6	2.73	8226	3.87
180	35	5.2	51	-14	16	20	4	2.97	14395	3.97
180	35	5.25	49	-23	20	24	5	3.27	13624	3.82
225	3	5	64	-35	34	46	8	3.06	10096	4.07
225	9	4.4	56	-23	20	34	6	2.94	6029	3.23
225	20	7.2	51	-44	56	90	14	2.96	5044	3.98
225	35	4.95	48	-39	28	41	9	4.21	681	3.16
225	35	4.95	48	-29	31	52	7	3.01	8102	4.28
270	9	4.4	58	-31	31	51	8	3.06	5201	3.88
270	27	5	63	-27	30	41	8	2.9	12594	3.66
270	33	8.4	45	-55	116	142	17	3.36	2967	6.98
270	33	8.4	53	-39	45	74	11	3.17	3486	4.1
270	35	5.25	53	-41	34	57	9	3.03	6817	3.92
315	10	4.4	58	-18	20	33	5	2.97	6171	3.95
315	27	5	62	-31	27	47	8	3.13	8030	3.52
315	27	5	61	-29	29	43	7	2.96	16003	4.08
315	35	4.95	48	-25	29	43	7	2.96	4523	4.22

Statistical Summary for Trans Bend Fr 22

Relative Heading	Speed	Sig Wave Height	Mean (uin/in)	Min-Mean (uin/in)	Max-Mean (uin/in)	PeakToPeak (uin/in)	Std Dev (uin/in)	Kurtosis	Mean Crossings	Max/Stdev
0	0	4.4	694	-31	28	42	9	2.86	1469	3.06
0	1	4.8	729	-28	55	68	8	5.58	1501	6.89
0	1	5.1	708	-22	37	43	7	3.28	1974	5.44
0	2	7.2	714	-34	35	70	9	2.89	1344	3.97
0	2	8.4	714	-34	35	70	9	2.89	1344	3.97
0	2	4.8	708	-14	18	30	5	2.82	1408	3.9
0	2	5.7	708	-12	13	23	4	2.77	2334	3.35
0	3	5	719	-24	28	52	8	3.03	953	3.73
0	10	4.4	708	-20	21	35	6	3.14	1321	3.51
0	20	7.2	713	-13	48	58	4	5.78	2430	11.64
0	27	5	704	-27	34	50	7	3.07	3510	4.76
0	33	8.4	719	-23	28	42	5	3.38	1837	5.12
0	33	8.4	720	-126	111	217	12	6.94	2401	9
0	33	8.4	718	-78	88	167	12	3.78	1346	7.67
0	35	4.95	728	-15	29	39	5	4.71	1721	6.16
0	35	5.2	720	-13	11	21	3	3.02	2971	3.69
0	35	5.25	713	-13	19	29	4	3.47	2063	4.8
30	32	8.4	720	-56	92	119	9	8.4	1284	9.95
45	20	7.2	714	-32	36	67	11	2.9	1158	3.44
45	27	5	704	-33	33	61	8	3.32	2981	3.9
45	33	8.4	716	-34	41	71	10	3.54	1503	4.18
45	33	8.4	694	-32	35	66	10	2.89	1380	3.55
45	35	5.25	716	-28	35	59	8	3.23	1110	4.13
90	0	5.2	700	-29	28	53	8	3.11	1367	3.33
90	3	4.8	709	-27	27	54	8	3.01	2328	3.63
90	20	7.2	713	-713	66	754	28	438.15	983	2.37
90	27	5	707	-32	24	55	7	3.25	2366	3.39
90	35	4.95	715	-43	51	75	12	3.1	1741	4.13
90	35	5.2	720	-40	47	64	10	3.2	2129	4.7
90	35	5.25	715	-28	42	62	8	3.21	2676	5.29
135	0	5.4	704	-704	48	722	17	410.15	1160	2.82
135	33	8.4	719	-30	41	55	9	3.05	2145	4.38
135	35	5.2	717	-27	32	49	8	3.06	2904	4.03
135	35	5	708	-20	25	38	6	3.17	1693	4.02
135	35	5.25	710	-15	17	25	5	2.97	5317	3.75
180	11	4.4	711	-16	12	25	4	2.99	1559	3.26
180	20	7.2	707	-18	28	30	6	3.37	2494	4.48
180	33	8.4	722	-23	26	36	6	2.9	2716	4.1
180	35	4.95	712	-17	20	37	5	3.03	3351	3.65
180	35	5.2	719	-14	13	21	4	2.92	4511	3.64
180	35	5.25	707	-17	20	23	5	2.95	3140	4.44
225	3	5	694	-33	39	50	12	2.66	955	3.18
225	9	4.4	711	-16	17	31	5	2.86	1703	3.7
225	20	7.2	707	-48	60	109	14	3.24	1136	4.44
225	35	4.95	721	-27	35	61	10	3.21	172	3.38
225	35	4.95	715	-25	31	49	7	3.3	2517	4.35
270	9	4.4	711	-28	28	53	8	2.99	1273	3.36
270	27	5	709	-25	26	43	8	2.96	3237	3.43
270	33	8.4	715	-53	78	124	17	3.07	960	4.46
270	33	8.4	719	-36	42	78	11	2.79	634	3.88
270	35	5.25	713	-27	33	57	8	3.2	1679	4.16
315	10	4.4	711	-14	17	31	5	2.99	1834	3.66
315	27	5	709	-28	21	39	7	3.11	2192	3.04
315	27	5	706	-23	26	48	7	2.9	4438	3.91
315	35	4.95	726	-21	35	44	7	3.1	1547	5.2

Statistical Summary for Trans Bend Fr 36

Relative Heading	Speed	Sig Wave Height	Mean (uin/in)	Min-Mean (uin/in)	Max-Mean (uin/in)	PeakToPeak (uin/in)	Std Dev (uin/in)	Kurtosis	Mean Crossings	Max/Stdev
0	0	4.4	107	-21	20	40	6	3.03	5175	3.39
0	1	4.8	81	-33	35	68	8	3.68	6214	4.46
0	1	5.1	77	-26	25	38	6	3.28	8236	4.11
0	2	7.2	83	-37	34	60	9	3	4210	3.66
0	2	8.4	83	-37	34	60	9	3	4210	3.66
0	2	4.8	76	-13	14	23	4	2.78	1715	3.46
0	2	5.7	75	-11	11	20	3	2.76	2286	3.32
0	3	5	94	-23	28	43	7	2.88	4730	3.78
0	10	4.4	113	-18	18	31	5	2.93	3007	3.37
0	20	7.2	78	-22	34	56	5	4.46	6958	7.57
0	27	5	105	-31	43	66	9	3.06	6190	4.7
0	33	8.4	84	-88	75	163	6	6.26	3279	11.66
0	33	8.4	90	-135	138	254	14	7.73	5123	9.86
0	33	8.4	88	-89	98	187	13	3.81	2435	7.75
0	35	4.95	89	-16	14	22	4	2.92	5248	3.42
0	35	5.2	92	-13	12	25	3	3.14	8646	4.33
0	35	5.25	72	-17	22	39	4	3.33	1447	4.91
30	32	8.4	85	-73	128	189	11	16.72	2488	11.62
45	20	7.2	80	-36	41	74	11	3.06	3966	3.78
45	27	5	102	-42	43	76	10	3.21	5498	4.37
45	33	8.4	85	-34	45	72	10	3.77	3702	4.65
45	33	8.4	85	-31	34	64	9	2.95	5650	3.58
45	35	5.25	72	-30	37	67	9	3.14	1020	4.11
90	0	5.2	105	-30	28	53	8	3.18	6078	3.48
90	3	4.8	109	-26	26	45	8	2.94	8164	3.39
90	20	7.2	82	-82	71	115	16	3.85	2555	4.5
90	27	5	104	-35	40	75	9	3.44	4317	4.73
90	35	4.95	86	-41	63	81	12	3.26	4081	5.24
90	35	5.2	95	-34	40	56	9	3.14	6953	4.39
90	35	5.25	74	-24	34	52	7	3.02	2416	4.6
135	0	5.4	96	-96	46	108	14	3.06	3836	3.26
135	33	8.4	87	-27	35	49	8	3.08	6043	4.29
135	35	5.2	91	-26	27	46	7	3	8912	3.75
135	35	5	106	-24	29	52	7	3.12	3094	4.08
135	35	5.25	74	-16	13	22	4	3.07	6663	3.34
180	11	4.4	113	-15	11	23	4	3.02	3249	3.13
180	20	7.2	78	-17	20	27	5	3.11	10298	4.05
180	33	8.4	88	-45	32	63	6	4.85	8276	5.55
180	35	4.95	80	-28	17	29	5	2.96	9525	3.58
180	35	5.2	91	-14	12	20	3	3.02	12976	3.59
180	35	5.25	73	-17	20	23	4	3.17	3342	4.88
225	3	5	103	-26	30	51	8	3.03	5592	3.8
225	9	4.4	113	-16	15	25	4	2.78	3903	3.45
225	20	7.2	81	-47	67	114	13	3.35	4170	5.13
225	35	4.95	86	-31	33	35	9	3.92	476	3.52
225	35	4.95	82	-27	26	46	6	3.49	8117	4.16
270	9	4.4	115	-28	29	55	8	3.03	3033	3.65
270	27	5	107	-25	29	49	8	2.85	5777	3.61
270	33	8.4	84	-56	77	120	17	3.16	2052	4.44
270	33	8.4	91	-43	43	81	11	3.09	2778	3.91
270	35	5.25	72	-28	34	56	7	3.45	1599	4.51
315	10	4.4	116	-15	15	30	4	3.16	4050	3.64
315	27	5	109	-31	31	57	7	3.6	6856	4.39
315	27	5	108	-27	40	67	8	2.88	7782	4.8
315	35	4.95	89	-21	24	43	6	3.01	4175	3.91

Statistical Summary for Trans Bend Fr 54

Relative Heading	Speed	Sig Wave Height	Mean (uin/in)	Min-Mean (uin/in)	Max-Mean (uin/in)	PeakToPeak (uin/in)	Std Dev (uin/in)	Kurtosis	Mean Crossings	Max/Stdev
0	0	4.4	633	-10	13	13	3	3.07	52659	3.76
0	1	4.8	630	-17	39	44	5	4.35	51204	8.32
0	1	5.1	631	-14	18	18	4	3.05	32144	4.82
0	2	7.2	628	-13	15	27	4	3.12	34433	4.23
0	2	8.4	628	-13	15	27	4	3.12	34433	4.23
0	2	4.8	645	-7	8	13	2	2.82	16151	3.71
0	2	5.7	647	-7	7	7	2	3.02	29632	3.84
0	3	5	632	-12	22	22	4	3.26	19119	5.18
0	10	4.4	627	-10	11	15	3	3.22	37149	4.2
0	20	7.2	630	-16	18	24	4	3.06	33280	5.03
0	27	5	624	-19	20	21	4	3.25	49658	5.4
0	33	8.4	633	-18	36	37	3	5.48	17927	10.77
0	33	8.4	630	-125	181	268	7	47.3	45667	26.21
0	33	8.4	629	-50	66	97	6	10.16	23387	11.75
0	35	4.95	630	-11	28	29	3	3.77	19265	8.58
0	35	5.2	632	-9	10	11	2	2.73	35553	3.91
0	35	5.25	648	-8	6	10	2	3.28	11947	3.35
30	32	8.4	631	-54	46	91	5	6.05	13001	8.44
45	20	7.2	628	-23	29	32	6	2.97	26901	4.53
45	27	5	627	-19	19	23	4	3.11	42038	4.25
45	33	8.4	632	-22	39	42	5	3.6	17024	7.58
45	33	8.4	632	-18	16	24	5	2.92	36212	3.33
45	35	5.25	647	-16	14	27	3	3.96	12058	4.71
90	0	5.2	639	-16	13	21	4	3.05	43002	3.61
90	3	4.8	636	-13	13	20	4	2.91	50715	3.64
90	20	7.2	627	-627	44	643	22	729.73	17016	2.03
90	27	5	631	-15	18	19	4	3.03	28412	4.63
90	35	4.95	627	-21	38	39	6	3.26	32616	6.81
90	35	5.2	634	-19	26	27	4	3.12	39723	5.83
90	35	5.25	646	-11	12	18	3	3.18	21260	4.07
135	0	5.4	636	-636	22	643	10	2689.07	30106	2.29
135	33	8.4	632	-15	21	22	4	3.05	49706	4.75
135	35	5.2	633	-17	19	20	4	3.11	46499	5.32
135	35	5	633	-14	13	19	3	3.12	20863	4.09
135	35	5.25	647	-8	8	9	2	2.91	30794	3.79
180	11	4.4	626	-6	8	8	2	2.83	56202	4.24
180	20	7.2	632	-11	16	17	3	3.58	49677	4.7
180	33	8.4	632	-10	18	19	3	2.95	58413	6.35
180	35	4.95	630	-9	19	19	3	4.36	44934	6.87
180	35	5.2	633	-9	11	11	3	2.72	68227	4.24
180	35	5.25	646	-7	7	8	2	3.08	24314	3.97
225	3	5	641	-23	19	23	6	2.91	15327	3.01
225	9	4.4	627	-8	8	10	2	2.83	64737	3.53
225	20	7.2	631	-22	52	61	7	3.57	27950	7.91
225	35	4.95	629	-16	20	20	5	3.55	5379	4.05
225	35	4.95	629	-12	18	20	4	3.19	51713	4.76
270	9	4.4	628	-12	14	18	3	3.03	49000	4.31
270	27	5	625	-14	12	17	4	3.01	45731	3.43
270	33	8.4	631	-52	59	72	8	3.96	12499	7.06
270	33	8.4	628	-17	30	39	5	3.3	19230	6.49
270	35	5.25	645	-17	15	25	4	3.17	11941	4.21
315	10	4.4	627	-10	8	10	2	2.93	46654	3.56
315	27	5	629	-14	13	21	3	2.99	32442	4.07
315	27	5	623	-17	15	23	3	3.12	55987	4.6
315	35	4.95	629	-16	16	24	4	2.9	25691	4.08

Statistical Summary for PCM Fr 30 Shear

Relative Heading	Speed	Sig Wave Height	Mean (uin/in)	Min-Mean (uin/in)	Max-Mean (uin/in)	PeakToPeak (uin/in)	Std Dev (uin/in)	Kurtosis	Mean Crossings	Max/Stdev
0	0	4.4	344	-72	82	148	20	3.06	1802	4.03
0	1	4.8	380	-59	115	158	19	3.1	1601	6
0	1	5.1	394	-83	102	165	25	3.13	2270	4.13
0	2	7.2	385	-102	103	183	32	2.82	2426	3.19
0	2	8.4	385	-102	103	183	32	2.82	2426	3.19
0	2	4.8	374	-81	81	154	25	2.83	969	3.28
0	2	5.7	375	-54	59	110	18	2.82	1650	3.29
0	3	5	391	-76	71	147	23	2.77	1209	3.16
0	10	4.4	348	-70	65	131	18	3.03	2517	3.6
0	20	7.2	395	-184	138	259	28	3.6	2074	4.84
0	27	5	340	-124	117	199	31	3.11	3618	3.82
0	33	8.4	371	-109	108	203	33	2.86	1528	3.29
0	33	8.4	381	-487	813	1254	56	9.62	2769	14.45
0	33	8.4	380	-430	491	640	56	3.87	1595	8.78
0	35	4.95	380	-63	120	180	18	3.14	1805	6.76
0	35	5.2	380	-63	60	113	18	2.72	2421	3.39
0	35	5.25	354	-87	66	128	22	3.06	1625	3.03
30	32	8.4	365	-211	235	412	44	3.78	1309	5.36
45	20	7.2	400	-116	130	225	31	3.41	2716	4.22
45	27	5	345	-159	136	242	33	3.21	3078	4.16
45	33	8.4	367	-107	132	223	32	3.12	2473	4.09
45	33	8.4	397	-113	91	187	27	2.93	1589	3.39
45	35	5.25	354	-124	136	224	31	3.17	1393	4.38
90	0	5.2	382	-73	68	141	22	2.74	1483	3.15
90	3	4.8	379	-75	78	137	22	2.84	1943	3.46
90	20	7.2	379	-379	259	544	61	4.45	1239	4.26
90	27	5	344	-120	102	168	27	3.29	2670	3.76
90	35	4.95	376	-108	167	183	27	3.53	3741	6.14
90	35	5.2	366	-162	172	251	45	3.21	2894	3.84
90	35	5.25	356	-139	132	216	35	3.03	2783	3.76
135	0	5.4	403	-403	111	405	22	19.4	2938	5.05
135	33	8.4	361	-147	179	316	49	2.9	2712	3.65
135	35	5.2	355	-129	108	173	30	3.34	4226	3.58
135	35	5	347	-85	100	142	29	2.93	1750	3.4
135	35	5.25	352	-92	97	133	25	3.09	4326	3.82
180	11	4.4	342	-68	53	91	15	3.29	2397	3.48
180	20	7.2	385	-131	149	151	39	3.3	2900	3.83
180	33	8.4	355	-120	141	207	40	2.8	2064	3.49
180	35	4.95	367	-96	102	153	28	2.94	3483	3.68
180	35	5.2	364	-61	65	100	16	2.95	5329	4.16
180	35	5.25	348	-54	74	76	19	2.8	4301	3.87
225	3	5	375	-77	72	137	21	2.92	1876	3.47
225	9	4.4	344	-66	67	126	20	3.03	2830	3.39
225	20	7.2	389	-164	145	291	48	2.85	2351	3
225	35	4.95	370	-88	103	126	35	2.76	217	2.95
225	35	4.95	356	-115	111	195	31	3.03	3606	3.61
270	9	4.4	346	-83	89	163	24	2.9	2623	3.71
270	27	5	335	-89	100	148	26	2.97	3951	3.86
270	33	8.4	362	-243	249	468	69	3.18	1194	3.62
270	33	8.4	384	-168	160	289	38	3.45	1444	4.2
270	35	5.25	352	-97	110	164	26	3.22	2513	4.24
315	10	4.4	349	-76	77	153	21	2.87	2266	3.62
315	27	5	359	-113	87	183	28	3.03	1522	3.1
315	27	5	340	-97	104	168	28	3.01	4974	3.72
315	35	4.95	381	-78	94	147	21	3.06	2024	4.37

Statistical Summary for PCM Fr 60 Axial

Relative Heading	Speed	Sig Wave Height	Mean (uin/in)	Min-Mean (uin/in)	Max-Mean (uin/in)	PeakToPeak (uin/in)	Std Dev (uin/in)	Kurtosis	Mean Crossings	Max/Stdev
0	0	4.4	552	-87	100	176	26	2.84	1059	3.78
0	1	4.8	529	-100	173	193	29	3.11	685	5.87
0	1	5.1	490	-99	103	191	29	3.23	946	3.54
0	2	7.2	556	-122	118	233	34	3.22	940	3.52
0	2	8.4	556	-122	118	233	34	3.22	940	3.52
0	2	4.8	540	-107	110	199	31	3.02	651	3.5
0	2	5.7	556	-90	77	147	23	2.95	1122	3.32
0	3	5	554	-93	104	197	30	2.67	574	3.44
0	10	4.4	560	-94	97	185	28	3.01	950	3.51
0	20	7.2	482	-228	170	398	37	3.22	815	4.58
0	27	5	537	-164	141	269	44	2.94	1206	3.17
0	33	8.4	550	-183	144	291	43	3.08	802	3.37
0	33	8.4	568	-1658	788	2413	77	22.44	1591	10.24
0	33	8.4	573	-1089	568	1657	70	7.48	957	8.1
0	35	4.95	474	-112	178	289	32	3.6	726	5.56
0	35	5.2	469	-73	57	124	18	3.15	1380	3.22
0	35	5.25	544	-91	97	181	30	2.79	649	3.26
30	32	8.4	552	-531	322	664	86	3.44	529	3.77
45	20	7.2	508	-311	248	559	70	3.32	732	3.55
45	27	5	530	-172	213	347	47	3.14	1133	4.5
45	33	8.4	560	-253	204	428	66	2.92	760	3.09
45	33	8.4	494	-167	151	307	47	3.06	709	3.2
45	35	5.25	545	-179	149	259	41	2.97	659	3.66
90	0	5.2	529	-99	103	202	30	3	993	3.44
90	3	4.8	546	-108	101	203	32	2.98	1371	3.18
90	20	7.2	557	-557	302	720	85	4.92	660	3.55
90	27	5	543	-160	147	238	43	3.13	810	3.43
90	35	4.95	536	-306	193	402	57	3.38	1053	3.37
90	35	5.2	527	-202	196	281	53	3.34	1107	3.68
90	35	5.25	555	-152	150	239	40	3.26	1265	3.74
135	0	5.4	538	-538	185	599	43	6.71	737	4.27
135	33	8.4	562	-237	167	362	54	3.31	818	3.1
135	35	5.2	538	-113	140	221	33	3.37	1574	4.2
135	35	5	536	-159	156	246	42	3.03	566	3.66
135	35	5.25	559	-125	88	169	27	3.12	1857	3.24
180	11	4.4	551	-53	66	111	17	3.43	1241	4.01
180	20	7.2	569	-118	125	221	37	2.79	1008	3.39
180	33	8.4	573	-124	120	189	40	2.77	831	3
180	35	4.95	593	-123	128	167	32	2.91	1229	4.06
180	35	5.2	563	-76	59	83	17	3.04	1979	3.5
180	35	5.25	554	-95	85	125	25	2.95	1396	3.45
225	3	5	544	-105	93	197	29	2.96	1242	3.25
225	9	4.4	549	-79	74	136	22	2.97	1372	3.31
225	20	7.2	539	-198	197	337	57	3.22	807	3.47
225	35	4.95	583	-133	128	180	42	3.32	123	3.06
225	35	4.95	618	-125	127	214	33	3.36	1174	3.87
270	9	4.4	552	-97	99	194	29	2.91	1212	3.39
270	27	5	544	-145	148	262	37	3	1515	3.97
270	33	8.4	586	-338	334	631	98	3.15	570	3.4
270	33	8.4	574	-192	209	363	60	2.88	425	3.5
270	35	5.25	534	-165	167	321	47	3.15	827	3.56
315	10	4.4	560	-84	97	178	24	3.18	1249	4.1
315	27	5	531	-138	112	250	32	3.23	1106	3.45
315	27	5	520	-153	159	225	41	2.98	1781	3.88
315	35	4.95	492	-111	133	205	33	3.03	926	4.06

Appendix B Global Response Weibull Analysis Results for Low Pass Filtered Data

Appendix B Global Response Weibull Analysis Results for Low Pass Filtered Data

Weibull Analysis Results for LB Fr 27 Port Hull Keel Based on Low Pass Peak to Peak Response

Relative Heading	Speed	Sig Wave Height	Correlation	Slope	Characteristic Value (uin/in)	YIntercept	Mean (uin/in)	Min (uin/in)	Max (uin/in)
0	0	4.4	0.99856	2.14264	38.0663	-7.80	94	257	617
0	1	4.8	0.9987	2.0967	29.6279	-7.11	68	167	484
0	1	5.1	0.99374	1.87319	52.3839	-7.42	116	566	469
0	2	7.2	0.99682	1.97965	95.4061	-9.02	228	1699	424
0	2	8.4	0.99682	1.97965	95.4061	-9.02	228	1699	424
0	2	5.7	0.99882	2.1659	41.9289	-8.09	96	316	338
0	2	4.8	0.98845	2.14184	50.5820	-8.40	110	458	317
0	3	5	0.97359	1.89607	53.2220	-7.54	133	564	273
0	10	4.4	0.99643	2.3447	36.6017	-8.44	105	246	526
0	20	7.2	0.99818	2.17822	68.0160	-9.19	161	892	594
0	27	5	0.99715	2.43881	70.7358	-10.39	167	703	936
0	33	8.4	0.99686	2.10063	91.6282	-9.49	247	1563	503
0	33	8.4	0.99819	1.90543	133.4560	-9.32	438	4597	851
0	33	8.4	0.99726	2.20718	127.9900	-10.71	362	3316	540
0	35	4.95	0.99764	2.22004	30.4777	-7.59	63	145	465
0	35	5.2	0.99876	2.06567	32.1661	-7.17	78	209	608
0	35	5.25	0.99556	2.19047	46.0873	-8.39	91	346	327
30	32	8.4	0.99905	1.97284	109.0360	-9.26	256	2532	447
45	20	7.2	0.99875	2.19286	62.9600	-9.08	156	698	695
45	27	5	0.99473	2.51633	69.6018	-10.68	144	695	858
45	33	8.4	0.9968	2.17574	72.3411	-9.32	160	887	698
45	33	8.4	0.99762	2.06829	36.0316	-7.41	77	239	459
45	35	5.25	0.99877	2.13356	60.0370	-8.74	148	694	342
90	0	5.2	0.99057	1.96713	46.2902	-7.54	132	407	439
90	3	4.8	0.98871	2.09168	50.7062	-8.21	108	390	605
90	20	7.2	0.96084	2.22331	54.1200	-8.87	1181	5134	536
90	27	5	0.99933	2.53945	58.6240	-10.34	121	489	504
90	35	4.95	0.99895	2.30579	33.6478	-8.11	80	187	628
90	35	5.2	0.99524	2.2565	45.4786	-8.61	106	309	805
90	35	5.25	0.99182	2.11483	44.7583	-8.04	117	310	633
135	0	5.4	0.98364	1.71495	26.7148	-5.63	392	704	487
135	33	8.4	0.97553	1.33989	65.3055	-5.60	193	1010	355
135	35	5.2	0.99789	1.89707	46.1590	-7.27	135	462	524
135	35	5	0.99651	2.24002	48.0701	-8.67	115	380	332
135	35	5.25	0.99285	1.80785	33.7678	-6.36	72	223	441
180	11	4.4	0.96296	1.46123	27.3125	-4.83	59	162	215
180	20	7.2	0.99331	1.09437	47.1273	-4.22	141	1244	140
180	33	8.4	0.98268	1.87624	102.5740	-8.69	208	1686	239
180	35	4.95	0.99753	2.01771	39.0914	-7.40	87	272	412
180	35	5.2	0.9744	1.7383	30.2301	-5.93	63	153	373
180	35	5.25	0.98043	1.50201	32.0035	-5.21	67	203	227
225	3	5	0.98976	2.11719	46.1821	-8.11	129	383	418
225	9	4.4	0.99051	1.7204	38.4786	-6.28	82	299	339
225	20	7.2	0.98914	1.70651	35.2958	-6.08	113	452	352
225	35	4.95	0.99918	2.17116	28.2491	-7.25	70	145	538
270	9	4.4	0.99935	2.37798	28.3002	-7.95	62	125	683
270	27	5	0.99067	2.23129	46.8668	-8.58	110	320	711
270	33	8.4	0.99436	2.44676	66.1233	-10.26	195	655	493
270	33	8.4	0.98443	1.81038	124.6540	-8.74	296	3029	295
270	35	5.25	0.99793	2.39358	48.5671	-9.29	110	345	560
315	10	4.4	0.99683	2.2333	39.4115	-8.21	105	304	596
315	27	5	0.99232	2.2358	58.5235	-9.10	139	563	525
315	27	5	0.98984	2.45934	64.1224	-10.23	144	513	1021
315	35	4.95	0.99874	2.22379	24.7591	-7.14	66	108	662

Note: Units of Strain Shown as micro-strain (uin/in)

Appendix B Global Response Weibull Analysis Results for Low Pass Filtered Data

Weibull Analysis Results for LB Fr 27 Port Hull Keel Based on Low Pass Min Response

Relative Heading	Speed	Sig Wave Height	Correlation	Slope	Characteristic Value (uin/in)	YIntercept	Mean (uin/in)	Min (uin/in)	Max (uin/in)	Variance $(uin/in)^2$	Size
0	0	4.4	0.9643	1.44	20	-4.3147	17	0	46	81	309
0	1	4.8	0.9822	1.66	15	-4.5455	13	0	35	47	242
0	1	5.1	0.9832	1.54	27	-5.0562	23	0	59	161	235
0	2	4.8	0.9769	1.68	26	-5.4925	23	0	61	159	159
0	2	5.7	0.9926	1.51	21	-4.6197	19	1	52	130	169
0	2	7.2	0.9676	1.62	50	-6.3656	43	1	119	456	212
0	2	8.4	0.9676	1.62	50	-6.3656	43	1	119	456	212
0	3	5	0.8864	1.15	30	-3.8998	23	0	69	161	137
0	10	4.4	0.9955	1.70	18	-4.9513	16	0	60	90	263
0	20	7.2	0.9920	1.94	34	-6.8344	30	1	80	227	297
0	27	5	0.9854	1.40	35	-4.9533	30	0	109	294	468
0	33	8.4	0.9957	1.83	46	-7.0079	40	1	119	442	251
0	33	8.4	0.9932	1.53	68	-6.4557	61	1	328	1894	425
0	33	8.4	0.9908	1.76	66	-7.3713	58	1	235	1219	270
0	35	4.95	0.9929	1.43	16	-3.9234	14	0	34	66	232
0	35	5.2	0.9585	1.42	17	-4.0174	14	0	37	60	304
0	35	5.25	0.9833	1.37	24	-4.3392	20	0	56	134	163
30	32	8.4	0.9878	1.60	56	-6.4228	49	1	146	806	224
45	20	7.2	0.9605	1.59	33	-5.5677	28	0	67	198	347
45	27	5	0.9781	1.50	35	-5.3414	30	0	80	259	429
45	33	8.4	0.9772	1.63	37	-5.8774	32	0	83	276	349
45	33	8.4	0.9832	1.32	18	-3.8368	16	0	45	92	230
45	35	5.25	0.9671	1.35	32	-4.6638	27	0	67	253	171
90	0	5.2	0.9694	1.51	24	-4.7678	20	0	61	117	220
90	3	4.8	0.9800	1.58	26	-5.1410	22	0	53	126	303
90	20	7.2	0.9858	1.27	29	-4.2711	25	0	104	275	268
90	27	5	0.9835	1.32	30	-4.4998	26	0	71	244	252
90	35	4.95	0.9953	1.26	17	-3.5765	15	0	58	115	314
90	35	5.2	0.9820	1.18	24	-3.7327	20	0	69	181	402
90	35	5.25	0.9931	1.22	21	-3.7507	19	0	58	171	316
135	0	5.4	0.9791	1.26	13	-3.2691	12	0	65	64	244
135	33	8.4	0.9721	0.92	32	-3.2010	28	0	95	374	177
135	35	5	0.9946	1.18	22	-3.6418	20	0	74	214	166
135	35	5.2	0.9898	1.09	23	-3.3877	20	0	66	214	262
135	35	5.25	0.9818	1.12	17	-3.1978	15	0	42	92	220
180	11	4.4	0.9121	0.91	15	-2.4685	12	0	32	49	108
180	20	7.2	0.9886	0.63	18	-1.8217	22	0	85	532	70
180	33	8.4	0.9581	1.23	53	-4.8762	45	1	118	580	120
180	35	4.95	0.9909	1.37	19	-4.0549	17	1	48	116	206
180	35	5.2	0.9629	1.09	15	-2.9831	13	0	36	66	187
180	35	5.25	0.9843	0.94	15	-2.5494	13	0	40	98	113
225	3	5	0.9709	1.41	24	-4.4984	21	0	72	137	209
225	9	4.4	0.9782	1.23	19	-3.6398	17	0	43	95	169
225	20	7.2	0.9889	0.94	16	-2.6226	16	0	76	218	176
225	35	4.95	0.9853	1.13	14	-3.0247	13	0	46	89	269
270	9	4.4	0.9655	1.40	15	-3.7847	13	0	32	50	342
270	27	5	0.9515	1.03	24	-3.2838	20	0	60	164	356
270	33	8.4	0.9616	1.27	36	-4.5216	30	0	91	323	246
270	33	8.4	0.9746	1.64	64	-6.8111	55	1	151	812	147
270	35	5.25	0.9795	1.31	26	-4.2924	22	0	69	175	280
315	10	4.4	0.9867	1.43	20	-4.2931	17	0	52	106	298
315	27	5	0.9636	1.19	32	-4.1142	26	0	84	246	263
315	27	5	0.9737	1.21	32	-4.2032	27	0	81	259	510
315	35	4.95	0.9929	1.49	12	-3.7533	11	0	33	42	331

Appendix B Global Response Weibull Analysis Results for Low Pass Filtered Data

Weibull Analysis Results for LB Fr 27 Port Hull Keel Based on Low Pass Max Response

Relative Heading	Speed	Sig Wave Height	Correlation	Slope	Characteristic Value (uin/in)	YIntercept	Mean (uin/in)	Min (uin/in)	Max (uin/in)	Variance $(uin/in)^2$	Size
0	0	4.4	0.9929	1.70	19	-5.0257	17	0	49	81	308
0	1	4.8	0.9802	1.58	15	-4.2770	13	0	35	49	242
0	1	5.1	0.9768	1.55	27	-5.1133	23	0	60	153	234
0	2	4.8	0.9897	1.48	25	-4.7937	22	1	53	157	158
0	2	5.7	0.9783	1.53	21	-4.6799	18	0	44	95	169
0	2	7.2	0.9953	1.80	47	-6.9116	41	3	109	463	212
0	2	8.4	0.9953	1.80	47	-6.9116	41	3	109	463	212
0	3	5	0.9819	1.77	26	-5.7807	23	1	64	151	136
0	10	4.4	0.9920	1.68	19	-4.9433	16	0	44	79	263
0	20	7.2	0.9968	1.81	35	-6.4166	31	2	83	271	297
0	27	5	0.9665	1.39	39	-5.0977	33	0	108	318	468
0	33	8.4	0.9780	1.54	48	-5.9665	41	1	127	453	252
0	33	8.4	0.9532	1.48	70	-6.2734	58	0	145	896	426
0	33	8.4	0.9759	1.75	65	-7.2846	56	0	128	765	270
0	35	4.95	0.9884	1.39	15	-3.7934	13	0	40	61	233
0	35	5.2	0.9975	1.76	16	-4.8843	14	1	42	64	304
0	35	5.25	0.9935	1.47	23	-4.6300	20	1	59	148	164
30	32	8.4	0.9882	1.57	55	-6.2874	48	1	114	671	223
45	20	7.2	0.9885	1.60	32	-5.5584	28	0	92	235	348
45	27	5	0.9749	1.44	37	-5.1992	32	0	102	315	429
45	33	8.4	0.9735	1.58	38	-5.7355	32	0	85	271	349
45	33	8.4	0.9822	1.30	19	-3.7856	16	0	43	87	229
45	35	5.25	0.9500	1.25	32	-4.3240	26	0	81	211	171
90	0	5.2	0.9794	1.58	24	-4.9954	20	0	71	121	219
90	3	4.8	0.9681	1.57	26	-5.1253	22	0	54	126	302
90	20	7.2	0.9622	1.05	26	-3.4228	25	0	1076	4339	268
90	27	5	0.9906	1.46	30	-4.9690	26	0	80	243	252
90	35	4.95	0.9962	1.18	16	-3.2732	15	0	64	118	314
90	35	5.2	0.9932	1.28	22	-3.9596	19	0	59	166	403
90	35	5.25	0.9883	1.18	23	-3.6944	20	0	67	173	317
135	0	5.4	0.9709	1.12	14	-2.9430	13	0	327	464	243
135	33	8.4	0.9799	0.93	31	-3.1881	28	0	98	403	178
135	35	5	0.9924	1.20	25	-3.8737	22	0	72	236	166
135	35	5.2	0.9707	1.12	24	-3.5662	20	0	69	159	262
135	35	5.25	0.9847	1.07	17	-3.0003	15	0	46	98	221
180	11	4.4	0.9717	1.08	13	-2.7979	11	0	31	53	107
180	20	7.2	0.9937	0.82	21	-2.4957	22	0	124	637	70
180	33	8.4	0.9804	1.27	51	-5.0043	44	0	115	700	119
180	35	4.95	0.9832	1.13	19	-3.3617	17	0	52	128	206
180	35	5.2	0.9615	1.16	16	-3.1910	13	0	36	58	186
180	35	5.25	0.9800	0.89	16	-2.4641	14	0	41	112	114
225	3	5	0.9751	1.34	23	-4.2242	20	0	60	137	209
225	9	4.4	0.9697	1.07	20	-3.2057	17	0	43	105	170
225	20	7.2	0.9954	1.08	17	-3.0441	16	0	72	224	176
225	35	4.95	0.9929	1.19	13	-3.0789	12	0	44	81	269
270	9	4.4	0.9855	1.59	14	-4.2421	12	0	31	44	341
270	27	5	0.9791	1.04	24	-3.3253	21	0	69	213	355
270	33	8.4	0.9927	1.47	33	-5.1173	29	0	104	289	247
270	33	8.4	0.9730	1.59	63	-6.5811	53	1	146	799	148
270	35	5.25	0.9802	1.31	24	-4.1490	20	0	69	145	280
315	10	4.4	0.9716	1.63	21	-4.9394	18	0	52	91	298
315	27	5	0.9495	1.32	30	-4.4967	25	0	80	201	262
315	27	5	0.9749	1.30	35	-4.6107	29	0	82	287	511
315	35	4.95	0.9875	1.59	13	-4.0466	11	0	33	36	331

Appendix B Global Response Weibull Analysis Results for Low Pass Filtered Data

Weibull Analysis Results for Split Load Frame 22 Low Pass Peak to Peak Response

Relative Heading	Speed	Sig Wave Height	Correlation	Slope	Characteristic Value (uin/in)	YIntercept	Mean (uin/in)	Min (uin/in)	Max (uin/in)	Variance $(uin/in)^2$	Size
0	0	4.4	0.9980	2.04	60	-8.3440	53	2	155	728	796
0	1	4.8	0.9944	2.22	83	-9.8080	73	2	169	1127	515
0	1	5.1	0.9861	1.80	84	-7.9945	73	0	181	1318	575
0	2	7.2	0.9780	2.09	87	-9.3393	75	0	197	1128	536
0	2	8.4	0.9780	2.09	87	-9.3393	75	0	197	1128	536
0	2	5.7	0.9965	2.13	47	-8.2352	42	1	105	382	484
0	2	4.8	0.9970	2.09	55	-8.3799	48	2	121	537	437
0	3	5	0.9961	2.32	77	-10.0979	69	10	186	1082	333
0	10	4.4	0.9832	1.92	52	-7.5893	45	0	116	435	699
0	20	7.2	0.9987	2.11	63	-8.7570	56	2	163	763	748
0	27	5	0.9851	1.93	59	-7.8504	51	0	120	561	839
0	33	8.4	0.9976	2.35	59	-9.5882	52	3	145	579	607
0	33	8.4	0.9964	2.20	98	-10.1083	86	2	222	1569	1063
0	33	8.4	0.9770	2.16	105	-10.0608	91	0	234	1630	669
0	35	4.95	0.9984	2.33	42	-8.7027	37	2	92	276	503
0	35	5.2	0.9991	2.26	45	-8.5844	40	2	100	343	730
0	35	5.25	0.9984	2.47	47	-9.5277	42	3	96	308	552
30	32	8.4	0.9920	1.70	77	-7.3790	67	1	171	1214	471
45	20	7.2	0.9942	1.86	82	-8.1998	72	2	207	1315	640
45	27	5	0.9942	2.09	67	-8.8141	59	1	172	781	957
45	33	8.4	0.9986	1.99	74	-8.5675	66	4	171	1174	578
45	33	8.4	0.9991	1.88	85	-8.3483	75	3	203	1637	570
45	35	5.25	0.9951	1.91	62	-7.8940	54	2	137	727	508
90	0	5.2	0.9989	2.00	65	-8.3415	57	3	160	833	576
90	3	4.8	0.9985	1.84	59	-7.5000	52	2	141	779	774
90	20	7.2	0.9963	2.05	121	-9.8593	107	5	441	2874	535
90	27	5	0.9989	2.08	53	-8.2291	46	2	126	539	590
90	35	4.95	0.9981	2.10	74	-9.0082	65	2	182	1067	631
90	35	5.2	0.9899	1.87	87	-8.3376	76	1	206	1365	751
90	35	5.25	0.9883	1.73	66	-7.2293	57	0	178	868	775
135	0	5.4	0.9975	1.97	91	-8.8755	80	3	192	1543	509
135	33	8.4	0.9956	1.69	90	-7.5829	79	4	235	1935	431
135	35	5.2	0.9970	1.89	73	-8.1354	64	2	165	1055	616
135	35	5	0.9977	1.89	45	-7.1874	40	3	107	429	404
135	35	5.25	0.9979	2.07	52	-8.1740	46	2	116	478	585
180	11	4.4	0.9769	1.67	35	-5.9460	30	0	101	268	394
180	20	7.2	0.9910	1.60	63	-6.6195	57	3	177	1347	249
180	33	8.4	0.9815	1.57	81	-6.8895	70	1	239	1362	319
180	35	4.95	0.9965	1.78	64	-7.3916	56	3	152	898	494
180	35	5.2	0.9958	1.78	37	-6.4547	33	1	89	286	488
180	35	5.25	0.9897	1.56	36	-5.6169	32	0	98	327	354
225	3	5	0.9931	1.99	63	-8.2400	55	1	127	699	544
225	9	4.4	0.9836	1.68	44	-6.3581	38	0	95	357	534
225	20	7.2	0.9899	1.73	102	-8.0068	88	1	219	2036	412
225	35	4.95	0.9983	1.88	68	-7.9099	59	2	155	965	460
270	9	4.4	0.9929	1.91	58	-7.7855	51	1	137	650	707
270	27	5	0.9966	1.83	52	-7.2154	45	1	125	563	745
270	33	8.4	0.9983	2.00	125	-9.6517	110	7	305	3026	439
270	33	8.4	0.9664	1.99	106	-9.2984	91	1	207	1492	370
270	35	5.25	0.9964	2.03	52	-8.0024	45	2	131	477	583
315	10	4.4	0.9931	2.08	49	-8.1072	43	1	113	431	835
315	27	5	0.9982	2.29	54	-9.1129	47	5	116	448	587
315	27	5	0.9908	2.14	53	-8.4677	46	1	108	406	1051
315	35	4.95	0.9982	2.20	61	-9.0259	54	2	158	674	650

Appendix B Global Response Weibull Analysis Results for Low Pass Filtered Data

Weibull Analysis Results for Split Load Frame 22 Low Pass Min Response

Relative Heading	Speed	Sig Wave Height	Correlation	Slope	Characteristic Value (uin/in)	YIntercept	Mean (uin/in)	Min (uin/in)	Max (uin/in)	Variance $(uin/in)^2$	Size
0	0	4.4	0.9816	1.48	31	-5.0794	27	0	79	228	398
0	1	4.8	0.9736	1.67	43	-6.2935	37	0	90	336	257
0	1	5.1	0.9320	1.24	46	-4.7303	37	0	89	388	288
0	2	4.8	0.9854	1.65	28	-5.5097	24	1	57	153	219
0	2	5.7	0.9716	1.63	24	-5.1987	21	0	50	112	242
0	2	7.2	0.9360	1.34	47	-5.1850	39	0	105	380	268
0	2	8.4	0.9360	1.34	47	-5.1850	39	0	105	380	268
0	3	5	0.9644	1.58	40	-5.8471	34	1	94	336	166
0	10	4.4	0.9811	1.26	26	-4.0970	22	0	62	185	349
0	20	7.2	0.9782	1.40	32	-4.8900	28	0	73	236	374
0	27	5	0.9880	1.11	28	-3.7282	25	0	90	295	420
0	33	8.4	0.9404	1.40	31	-4.8315	26	0	70	194	303
0	33	8.4	0.9860	1.62	51	-6.3978	44	0	122	547	532
0	33	8.4	0.9685	1.54	56	-6.1791	47	0	115	577	335
0	35	4.95	0.9884	1.43	22	-4.3932	19	0	61	127	251
0	35	5.2	0.9790	1.53	23	-4.8193	20	0	58	121	365
0	35	5.25	0.9772	1.64	24	-5.2391	21	0	49	107	276
30	32	8.4	0.9762	1.26	38	-4.5949	32	1	78	345	235
45	20	7.2	0.9553	1.18	42	-4.4244	35	0	89	388	320
45	27	5	0.9928	1.28	33	-4.4867	30	0	95	382	478
45	33	8.4	0.9744	1.11	38	-4.0587	33	0	95	407	289
45	33	8.4	0.9851	1.38	44	-5.2342	38	0	99	491	285
45	35	5.25	0.9822	1.16	32	-4.0169	28	0	76	301	254
90	0	5.2	0.9805	1.52	33	-5.3170	29	0	86	243	288
90	3	4.8	0.9920	1.43	29	-4.8343	26	0	71	231	387
90	20	7.2	0.9636	1.11	61	-4.5630	51	0	128	878	268
90	27	5	0.9927	1.31	26	-4.2878	23	0	65	221	295
90	35	4.95	0.9907	1.28	36	-4.6010	32	0	96	423	316
90	35	5.2	0.9924	1.06	42	-3.9797	39	0	125	802	375
90	35	5.25	0.9880	1.03	32	-3.5469	28	0	104	416	387
135	0	5.4	0.9867	1.46	46	-5.5813	40	1	109	487	255
135	33	8.4	0.9883	1.03	43	-3.8879	39	0	120	773	216
135	35	5	0.9853	1.04	22	-3.2150	19	0	63	199	202
135	35	5.2	0.9673	0.94	37	-3.3860	32	0	109	502	308
135	35	5.25	0.9900	1.15	25	-3.6910	22	0	59	218	293
180	11	4.4	0.9529	1.05	18	-3.0548	15	0	51	98	197
180	20	7.2	0.9932	0.94	29	-3.1954	28	0	92	553	124
180	33	8.4	0.9666	1.06	42	-3.9486	35	0	119	501	160
180	35	4.95	0.9920	1.09	31	-3.7170	28	0	106	448	247
180	35	5.2	0.9907	1.05	17	-3.0051	16	0	53	132	244
180	35	5.25	0.9932	0.98	16	-2.7402	15	0	71	147	177
225	3	5	0.9488	1.18	34	-4.1633	28	0	82	260	272
225	9	4.4	0.9777	1.17	22	-3.5968	19	0	56	129	267
225	20	7.2	0.9769	0.96	48	-3.7178	42	0	125	902	206
225	35	4.95	0.9894	1.12	34	-3.9440	30	0	94	448	230
270	9	4.4	0.9712	1.31	30	-4.4254	25	0	67	208	354
270	27	5	0.9928	1.05	25	-3.3803	22	0	93	280	373
270	33	8.4	0.9899	1.19	63	-4.9448	55	1	166	1370	220
270	33	8.4	0.9318	1.30	56	-5.2308	45	0	99	473	185
270	35	5.25	0.9671	1.05	27	-3.4559	23	0	63	202	292
315	10	4.4	0.9491	1.23	26	-3.9919	21	0	59	159	417
315	27	5	0.9824	1.24	28	-4.1074	24	0	70	226	294
315	27	5	0.9913	1.15	25	-3.7114	23	0	75	238	525
315	35	4.95	0.9927	1.34	31	-4.5919	27	0	92	313	325

Appendix B Global Response Weibull Analysis Results for Low Pass Filtered Data

Weibull Analysis Results for Split Load Frame 22 Low Pass Max Response

Relative Heading	Speed	Sig Wave Height	Correlation	Slope	Characteristic Value (uin/in)	YIntercept	Mean (uin/in)	Min (uin/in)	Max (uin/in)	Variance $(uin/in)^2$	Size
0	0	4.4	0.9864	1.55	30	-5.2605	26	0	87	220	398
0	1	4.8	0.9759	1.75	43	-6.5558	37	0	88	348	258
0	1	5.1	0.9530	1.24	44	-4.6861	36	0	104	389	287
0	2	4.8	0.9646	1.31	29	-4.4137	24	0	67	189	218
0	2	5.7	0.9533	1.27	26	-4.1117	21	0	62	132	242
0	2	7.2	0.9279	1.46	46	-5.5709	37	0	93	312	268
0	2	8.4	0.9279	1.46	46	-5.5709	37	0	93	312	268
0	3	5	0.9982	2.00	39	-7.3064	34	2	93	321	167
0	10	4.4	0.9712	1.34	27	-4.4113	23	0	66	163	350
0	20	7.2	0.9804	1.32	33	-4.6082	28	0	105	300	374
0	27	5	0.9810	1.08	30	-3.6591	26	0	87	301	419
0	33	8.4	0.9919	1.57	30	-5.3270	26	1	75	219	304
0	33	8.4	0.9795	1.54	49	-5.9913	42	0	115	504	531
0	33	8.4	0.9685	1.49	52	-5.9087	44	0	125	547	334
0	35	4.95	0.9734	1.21	22	-3.7260	18	0	52	123	252
0	35	5.2	0.9753	1.43	23	-4.4872	20	0	50	120	365
0	35	5.25	0.9780	1.62	24	-5.1794	21	0	58	110	276
30	32	8.4	0.9846	1.20	39	-4.4041	34	0	101	488	236
45	20	7.2	0.9803	1.16	43	-4.3588	37	0	118	572	320
45	27	5	0.9792	1.15	34	-4.0516	29	0	95	374	479
45	33	8.4	0.9919	1.37	38	-4.9790	33	1	105	420	289
45	33	8.4	0.9781	1.17	44	-4.4063	37	0	108	548	285
45	35	5.25	0.9770	1.08	31	-3.7110	27	0	88	294	254
90	0	5.2	0.9789	1.35	33	-4.7429	28	0	90	278	288
90	3	4.8	0.9805	1.18	31	-4.0294	26	0	71	271	387
90	20	7.2	0.9902	1.19	63	-4.9228	56	0	373	1678	267
90	27	5	0.9973	1.20	26	-3.8967	23	0	82	297	295
90	35	4.95	0.9905	1.05	37	-3.7871	33	0	123	608	315
90	35	5.2	0.9786	1.05	43	-3.9376	37	0	151	656	376
90	35	5.25	0.9899	1.01	32	-3.4975	29	0	103	450	388
135	0	5.4	0.9616	1.20	48	-4.6646	40	0	127	542	254
135	33	8.4	0.9933	1.05	44	-3.9803	40	0	154	959	215
135	35	5	0.9961	1.14	22	-3.5435	20	0	72	234	202
135	35	5.2	0.9830	1.16	37	-4.1898	32	0	95	459	308
135	35	5.25	0.9890	1.11	27	-3.6383	24	0	73	267	292
180	11	4.4	0.9718	1.02	18	-2.9474	15	0	50	102	197
180	20	7.2	0.9972	0.92	29	-3.1197	29	0	123	688	125
180	33	8.4	0.9819	1.01	39	-3.7019	34	0	138	686	159
180	35	4.95	0.9889	1.13	31	-3.8672	28	0	104	370	247
180	35	5.2	0.9844	1.14	19	-3.3809	17	0	49	119	244
180	35	5.25	0.9948	1.00	17	-2.8671	17	0	63	201	177
225	3	5	0.9709	1.20	32	-4.1549	27	0	76	274	272
225	9	4.4	0.9733	1.07	22	-3.3245	19	0	60	136	267
225	20	7.2	0.9887	1.12	53	-4.4396	47	0	154	1024	206
225	35	4.95	0.9864	1.04	32	-3.6166	29	0	104	428	230
270	9	4.4	0.9738	1.31	31	-4.4903	26	0	74	224	353
270	27	5	0.9944	1.13	25	-3.6395	23	0	90	289	372
270	33	8.4	0.9824	1.03	63	-4.2481	55	0	175	1470	219
270	33	8.4	0.9272	1.32	57	-5.3457	46	0	120	505	185
270	35	5.25	0.9954	1.29	26	-4.1824	23	0	81	246	291
315	10	4.4	0.9881	1.41	25	-4.5471	22	0	65	161	418
315	27	5	0.9898	1.46	27	-4.8254	24	0	64	184	293
315	27	5	0.9787	1.16	27	-3.8224	23	0	79	231	526
315	35	4.95	0.9896	1.39	30	-4.7378	26	0	77	249	325

Appendix B Global Response Weibull Analysis Results for Low Pass Filtered Data

Weibull Analysis Results for Transverse Bending Frame 22 Low Pass Peak to Peak Response

Relative Heading	Speed	Sig Wave Height	Correlation	Slope	Characteristic Value (uin/in)	YIntercept	Mean (uin/in)	Min (uin/in)	Max (uin/in)	Variance $(uin/in)^2$	Size
0	0	4.4	0.9794	2.12	19	-6.3015	17	0	42	62	439
0	1	4.8	0.9878	1.94	21	-5.9372	19	0	58	106	465
0	1	5.1	0.9952	1.81	19	-5.2859	16	0	48	80	490
0	2	7.2	0.9864	1.86	25	-6.0128	22	0	67	112	508
0	2	8.4	0.9864	1.86	25	-6.0128	22	0	67	112	508
0	2	5.7	0.9943	2.23	11	-5.3388	10	0	23	18	420
0	2	4.8	0.9853	1.97	13	-5.0526	11	1	29	27	379
0	3	5	0.9907	1.77	21	-5.4021	18	1	50	95	285
0	10	4.4	0.9862	1.87	16	-5.1791	14	0	35	47	533
0	20	7.2	0.9974	2.13	10	-4.9583	9	0	29	19	504
0	27	5	0.9847	2.06	19	-6.0877	17	0	48	59	800
0	33	8.4	0.9990	2.07	15	-5.5458	13	1	32	41	431
0	33	8.4	0.9957	1.98	31	-6.8039	27	1	101	184	871
0	33	8.4	0.9942	1.83	31	-6.2845	27	1	74	199	560
0	35	4.95	0.9933	2.21	12	-5.4596	10	1	38	28	304
0	35	5.2	0.9980	2.24	8	-4.5510	7	0	18	10	435
0	35	5.25	0.9989	1.89	10	-4.2967	9	1	27	22	289
30	32	8.4	0.9960	1.87	23	-5.9050	21	1	92	148	393
45	20	7.2	0.9930	2.05	29	-6.9090	26	1	65	157	492
45	27	5	0.9983	2.16	22	-6.7051	20	1	59	92	799
45	33	8.4	0.9981	1.96	26	-6.3454	23	1	66	156	480
45	33	8.4	0.9948	2.15	28	-7.1275	24	1	65	132	492
45	35	5.25	0.9988	1.97	22	-6.1051	20	1	60	109	318
90	0	5.2	0.9907	1.83	23	-5.7261	20	0	52	108	541
90	3	4.8	0.9696	1.80	22	-5.5353	19	0	53	85	700
90	20	7.2	0.9749	1.77	46	-6.7878	43	1	868	3336	463
90	27	5	0.9945	2.04	18	-5.9229	16	1	52	63	432
90	35	4.95	0.9870	1.91	34	-6.7180	29	1	70	196	515
90	35	5.2	0.9810	2.00	27	-6.5707	23	0	62	116	627
90	35	5.25	0.9962	2.26	21	-6.9093	19	1	58	69	610
135	0	5.4	0.9892	2.00	42	-7.4564	37	1	301	593	450
135	33	8.4	0.9760	1.74	24	-5.5444	21	0	54	102	419
135	35	5.2	0.9908	2.00	21	-6.0809	18	0	47	74	612
135	35	5	0.9962	2.31	16	-6.3838	14	1	36	41	285
135	35	5.25	0.9854	1.81	11	-4.3570	10	0	26	23	521
180	11	4.4	0.9952	1.99	10	-4.6531	9	1	28	21	391
180	20	7.2	0.9981	1.72	13	-4.3593	11	1	31	40	342
180	33	8.4	0.9937	1.71	16	-4.6809	14	0	41	52	320
180	35	4.95	0.9730	1.76	14	-4.6454	12	0	32	32	456
180	35	5.2	0.9940	2.09	9	-4.6656	8	0	20	14	455
180	35	5.25	0.9741	2.00	11	-4.8557	10	0	26	20	324
225	3	5	0.9928	2.29	24	-7.3188	21	1	49	92	287
225	9	4.4	0.9964	2.09	13	-5.3712	11	0	30	30	535
225	20	7.2	0.9964	2.15	36	-7.7336	32	2	106	258	494
225	35	4.95	0.9981	1.99	18	-5.7166	16	1	46	67	407
270	9	4.4	0.9877	1.94	24	-6.1416	21	0	53	104	645
270	27	5	0.9978	2.37	20	-7.0815	18	2	41	63	719
270	33	8.4	0.9706	1.70	48	-6.5752	40	0	119	401	372
270	33	8.4	0.9952	2.02	31	-6.9156	27	2	62	162	341
270	35	5.25	0.9857	1.99	22	-6.1380	19	0	55	88	442
315	10	4.4	0.9941	2.19	12	-5.5057	11	0	30	28	620
315	27	5	0.9954	2.56	18	-7.3692	16	1	34	41	472
315	27	5	0.9977	2.52	17	-7.2081	15	1	44	41	848
315	35	4.95	0.9988	1.99	17	-5.6499	15	1	43	57	363

Appendix B Global Response Weibull Analysis Results for Low Pass Filtered Data

Weibull Analysis Results for Transverse Bending Frame 22 Low Pass Min Response

Relative Heading	Speed	Sig Wave Height	Correlation	Slope	Characteristic Value (uin/in)	YIntercept	Mean (uin/in)	Min (uin/in)	Max (uin/in)	Variance $(uin/in)^2$	Size
0	0	4.4	0.9970	1.22	9	-2.6313	8	0	31	39	219
0	1	4.8	0.9607	1.48	11	-3.5621	9	0	27	26	232
0	1	5.1	0.9807	1.49	9	-3.3555	8	0	22	22	245
0	2	4.8	0.9789	1.49	6	-2.7836	6	0	14	9	190
0	2	5.7	0.9887	1.84	5	-3.1251	5	0	11	6	210
0	2	7.2	0.9488	1.28	13	-3.3349	11	0	35	34	254
0	2	8.4	0.9488	1.28	13	-3.3349	11	0	35	34	254
0	3	5	0.9715	1.43	11	-3.3851	9	0	23	25	142
0	10	4.4	0.9699	1.08	8	-2.2425	7	0	20	19	266
0	20	7.2	0.9603	1.13	5	-1.8722	4	0	13	7	252
0	27	5	0.9708	1.20	10	-2.7275	8	0	26	26	400
0	33	8.4	0.9715	1.34	8	-2.7033	6	0	17	13	215
0	33	8.4	0.9823	1.61	16	-4.4241	13	0	38	49	436
0	33	8.4	0.9679	1.42	16	-3.9137	13	0	33	49	280
0	35	4.95	0.9829	1.35	6	-2.3908	5	0	13	9	152
0	35	5.2	0.9770	1.28	4	-1.7354	3	0	11	4	217
0	35	5.25	0.9898	1.36	5	-2.1552	4	0	12	7	145
30	32	8.4	0.9794	1.53	12	-3.7737	10	0	23	29	196
45	20	7.2	0.9767	1.39	14	-3.6869	12	0	31	45	246
45	27	5	0.9803	1.30	11	-3.1385	10	0	33	36	400
45	33	8.4	0.9959	1.48	13	-3.7486	11	0	32	48	240
45	33	8.4	0.9848	1.64	14	-4.3132	12	0	32	39	246
45	35	5.25	0.9310	1.15	12	-2.8435	10	0	27	31	159
90	0	5.2	0.9912	1.50	12	-3.6617	10	0	29	34	271
90	3	4.8	0.9111	1.13	12	-2.7848	9	0	26	25	350
90	20	7.2	0.9593	1.26	21	-3.8721	21	0	808	2789	232
90	27	5	0.9805	1.24	9	-2.7536	8	0	31	28	216
90	35	4.95	0.9555	1.08	17	-3.0884	14	0	40	74	258
90	35	5.2	0.9857	1.21	13	-3.1391	12	0	39	60	313
90	35	5.25	0.9848	1.32	10	-3.0760	9	0	27	29	305
135	0	5.4	0.9461	1.19	22	-3.6889	19	0	252	339	225
135	33	8.4	0.9859	1.16	11	-2.8178	10	0	28	44	210
135	35	5	0.9667	1.28	8	-2.6639	7	0	18	16	142
135	35	5.2	0.9512	1.16	11	-2.7872	9	0	27	30	306
135	35	5.25	0.9916	1.11	5	-1.8757	5	0	14	12	261
180	11	4.4	0.9707	1.37	5	-2.2894	5	0	16	7	195
180	20	7.2	0.9942	1.03	6	-1.8252	5	0	18	20	171
180	33	8.4	0.9866	1.00	7	-2.0063	7	0	23	24	160
180	35	4.95	0.9810	1.10	7	-2.1205	6	0	16	16	228
180	35	5.2	0.9883	1.25	5	-1.9163	4	0	12	7	227
180	35	5.25	0.9580	1.01	6	-1.8192	5	0	16	10	162
225	3	5	0.9910	1.09	13	-2.7707	12	0	32	83	144
225	9	4.4	0.9820	1.43	7	-2.7319	6	0	15	10	267
225	20	7.2	0.9899	1.36	17	-3.8948	15	0	46	87	247
225	35	4.95	0.9750	1.09	9	-2.4065	8	0	24	25	204
270	9	4.4	0.9590	1.32	12	-3.2777	10	0	27	31	322
270	27	5	0.9611	1.14	11	-2.6881	9	0	25	30	360
270	33	8.4	0.9769	1.15	23	-3.5691	19	0	52	147	186
270	33	8.4	0.9866	1.75	15	-4.7800	13	1	32	43	171
270	35	5.25	0.9831	1.43	11	-3.4452	10	0	27	30	221
315	10	4.4	0.9749	1.47	6	-2.7015	5	0	14	9	310
315	27	5	0.9968	1.41	8	-3.0169	8	0	28	26	236
315	27	5	0.9887	1.52	9	-3.3358	8	0	21	18	424
315	35	4.95	0.9798	1.21	9	-2.6146	8	0	20	22	181

Appendix B Global Response Weibull Analysis Results for Low Pass Filtered Data

Weibull Analysis Results for Transverse Bending Frame 22 Low Pass Max Response

Relative Heading	Speed	Sig Wave Height	Correlation	Slope	Characteristic Value (uin/in)	YIntercept	Mean (uin/in)	Min (uin/in)	Max (uin/in)	Variance $(uin/in)^2$	Size
0	0	4.4	0.9865	1.24	10	-2.8723	9	0	28	39	220
0	1	4.8	0.9770	1.47	11	-3.5175	10	0	47	42	233
0	1	5.1	0.9757	1.36	10	-3.0946	8	0	27	24	245
0	2	4.8	0.9719	1.40	7	-2.6694	6	0	18	10	189
0	2	5.7	0.9391	1.50	6	-2.6714	5	0	12	6	210
0	2	7.2	0.9664	1.42	13	-3.6273	11	0	32	33	254
0	2	8.4	0.9664	1.42	13	-3.6273	11	0	32	33	254
0	3	5	0.9895	1.56	11	-3.7129	9	0	27	29	143
0	10	4.4	0.9666	1.26	8	-2.6919	7	0	20	16	267
0	20	7.2	0.9735	1.08	5	-1.8328	5	0	19	10	252
0	27	5	0.9765	1.24	10	-2.8567	9	0	30	27	400
0	33	8.4	0.9861	1.45	8	-2.9443	7	0	17	14	216
0	33	8.4	0.9790	1.35	16	-3.7416	14	0	63	69	435
0	33	8.4	0.9852	1.34	16	-3.7502	14	0	47	74	280
0	35	4.95	0.9950	1.43	6	-2.5612	5	0	27	14	152
0	35	5.2	0.9878	1.34	4	-1.8496	3	0	9	4	218
0	35	5.25	0.9794	0.87	5	-1.3861	4	0	18	11	144
30	32	8.4	0.9749	1.14	12	-2.8388	11	0	70	74	197
45	20	7.2	0.9697	1.40	16	-3.8694	14	0	36	59	246
45	27	5	0.9903	1.43	11	-3.4781	10	0	31	37	399
45	33	8.4	0.9875	1.35	13	-3.4929	12	0	38	55	240
45	33	8.4	0.9855	1.58	14	-4.1988	12	0	34	45	246
45	35	5.25	0.9789	1.16	12	-2.8627	10	0	33	42	159
90	0	5.2	0.9614	1.19	12	-2.9542	10	0	27	37	270
90	3	4.8	0.9624	1.36	11	-3.3033	9	0	27	27	350
90	20	7.2	0.9784	1.20	25	-3.8842	22	0	65	200	231
90	27	5	0.9877	1.19	9	-2.6419	8	0	24	28	216
90	35	4.95	0.9784	1.12	17	-3.2132	15	0	47	92	257
90	35	5.2	0.9700	1.14	14	-2.9804	11	0	36	51	314
90	35	5.25	0.9591	1.15	12	-2.8440	10	0	39	35	305
135	0	5.4	0.9932	1.50	21	-4.5729	19	1	49	125	225
135	33	8.4	0.9770	1.03	12	-2.5817	11	0	39	54	209
135	35	5	0.9418	1.01	9	-2.2030	7	0	24	23	143
135	35	5.2	0.9852	1.30	10	-3.0461	9	0	30	32	306
135	35	5.25	0.9937	1.14	5	-1.9194	5	0	16	12	260
180	11	4.4	0.9854	1.44	5	-2.4141	5	0	12	7	196
180	20	7.2	0.9982	1.09	6	-1.9733	6	0	27	24	171
180	33	8.4	0.9893	1.16	8	-2.3591	7	0	22	24	160
180	35	4.95	0.9882	1.19	7	-2.2507	6	0	18	16	228
180	35	5.2	0.9807	1.24	5	-1.9379	4	0	12	6	228
180	35	5.25	0.9936	1.27	5	-2.1468	5	0	19	11	162
225	3	5	0.9801	1.12	11	-2.6624	9	0	38	50	143
225	9	4.4	0.9459	1.19	7	-2.3166	6	0	17	10	268
225	20	7.2	0.9859	1.36	19	-4.0479	17	0	59	110	247
225	35	4.95	0.9861	1.02	9	-2.1905	8	0	29	35	203
270	9	4.4	0.9579	1.28	13	-3.2401	10	0	28	35	323
270	27	5	0.9859	1.34	10	-3.1174	9	0	25	28	359
270	33	8.4	0.9635	1.07	25	-3.4570	21	0	76	172	186
270	33	8.4	0.9543	1.35	16	-3.7547	13	0	34	54	170
270	35	5.25	0.9842	1.31	11	-3.1567	10	0	32	36	221
315	10	4.4	0.9827	1.29	6	-2.4076	6	0	16	12	310
315	27	5	0.9276	0.99	10	-2.3234	8	0	20	19	236
315	27	5	0.9792	1.16	9	-2.5355	8	0	24	25	424
315	35	4.95	0.9767	1.25	9	-2.7067	8	0	23	24	182

Appendix B Global Response Weibull Analysis Results for Low Pass Filtered Data

Weibull Analysis Results for Pitch Connecting Moment Response Low Pass Peak to Peak Response

Relative Heading	Speed	Sig Wave Height	Correlation	Slope	Characteristic Value (uin/in)	YIntercept	Mean (uin/in)	Min (uin/in)	Max (uin/in)	Variance $(uin/in)^2$	Size
0	0	4.4	0.9807	1.90	58	-7.7377	51	0	141	611	702
0	1	4.8	0.9980	2.07	53	-8.2409	47	4	130	518	523
0	1	5.1	0.9946	1.95	69	-8.2582	61	2	163	1001	512
0	2	7.2	0.9981	2.18	91	-9.8360	81	6	192	1496	470
0	2	8.4	0.9981	2.18	91	-9.8360	81	6	192	1496	470
0	2	5.7	0.9676	1.87	51	-7.3283	43	0	104	404	406
0	2	4.8	0.9983	2.23	71	-9.4975	63	7	147	828	355
0	3	5	0.9957	2.15	65	-9.0053	57	3	138	713	295
0	10	4.4	0.9936	1.86	51	-7.3297	45	1	125	496	563
0	20	7.2	0.9969	2.16	79	-9.4360	70	3	188	1209	616
0	27	5	0.9964	2.33	80	-10.2285	71	3	195	938	850
0	33	8.4	0.9958	2.06	89	-9.2361	78	1	199	1445	531
0	33	8.4	0.9862	1.84	138	-9.0702	121	0	500	4674	890
0	33	8.4	0.9913	1.96	153	-9.8802	134	3	436	4600	562
0	35	4.95	0.9980	2.27	42	-8.5019	37	2	103	282	463
0	35	5.2	0.9889	2.20	48	-8.5306	42	1	101	333	647
0	35	5.25	0.9951	2.09	58	-8.4844	51	2	131	558	431
30	32	8.4	0.9961	2.07	115	-9.8097	102	8	261	2826	453
45	20	7.2	0.9919	2.17	86	-9.6508	76	1	209	1341	629
45	27	5	0.9940	2.15	86	-9.5604	75	2	203	1182	880
45	33	8.4	0.9965	2.25	89	-10.1013	78	3	201	1287	649
45	33	8.4	0.9937	2.13	75	-9.1911	66	1	180	1003	477
45	35	5.25	0.9974	2.21	84	-9.7648	74	7	201	1211	432
90	0	5.2	0.9925	2.00	62	-8.2541	54	1	137	634	498
90	3	4.8	0.9944	1.88	62	-7.7729	54	1	133	730	663
90	20	7.2	0.9974	2.22	162	-11.3127	144	7	575	4918	495
90	27	5	0.9969	2.15	64	-8.9536	56	3	153	669	468
90	35	4.95	0.9943	2.04	62	-8.4067	55	1	222	775	635
90	35	5.2	0.9915	2.07	98	-9.4950	86	1	283	1746	652
90	35	5.25	0.9974	2.13	79	-9.2844	70	5	213	1160	605
135	0	5.4	0.9982	1.92	56	-7.7199	49	2	183	718	540
135	33	8.4	0.9943	1.59	109	-7.4448	95	3	298	2920	318
135	35	5.2	0.9945	1.95	72	-8.3509	63	3	171	1087	550
135	35	5	0.9928	1.91	67	-8.0561	59	3	133	786	278
135	35	5.25	0.9921	1.62	57	-6.5265	49	0	127	772	434
180	11	4.4	0.9771	1.60	41	-5.9372	35	0	114	354	305
180	20	7.2	0.9939	1.58	71	-6.7295	63	1	211	1681	248
180	33	8.4	0.9804	1.69	103	-7.8502	88	2	198	1880	244
180	35	4.95	0.9785	2.11	71	-8.9931	62	0	152	827	457
180	35	5.2	0.9864	1.91	42	-7.1137	36	1	90	295	439
180	35	5.25	0.9920	1.79	45	-6.8102	39	2	88	387	265
225	3	5	0.9981	2.04	57	-8.2365	50	3	134	612	500
225	9	4.4	0.9965	1.93	53	-7.6727	47	2	121	550	502
225	20	7.2	0.9953	1.74	114	-8.2220	100	4	278	2946	350
225	35	4.95	0.9979	1.67	62	-6.9069	56	2	202	1236	376
270	9	4.4	0.9940	2.10	68	-8.8523	59	1	157	753	681
270	27	5	0.9991	2.27	62	-9.3792	55	4	141	652	649
270	33	8.4	0.9857	2.00	176	-10.3644	153	4	444	5008	450
270	33	8.4	0.9950	1.92	101	-8.8902	90	3	262	2571	338
270	35	5.25	0.9804	1.91	69	-8.0859	60	1	153	796	573
315	10	4.4	0.9918	2.18	60	-8.9419	53	1	149	592	648
315	27	5	0.9887	2.08	76	-8.9966	66	2	150	828	482
315	27	5	0.9952	2.21	72	-9.4582	63	2	165	809	1028
315	35	4.95	0.9984	2.46	58	-9.9667	51	4	117	509	572

Appendix B Global Response Weibull Analysis Results for Low Pass Filtered Data

Weibull Analysis Results for Pitch Connecting Moment Response Low Pass Min Response

Relative Heading	Speed	Sig Wave Height	Correlation	Slope	Characteristic Value (uin/in)	YIntercept	Mean (uin/in)	Min (uin/in)	Max (uin/in)	Variance $(uin/in)^2$	Size
135	0	5.4	0.9809	1.28	28	-4.2903	24	0	148	260	270
0	1	4.8	0.9222	1.31	30	-4.4350	24	0	57	155	261
0	1	5.1	0.9720	1.69	36	-6.0374	31	0	79	262	256
0	20	7.2	0.9314	1.38	43	-5.1847	35	0	96	352	308
180	20	7.2	0.9764	0.67	35	-2.3688	32	0	126	821	124
225	20	7.2	0.9880	1.05	55	-4.2189	49	0	161	1250	175
45	20	7.2	0.8960	1.14	47	-4.3939	36	0	109	342	315
90	20	7.2	0.9846	1.25	83	-5.5246	72	1	416	2398	248
0	2	7.2	0.9601	1.45	48	-5.6026	40	0	98	442	235
0	2	8.4	0.9601	1.45	48	-5.6026	40	0	98	442	235
30	32	8.4	0.9871	1.63	55	-6.5223	47	1	137	668	226
0	33	8.4	0.9883	1.69	44	-6.4316	39	1	98	411	265
0	33	8.4	0.9850	1.50	71	-6.3903	61	0	183	1254	445
0	33	8.4	0.9630	1.40	80	-6.1399	67	1	217	1318	281
135	33	8.4	0.9899	0.96	49	-3.7269	46	0	140	1371	159
180	33	8.4	0.9778	0.98	50	-3.8399	43	0	114	853	122
270	33	8.4	0.9892	1.22	87	-5.4345	76	1	220	2508	225
270	33	8.4	0.8747	1.04	61	-4.2961	46	0	135	688	169
45	33	8.4	0.9454	1.36	46	-5.1960	38	0	97	349	325
45	33	8.4	0.9848	1.67	38	-6.0534	33	1	108	316	238
0	35	4.95	0.9200	0.94	25	-3.0373	19	0	54	131	231
0	35	5.2	0.9645	1.55	25	-4.9725	21	0	47	103	323
135	35	5.2	0.9899	1.10	35	-3.9141	32	0	124	560	275
180	35	4.95	0.9852	1.28	37	-4.6474	32	0	90	394	229
180	35	5.2	0.9689	1.24	22	-3.8222	19	0	56	113	219
225	35	4.95	0.9939	0.96	29	-3.2565	28	0	110	556	188
315	35	4.95	0.9969	1.82	30	-6.1535	26	1	74	199	286
90	35	4.95	0.9877	1.10	29	-3.6939	26	0	97	377	317
90	35	5.2	0.9973	1.16	47	-4.4734	43	0	156	1090	326
0	3	5	0.9825	1.73	34	-6.0861	29	1	71	200	147
0	0	4.4	0.9791	1.52	30	-5.1369	25	0	70	186	351
90	0	5.2	0.9790	1.54	32	-5.3260	27	1	71	205	249
0	10	4.4	0.9748	1.29	26	-4.2115	22	0	67	168	281
315	10	4.4	0.9476	1.32	32	-4.5853	26	0	74	195	324
180	11	4.4	0.9813	1.11	21	-3.3572	18	0	66	138	153
315	27	5	0.9816	1.07	38	-3.9217	33	0	97	504	241
0	27	5	0.9939	1.42	40	-5.2285	35	0	123	487	425
270	27	5	0.9858	1.24	32	-4.2886	28	0	87	320	324
315	27	5	0.9906	1.28	36	-4.5701	31	0	93	404	514
45	27	5	0.9762	1.20	44	-4.5595	38	0	142	562	440
90	27	5	0.9870	1.12	31	-3.8534	28	0	119	381	234
135	35	5	0.9864	0.94	33	-3.2724	30	0	82	521	139
225	3	5	0.9920	1.64	29	-5.5256	25	1	75	185	250
90	3	4.8	0.9727	1.32	32	-4.5603	27	0	72	237	331
225	9	4.4	0.9708	1.17	28	-3.8945	24	0	63	198	251
270	9	4.4	0.9751	1.40	35	-4.9419	29	0	83	267	341
0	2	5.7	0.9060	1.09	28	-3.6470	22	0	51	137	203
0	35	5.25	0.9934	1.62	29	-5.4549	25	1	72	221	215
135	35	5.25	0.9922	1.05	27	-3.4381	25	0	81	366	217
180	35	5.25	0.9875	1.12	20	-3.3707	18	1	51	186	132
270	35	5.25	0.9637	1.20	35	-4.2523	29	0	82	314	286
45	35	5.25	0.9924	1.53	43	-5.7371	37	1	110	461	216
90	35	5.25	0.9979	1.19	36	-4.2797	33	0	135	645	302
0	2	4.8	0.9602	1.37	37	-4.9530	31	0	78	280	178

Appendix B Global Response Weibull Analysis Results for Low Pass Filtered Data

Weibull Analysis Results for Pitch Connecting Moment Response Low Pass Max Response

Relative Heading	Speed	Sig Wave Height	Correlation	Slope	Characteristic Value (uin/in)	YIntercept	Mean (uin/in)	Min (uin/in)	Max (uin/in)	Variance $(uin/in)^2$	Size
0	0	4.4	0.9628	1.37	30	-4.6758	25	0	79	194	351
0	1	4.8	0.9619	1.48	28	-4.9064	23	0	84	156	262
0	1	5.1	0.8544	0.99	42	-3.6790	30	0	91	296	256
0	2	4.8	0.9869	1.76	36	-6.3034	31	1	77	250	177
0	2	5.7	0.9785	1.39	25	-4.4796	21	0	57	143	203
0	2	7.2	0.9848	1.93	46	-7.3972	40	1	102	416	235
0	2	8.4	0.9848	1.93	46	-7.3972	40	1	102	416	235
0	3	5	0.9622	1.60	34	-5.6260	29	0	68	224	148
0	10	4.4	0.9804	1.46	26	-4.7639	22	0	64	151	282
0	20	7.2	0.9679	1.42	41	-5.2686	35	0	108	393	308
0	27	5	0.9856	1.32	41	-4.9301	36	0	114	481	425
0	33	8.4	0.9894	1.58	46	-6.0570	40	1	105	470	266
0	33	8.4	0.9561	1.25	72	-5.3419	60	0	338	1696	445
0	33	8.4	0.9843	1.55	78	-6.7490	67	1	219	1496	281
0	35	4.95	0.9888	1.28	20	-3.8504	18	0	52	127	232
0	35	5.2	0.9829	1.71	24	-5.4686	21	0	54	112	324
0	35	5.25	0.9789	1.30	30	-4.4316	26	0	63	216	216
30	32	8.4	0.9974	1.59	61	-6.5274	55	3	144	1126	227
45	20	7.2	0.9859	1.46	46	-5.5835	40	0	124	586	314
45	27	5	0.9939	1.38	42	-5.1593	37	0	127	558	440
45	33	8.4	0.9925	1.67	47	-6.4370	41	1	109	536	324
45	33	8.4	0.9521	1.19	41	-4.4184	34	0	87	346	239
45	35	5.25	0.9826	1.36	43	-5.0943	37	0	118	485	216
90	0	5.2	0.9453	1.27	33	-4.4294	27	0	67	195	249
90	3	4.8	0.9534	1.20	33	-4.1962	27	0	76	228	332
90	20	7.2	0.9898	1.55	82	-6.8305	71	1	248	1821	247
90	27	5	0.9886	1.01	31	-3.4871	28	0	97	454	234
90	35	4.95	0.9859	1.09	33	-3.8231	29	0	150	434	318
90	35	5.2	0.9970	1.13	46	-4.3311	43	0	159	1117	326
90	35	5.25	0.9934	1.22	40	-4.5285	36	0	119	617	303
135	0	5.4	0.9623	1.22	29	-4.1097	25	0	109	257	270
135	33	8.4	0.9836	0.92	54	-3.6813	49	0	179	1521	159
135	35	5	0.9936	1.08	30	-3.6686	28	0	97	546	139
135	35	5.2	0.9849	1.13	36	-4.0518	32	0	104	458	275
135	35	5.25	0.9829	0.97	28	-3.2085	25	0	91	361	217
180	11	4.4	0.9694	1.11	20	-3.3128	17	0	49	113	152
180	20	7.2	0.9958	0.90	32	-3.1069	31	0	138	834	124
180	33	8.4	0.9812	1.02	51	-4.0336	45	1	130	979	122
180	35	4.95	0.9871	1.20	34	-4.2472	30	0	95	393	228
180	35	5.2	0.9885	1.24	20	-3.7168	18	0	58	127	220
180	35	5.25	0.9862	1.00	23	-3.1442	21	0	67	225	133
225	3	5	0.9732	1.34	30	-4.5423	25	0	70	208	250
225	9	4.4	0.9806	1.26	27	-4.1522	23	0	65	204	251
225	20	7.2	0.9878	1.01	56	-4.0640	51	0	139	1429	175
225	35	4.95	0.9971	1.02	29	-3.4217	28	0	107	565	188
270	9	4.4	0.9809	1.60	35	-5.6875	30	0	86	242	340
270	27	5	0.9670	0.99	32	-3.4218	27	0	96	365	325
270	33	8.4	0.9941	1.29	86	-5.7275	76	1	236	2505	225
270	33	8.4	0.9983	1.67	49	-6.5191	44	3	134	753	169
270	35	5.25	0.9773	1.14	36	-4.0576	31	0	106	420	287
315	10	4.4	0.9634	1.47	32	-5.0892	27	0	75	196	324
315	27	5	0.9727	1.26	38	-4.5963	32	0	85	339	241
315	27	5	0.9751	1.24	38	-4.4978	32	0	98	380	514
315	35	4.95	0.9844	1.51	29	-5.1022	25	0	72	190	286

Appendix C Statistical summary by channel for Wave Impact Measurements

Weibull Analysis and Run Statistics in Head Seas for Tbar_4_Cntr_Bow_Fr57-58

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
3.0	10	0	OFF	0.9468	6.29	-35.7262	0	292	315	217	310	273	34	5	14.2
4.2	8.5	0	ON	0.9904	0.52	-1.9160	97	41	148	98	305	147	75	7	41.9
10.0	10	0	OFF	0.9927	1.40	-7.4425	86	204	540	98	548	269	122	49	100.2
10.0	10	0	OFF	0.9866	1.22	-6.5138	85	211	546	102	775	273	148	24	41.9
10.0	10	0	OFF	0.9885	1.38	-7.1418	94	174	428	107	601	252	120	32	67.4
10.0	10	0	OFF	0.9901	0.96	-4.9167	106	168	640	110	671	264	136	37	71.7
10.0		0	OFF	0.9922	1.16	-6.0750	114	189	545	123	776	287	144	30	60.5
10.0		0	OFF	0.9955	1.32	-6.8037	114	176	469	124	674	272	120	38	82.5
10.0		0	OFF	0.9952	2.16	-12.0423	43	263	467	96	566	274	108	32	64.1
11.0		0	OFF	0.9663	2.31	-12.6098	0	236	338	81	321	205	78	10	20
11.0		0	OFF	0.9633	0.65	-3.0484	86	111	183	97	237	174	73	4	8.4
11.0		0	OFF	0.9891	1.17	-5.7686	73	138	323	85	364	195	92	15	16.2
12.0	10	0	OFF	0.9941	1.06	-5.2548	83	143	539	85	660	221	132	59	116.1
14.0	10	0	OFF	0.9741	0.77	-3.7011	86	121	534	91	754	210	146	23	46.3
14.0	10	0	ON	0.9926	1.05	-5.1424	101	136	478	105	516	231	114	41	83.5
14.0	7.5	0	OFF							102	113	108	8	2	4
16.3	8.5	0	ON	0.9961	0.81	-4.2547	199	189	862	201	1200	395	223	31	186.6
16.3	8.5	0	ON	0.9886	0.86	-4.4800	195	185	574	203	761	372	173	14	99.6
16.3	8.5	0	ON	0.9923	0.66	-3.3849	217	165	906	219	1322	410	264	22	141.1
20.0	8.5	0	Locked	0.9803	0.76	-4.1718	202	234	1242	207	1038	430	203	36	242.7
20.0	8.5	0	Locked	0.9950	0.75	-3.9585	203	200	1180	206	1190	425	250	43	252.1
20.3	8.5	0	ON	0.9819	1.05	-5.9790	193	290	973	201	2341	482	377	36	142.9
20.3	8.5	0	ON	0.9839	1.05	-6.1275	177	339	1087	201	1138	486	245	30	193.9
20.3	8.5	0	ON	0.9892	0.99	-5.4908	215	257	974	220	1446	464	244	42	201.3
23.5	8.5	0	Locked	0.9948	1.00	-5.7198	198	302	1187	203	1158	488	263	51	231.2
24.8	8.5	0	ON	0.9916	0.83	-4.7038	88	283	1559	91	2139	381	346	63	328.2
30.0		0	ON	0.9866	0.64	-3.2384	125	153	518	130	503	270	138	9	18.9
30.0	7	0	ON							85	835	382	399	3	6
30.0	7	0	OFF							149	224	186	53	2	6.1
30.7	10	0	On/OFF	0.9720	0.51	-2.3714	86	106	495	87	331	189	97	9	31.3
31.0	7	0	OFF							137	230	196	51	3	5.1
33.0	6	0	OFF							104	490	250	210	3	17.4
7 - 30		0	ON/OFF	0.9868	0.84	-4.1870	85	143	622	88	554	221	120	32	64.8
	10	0	OFF							115	172	153	32	3	37.6
	10	0	On/OFF	0.9966	1.07	-5.4162	66	161	581	70	660	218	135	50	109.8
	10	0	OFF	0.9935	1.36	-7.0116	87	172	401	104	483	239	106	24	57.8

Note: Units of Strain Shown as micro-strain (uin/in)

Weibull Analysis and Run Statistics in Oblique Seas for Tbar_4_Cntr_Bow_Fr57-58

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
29.0	9	25	Locked	0.9923	0.71	-4.3749	203	459	2273	209	1888	688	517	23	144.5
29.5	N/A	30	ON	0.9894	0.82	-4.5939	89	277	1587	91	1045	365	261	64	329.1
29.5	N/A	30	ON	0.9930	0.67	-3.5497	91	199	1214	93	776	306	224	29	180.0
30.5	N/A	30	ON	0.9867	0.88	-4.8854	88	250	987	93	1211	342	275	29	174.6
31.1	N/A	30	ON							154	170	160	9	3	22.9
31.1	N/A	30	ON	0.9118	1.06	-4.4746	84	68	118	95	220	139	42	6	37.2
33.1	N/A	30	ON	0.9878	1.23	-6.5102	71	199	429	94	509	246	129	13	70.7
34.1	N/A	30	ON	0.9797	0.76	-3.8537	94	163	766	96	962	271	235	25	142.9
33.5	6	45	OFF	0.9908	0.71	-3.8941	92	249	703	105	889	328	257	8	47.4
12.0	10	315	OFF	0.9862	0.85	-3.7596	101	85	293	104	401	183	79	17	35
13.0	Dark	315	Off	0.9889	1.01	-4.5248	103	90	282	107	472	188	87	24	36.4
13.0	Dark	315	OFF	0.9675	3.14	-18.5933	0	376	475	203	440	334	91	8	15.7
13.0	Dark	315	OFF	0.9800	2.66	-15.5737	48	352	463	203	498	357	103	8	16.1
13.0	Dark	315	OFF	0.9622	1.03	-5.4459	173	196	488	201	714	348	153	13	25.3
14.0	Dark	315	Off	0.9888	0.86	-4.2146	114	136	537	117	1061	254	186	26	56.5
22.5	10	315	ON	0.9755	0.31	-1.5160	91	128	365	92	392	222	148	4	18.1
30.0	10	315	On/OFF	0.9884	1.10	-5.7765	53	193	498	66	588	229	154	17	34.2
32.0	Dark	315	Off/ON	0.9757	0.64	-2.8736	119	88	457	120	584	226	138	18	31.9
33.0	10	315	ON	0.9815	0.47	-2.2131	107	110	451	109	385	217	115	7	22.6
NA	10	315	OFF	0.9083	0.35	-0.9548	100	15	20	101	146	116	26	3	9.8
	Dark	315	Off	0.9724	0.65	-2.9284	100	89	339	104	300	183	73	11	88.8
	10	315	ON	0.9849	1.04	-5.5943	70	212	770	75	1373	284	258	47	169.7
12.0	10	NA	OFF							239	321	280	58	2	4.2
13.0	Dark	NA	OFF	0.9804	1.56	-7.7301	185	142	290	207	540	310	78	21	42.3
13.0	Dark	NA	OFF	0.9869	0.85	-4.4885	196	195	722	202	690	376	149	21	42.5
13.0	Dark	NA	OFF	0.9726	1.05	-5.7442	176	243	490	206	795	386	181	8	16.4
13.0	Dark	NA	OFF	0.9793	0.56	-2.4089	201	71	260	203	585	282	126	8	13.2
13.0	Dark	NA	OFF	0.9664	0.37	-1.7956	235	136	332	238	488	361	133	4	6
NA	10	NA	On/OFF	0.9725	0.75	-3.1791	98	71	231	101	354	165	72	11	24.6

Appendix C Statistical summary by channel for Wave Impact Measurements

Weibull Analysis and Run Statistics in Head Seas for Tbar10_Cntr_Bow_Fr57-58

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
4.2	8.5	0	ON							92	606	270	291	3	17.9
10.0	10	0	OFF	0.9887	1.75	-10.3351	41	367	780	86	944	364	197	42	85.9
10.0	10	0	OFF	0.9771	1.38	-8.3046	76	403	920	114	1531	432	284	23	40.2
10.0	10	0	OFF	0.9910	1.52	-8.9713	103	368	812	140	985	428	216	28	59
10.0	10	0	OFF	0.9911	1.22	-7.2871	77	397	1139	101	1203	430	248	37	71.7
10.0		0	OFF	0.9840	1.98	-11.9065	42	414	772	107	845	405	189	31	62.5
10.0		0	OFF	0.9860	1.76	-10.5715	88	412	841	151	1094	449	207	33	71.6
10.0		0	OFF	0.9921	1.57	-9.2899	64	369	809	102	763	388	194	31	62.1
11.0		0	OFF	0.9863	2.02	-11.9233	0	370	547	113	540	318	132	9	18
11.0		0	OFF							238	441	339	143	2	4.2
11.0		0	OFF	0.9836	1.99	-11.7737	0	371	603	86	601	321	146	14	15.1
12.0	10	0	OFF	0.9874	1.68	-9.9241	37	372	819	78	1127	364	202	43	84.6
14.0	10	0	OFF	0.9912	1.52	-8.3498	48	243	483	84	597	259	131	17	34.2
14.0	10	0	ON	0.9721	1.59	-9.0674	96	297	647	124	804	359	176	32	65.1
16.3	8.5	0	ON	0.9814	0.94	-5.6821	201	420	1544	211	1866	616	425	30	180.6
16.3	8.5	0	ON	0.9814	1.27	-7.6513	166	409	813	230	846	514	213	11	78.3
16.3	8.5	0	ON	0.9952	0.93	-5.5269	196	371	1199	210	1471	546	327	20	128.3
20.0	8.5	0	Locked	0.9882	1.07	-6.3726	190	379	1216	205	1065	530	244	33	222.5
20.0	8.5	0	Locked	0.9957	1.00	-5.8947	201	359	1323	213	1470	542	305	40	234.5
20.3	8.5	0	ON	0.9926	0.85	-5.1429	200	428	1943	208	2322	628	467	37	146.9
20.3	8.5	0	ON	0.9932	1.37	-8.6462	152	540	1286	208	1467	627	313	27	174.5
20.3	8.5	0	ON	0.9933	1.37	-8.5019	179	493	1257	219	1308	619	306	37	177.4
23.5	8.5	0	Locked	0.9916	0.93	-5.5101	208	379	1622	214	2084	592	409	47	213.1
24.8	8.5	0	ON	0.9914	1.06	-6.7771	73	609	2080	98	3252	649	574	39	203.2
30.0		0	ON	0.9649	0.47	-2.4416	87	186	649	90	1182	325	423	6	12.6
30.7	10	0	On/OFF	0.9714	1.49	-8.8228	73	367	457	209	506	375	144	4	13.9
31.0	7	0	OFF							102	106	104	2	2	3.4
33.0	6	0	OFF							185	438	311	179	2	11.6
7 - 30		0	ON/OFF	0.9872	1.63	-9.9475	16	447	885	90	759	402	204	21	42.5
	10	0	OFF							164	242	203	56	2	25.1
	10	0	On/OFF	0.9880	1.56	-8.8100	57	285	654	80	751	310	170	39	85.7
	10	0	OFF	0.9842	1.69	-9.6247	108	301	610	146	975	373	171	27	65

Appendix C Statistical summary by channel for Wave Impact Measurements

Weibull Analysis and Run Statistics in Oblique Seas for Tbar10_Cntr_Bow_Fr57-58

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
29.0	9	25	Locked	0.9922	0.69	-4.2240	211	455	2383	215	2088	708	551	23	144.5
29.5	N/A	30	ON	0.9893	1.00	-6.6741	78	777	2707	98	2862	834	753	33	169.7
29.5	N/A	30	ON	0.9948	1.09	-7.0623	135	645	1642	186	1709	711	448	16	99.3
30.5	N/A	30	ON	0.9901	1.21	-7.9740	63	721	1732	122	1999	711	517	18	108.4
33.1	N/A	30	ON	0.9655	1.28	-7.8756	0	479	756	99	619	392	210	6	32.6
34.1	N/A	30	ON	0.9817	0.47	-2.4911	100	191	1306	101	1415	394	456	12	68.6
33.5	6	45	OFF							664	1330	919	360	3	17.8
12.0	10	315	OFF	0.9844	0.93	-4.5167	153	130	345	165	484	270	100	12	24.7
13.0	Dark	315	Off	0.9900	1.57	-8.1619	95	184	384	126	470	255	93	24	36.4
13.0	Dark	315	OFF	0.9834	1.48	-9.3061	95	527	825	233	830	539	236	7	13.7
13.0	Dark	315	OFF	0.9862	0.58	-2.8968	233	152	739	236	739	394	177	12	24.2
13.0	Dark	315	OFF	0.9730	1.38	-7.9934	163	326	659	211	741	443	167	14	27.2
14.0	Dark	315	Off	0.9970	1.66	-9.5880	68	323	632	117	750	350	161	21	45.6
22.5	10	315	ON							252	373	313	86	2	9.1
30.0	10	315	On/OFF	0.9731	0.68	-3.4571	91	157	595	95	417	234	120	12	24.1
32.0	Dark	315	Off/ON	0.9662	0.81	-4.2420	105	190	533	121	447	271	131	10	17.7
33.0	10	315	ON	0.9921	0.76	-3.5345	78	104	194	89	323	168	92	5	16.2
NA	10	315	OFF							219	305	262	61	2	6.6
	Dark	315	Off	0.9199	1.82	-10.1978	126	275	425	201	638	359	118	9	72.6
	10	315	ON	0.9753	0.93	-5.5140	127	375	1398	135	2579	522	543	30	108.3
12.0	10	NA	OFF							273	443	358	120	2	4.2
13.0	Dark	NA	OFF	0.9904	1.11	-6.0291	189	223	631	204	920	391	168	24	48.3
13.0	Dark	NA	OFF	0.9914	0.96	-5.3936	200	281	1010	208	1635	475	296	30	60.6
13.0	Dark	NA	OFF	0.9884	0.98	-5.5467	181	286	697	210	846	435	211	11	22.5
13.0	Dark	NA	OFF	0.9313	0.82	-3.9537	202	123	341	208	611	316	130	10	16.5
13.0	Dark	NA	OFF	0.9817	0.60	-3.1731	203	203	541	212	650	393	201	6	9
NA	10	NA	On/OFF	0.9870	1.08	-4.3602	208	57	106	217	316	257	37	7	15.7

Appendix C Statistical summary by channel for Wave Impact Measurements

Weibull Analysis and Run Statistics in Head Seas for Tbar_16_Cntr_Bow_Fr57-58

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
10.0	10	0	OFF	0.9632	1.69	-9.9601	41	358	779	75	1170	357	221	42	85.9
10.0	10	0	OFF	0.9927	1.32	-8.1186	171	479	1103	218	1156	592	288	20	34.9
10.0	10	0	OFF	0.9925	1.25	-7.8585	79	539	1374	115	1502	566	387	25	52.7
10.0	10	0	OFF	0.9889	1.22	-7.7517	114	590	1528	171	1870	640	397	24	46.5
10.0		0	OFF	0.9935	1.10	-6.7163	234	442	1290	256	1452	640	341	26	52.4
10.0		0	OFF	0.9881	1.69	-10.8718	69	611	1236	155	1413	605	315	27	58.6
10.0		0	OFF	0.9887	1.21	-7.5817	122	540	1453	163	1236	596	313	27	54
11.0		0	OFF	0.9862	1.00	-5.7573	250	317	567	297	946	519	229	6	12
11.0		0	OFF							119	740	330	355	3	6.3
11.0		0	OFF	0.9875	1.98	-12.4648	0	547	834	155	786	470	196	10	10.8
12.0	10	0	OFF	0.9956	1.34	-7.8706	80	350	915	102	1264	395	236	38	74.8
14.0	10	0	OFF	0.9743	1.13	-6.2929	56	263	588	87	729	284	177	12	24.2
14.0	10	0	ON	0.9820	1.90	-11.7533	0	491	909	69	1091	427	223	25	50.9
16.3	8.5	0	ON	0.9871	1.11	-7.2787	182	725	2132	214	3398	862	675	27	162.5
16.3	8.5	0	ON	0.9914	1.06	-6.3856	227	411	937	267	1176	592	300	11	78.3
16.3	8.5	0	ON	0.9648	1.08	-6.9311	155	628	1507	208	1603	711	461	13	83.4
20.0	8.5	0	Locked	0.9876	1.50	-9.2814	154	495	1081	212	1034	584	245	25	168.5
20.0	8.5	0	Locked	0.9907	1.27	-7.6910	204	418	1115	228	1752	582	304	33	193.5
20.3	8.5	0	ON	0.9881	0.89	-5.5377	243	497	1759	262	1496	703	386	22	87.3
20.3	8.5	0	ON	0.9874	0.82	-4.9092	211	401	1698	222	1324	595	343	26	168.0
20.3	8.5	0	ON	0.9902	1.40	-8.7337	161	522	1272	221	1510	620	294	32	153.4
23.5	8.5	0	Locked	0.9806	0.83	-5.2008	210	512	2199	222	3569	762	717	29	131.5
24.8	8.5	0	ON	0.9941	1.20	-8.0481	65	811	2315	103	2483	809	613	34	177.1
30.7	10	0	On/OFF							227	523	387	150	3	10.4
33.0	6	0	OFF							424	548	474	65	3	17.4
		0	ON/OFF	0.9910	1.61	-9.8041	52	448	845	134	823	439	211	16	32.4
	10	0	On/OFF	0.9731	1.46	-8.1908	75	273	637	99	1079	319	193	31	68.1
	10	0	OFF	0.9950	1.04	-6.1823	132	392	1199	153	1119	489	287	24	57.8

Weibull Analysis and Run Statistics in Oblique Seas for Tbar_16_Cntr_Bow_Fr57_58

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
29.0	9	25	Locked	0.9952	0.98	-6.6315	238	853	2226	305	2630	1008	657	13	81.7
29.5	N/A	30	ON	0.9872	0.74	-5.0360	93	890	4573	103	3184	966	819	29	149.1
29.5	N/A	30	ON	0.9276	1.32	-9.1947	0	1054	2099	134	1317	854	387	12	74.5
30.5	N/A	30	ON	0.9886	0.83	-5.2198	116	535	1827	134	1550	620	447	16	96.3
33.1	N/A	30	ON	0.9767	0.37	-2.1882	92	381	925	99	891	450	389	4	21.8
34.1	N/A	30	ON							146	1768	935	812	3	17.1
33.5	6	45	OFF							1014	2710	1708	889	3	17.8
12.0	10	315	OFF	0.9795	0.87	-4.5451	138	188	368	160	495	296	127	6	12.3
13.0	Dark	315	Off	0.9740	1.16	-6.5100	87	270	671	116	848	328	198	18	27.3
13.0	Dark	315	OFF	0.9627	0.51	-2.7626	365	216	671	370	954	581	260	6	11.8
13.0	Dark	315	OFF	0.9842	0.72	-4.1755	188	342	1028	202	1435	529	405	9	18.1
13.0	Dark	315	OFF	0.9689	1.28	-7.4070	163	326	680	202	935	448	215	13	25.3
14.0	Dark	315	Off	0.9853	1.06	-5.5876	139	193	525	150	956	317	182	18	39.1
30.0	10	315	On/OFF							78	289	155	116	3	6
32.0	Dark	315	Off/ON							129	605	380	239	3	5.3
NA	10	315	OFF							156	346	251	134	2	6.6
	Dark	315	Off	0.9708	0.85	-4.9365	100	336	796	142	931	399	275	8	64.6
	10	315	ON	0.9942	1.18	-7.4052	52	523	1391	91	1629	527	389	24	86.7
13.0	Dark	NA	OFF	0.9717	1.40	-8.6787	100	486	1036	200	1266	524	283	18	36.2
13.0	Dark	NA	OFF	0.9836	1.26	-7.5578	158	408	1024	210	993	518	246	24	48.5
13.0	Dark	NA	OFF	0.9796	0.81	-4.8032	179	372	846	223	1045	508	300	7	14.3
13.0	Dark	NA	OFF	0.9919	0.65	-3.3678	214	183	381	227	675	377	178	5	8.2
13.0	Dark	NA	OFF	0.9830	0.85	-4.6172	190	230	582	208	701	393	171	9	13.5
NA	10	NA	On/OFF	0.9809	1.77	-10.2410	0	324	424	121	454	274	123	5	11.2

Appendix C Statistical summary by channel for Wave Impact Measurements

Weibull Analysis and Run Statistics in Head Seas for Tbar4 _Stbd_Void-1_Fr57-58

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
10.0	10	0	OFF	0.9908	0.95	-5.4225	97	298	1199	107	1267	382	264	43	88
10.0	10	0	OFF	0.9930	0.94	-5.5893	130	389	1094	152	1054	482	290	14	24.5
10.0	10	0	OFF	0.9866	0.81	-4.6368	127	302	1116	135	939	421	281	18	37.9
10.0	10	0	OFF	0.9695	1.93	-12.5995	0	688	1168	166	1127	592	262	16	31
10.0		0	OFF	0.9917	0.85	-5.0148	210	361	1282	220	1738	567	393	19	38.3
10.0		0	OFF	0.9842	0.92	-5.7818	184	521	1570	210	1445	657	389	16	34.7
10.0		0	OFF	0.9754	1.24	-7.9685	48	616	1512	137	1519	589	374	21	42
11.0		0	OFF	0.9583	0.28	-1.4312	144	165	527	146	1682	542	760	4	8
11.0		0	OFF	1.0000	0.40	-2.1411	242	223	283	252	751	444	268	3	6.3
11.0		0	OFF	0.9835	0.47	-2.3267	101	140	383	105	397	233	140	5	5.4
12.0	10	0	OFF	0.9906	1.25	-7.6793	94	472	1338	115	1450	527	346	39	76.8
14.0	10	0	OFF	0.9865	0.76	-4.6175	72	425	1399	89	1038	465	345	12	24.2
14.0	10	0	ON	0.9817	1.29	-8.4947	38	726	1832	85	3098	701	603	27	55
14.0	7.5	0	OFF	1.0000	2.16	-11.1494	0	176	148	116	184	150	48	2	4
16.3	8.5	0	ON	0.9850	1.23	-8.5632	135	1038	2755	220	3320	1063	735	28	168.6
16.3	8.5	0	ON	0.9780	0.69	-4.4404	221	642	2638	233	3678	944	1019	14	99.6
16.3	8.5	0	ON	0.9841	0.68	-4.6268	212	934	4071	236	3019	1132	896	15	96.2
20.0	8.5	0	Locked	0.9912	1.58	-10.8985	93	969	2042	248	2111	941	505	26	175.3
20.0	8.5	0	Locked	0.9930	1.03	-6.7381	223	705	2527	247	3434	888	634	41	240.4
20.3	8.5	0	ON	0.9927	1.11	-7.5147	174	847	2416	220	2718	947	652	25	99.2
20.3	8.5	0	ON	0.9828	0.85	-5.5510	205	705	2922	217	4428	942	889	28	181.0
20.3	8.5	0	ON	0.9908	1.81	-12.8248	77	1182	2359	290	2494	1112	555	33	158.2
23.5	8.5	0	Locked	0.9891	0.86	-5.9763	180	1010	4259	204	5484	1197	1142	32	145.1
24.8	8.5	0	ON	0.9970	0.66	-4.4674	91	908	6708	94	5292	1133	1215	41	213.6
30.0		0	ON	1.0000	1.36	-7.6731	0	280	214	144	300	222	110	2	4.2
33.0	6	0	OFF	1.0000	0.37	-2.7591	0	1797	664	155	2320	1238	1531	2	11.6
7 - 30		0	ON/OFF	0.9867	1.45	-9.4906	5	704	1376	124	1375	610	356	14	28.3
	10	0	OFF	1.0000	1.76	-11.2482	0	600	487	359	633	496	194	2	25.1
	10	0	On/OFF	0.9832	1.01	-6.1253	88	419	1387	101	1460	488	374	29	63.7
	10	0	OFF	0.9944	0.90	-5.4761	49	446	1390	68	1302	470	393	16	38.5

Weibull Analysis and Run Statistics in Oblique Seas for Tbar4 _Stbd_Void-1_Fr57-58

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
29.0	9	25	Locked	0.9898	1.08	-7.7295	170	1288	3313	261	4235	1339	1030	16	100.5
29.5	N/A	30	ON	0.9868	1.49	-10.8740	0	1463	3228	193	2473	1268	724	26	133.7
29.5	N/A	30	ON	0.9878	1.12	-7.6246	14	926	2153	129	1852	822	569	13	80.7
30.5	N/A	30	ON	0.9745	0.93	-6.5150	61	1092	3096	174	2749	1045	817	14	84.3
33.1	N/A	30	ON	0.9238	0.26	-1.4391	223	248	865	225	883	520	344	4	21.8
34.1	N/A	30	ON	0.9843	0.56	-4.1092	143	1541	2761	247	3989	1519	1682	4	22.9
33.5	6	45	OFF	1.0000	0.87	-5.9813	481	953	1061	709	1867	1228	588	3	17.8
12.0	10	315	OFF	0.9530	1.25	-8.2378	0	741	1085	194	907	600	317	5	10.3
13.0	Dark	315	Off	0.9425	1.94	-11.8526	0	445	733	107	581	377	141	14	21.2
13.0	Dark	315	OFF	0.9935	0.57	-3.1117	339	233	749	346	1183	580	300	7	13.7
13.0	Dark	315	OFF	0.9952	1.22	-7.8167	113	602	1192	203	1270	632	357	10	20.1
13.0	Dark	315	OFF	0.9856	0.54	-3.1614	212	349	1885	216	1309	587	406	12	23.4
14.0	Dark	315	Off	0.9779	0.88	-5.0097	151	295	1007	160	1396	450	354	19	41.3
30.0	10	315	On/OFF	0.9410	0.36	-1.3318	108	40	100	109	191	147	44	4	8
32.0	Dark	315	Off/ON	0.9458	1.14	-7.4282	0	676	900	166	768	530	270	4	7.1
NA	10	315	OFF	1.0000	0.68	-4.2231	0	499	291	132	573	353	312	2	6.6
	Dark	315	Off	0.9941	1.37	-8.2205	129	406	661	226	784	473	203	7	56.5
	10	315	ON	0.9928	1.33	-8.4537	58	589	1409	115	1306	580	362	24	86.7
13.0	Dark	NA	OFF	0.9863	0.62	-3.7930	212	436	2153	218	1572	647	417	15	30.2
13.0	Dark	NA	OFF	0.9904	0.88	-5.2415	202	387	1165	221	1186	557	309	14	28.3
13.0	Dark	NA	OFF	0.9894	1.68	-10.6411	52	562	746	253	880	526	233	5	10.2
13.0	Dark	NA	OFF	0.9815	0.79	-4.5135	186	302	631	215	782	445	223	6	9.9
13.0	Dark	NA	OFF	0.9951	0.59	-3.5312	320	404	1088	337	1469	713	447	6	9
NA	10	NA	On/OFF	0.9233	1.62	-9.7296	0	399	488	150	419	327	124	4	8.9

Appendix C Statistical summary by channel for Wave Impact Measurements

Weibull Analysis and Run Statistics in Head Seas for Tbar10 _Stbd_Void-1_Fr57-58

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
10.0	10	0	OFF	0.9959	1.13	-6.5247	58	322	1097	69	1337	360	265	54	110.4
10.0	10	0	OFF	0.9844	0.60	-3.3837	99	269	1275	105	971	376	290	13	22.7
10.0	10	0	OFF	0.9927	0.80	-4.3605	97	237	825	105	731	323	210	15	31.6
10.0	10	0	OFF	0.9905	1.03	-5.9764	126	331	910	149	842	420	222	17	32.9
10.0		0	OFF	0.9874	0.89	-5.4234	97	431	1380	118	1222	499	361	17	34.3
10.0		0	OFF	0.9847	1.41	-8.6101	32	443	881	94	1100	418	266	14	30.4
10.0		0	OFF	0.9782	0.92	-5.3307	148	333	1037	163	793	444	221	17	34
11.0		0	OFF	1.0000	0.69	-4.1005	0	377	222	102	432	267	233	2	4
11.0		0	OFF	1.0000	0.56	-2.7207	279	131	156	293	515	385	116	3	6.3
11.0		0	OFF	1.0000	5.17	-28.8011	0	263	245	221	268	244	33	2	2.2
12.0	10	0	OFF	0.9955	1.72	-10.8335	19	542	1147	82	1225	496	278	38	74.8
14.0	10	0	OFF	0.9844	0.75	-4.4422	73	386	1310	89	1033	429	315	12	24.2
14.0	10	0	ON	0.9873	0.89	-5.5281	78	488	1942	89	1925	566	514	31	63.1
14.0	7.5	0	OFF	1.0000	6.05	-38.0507	0	540	509	465	549	507	59	2	4
16.3	8.5	0	ON	0.9950	1.26	-8.5817	158	908	2399	217	2223	971	590	30	180.6
16.3	8.5	0	ON	0.9924	0.61	-3.7681	273	491	2424	280	2437	816	645	14	99.6
16.3	8.5	0	ON	0.9966	0.73	-4.5152	211	497	2248	218	1985	734	573	20	128.3
20.0	8.5	0	Locked	0.9918	1.00	-6.4929	222	647	2391	237	2195	841	576	41	276.4
20.0	8.5	0	Locked	0.9945	1.41	-9.2984	180	716	1886	221	2235	824	461	51	299.0
20.3	8.5	0	ON	0.9928	1.02	-6.8606	188	852	2968	213	3366	1002	760	35	138.9
20.3	8.5	0	ON	0.9893	1.12	-7.1951	172	634	1949	212	2225	758	508	33	213.3
20.3	8.5	0	ON	0.9939	1.25	-8.3691	162	791	2284	200	2761	882	561	44	210.9
23.5	8.5	0	Locked	0.9935	0.73	-4.6895	197	591	3955	202	3990	858	817	57	258.4
24.8	8.5	0	ON	0.9904	0.69	-4.6123	108	793	5874	112	5177	948	955	54	281.3
30.0		0	ON	0.9780	0.93	-5.6073	86	429	946	134	823	449	260	8	16.8
30.0	7	0	ON	1.0000	2.68	-14.3464	0	209	183	150	217	183	48	2	4
30.0	7	0	OFF	1.0000	1.00	-6.0649	0	421	292	171	462	317	206	2	6.1
30.7	10	0	On/OFF	0.9798	0.48	-2.6321	153	248	843	158	747	397	257	6	20.8
31.0	7	0	OFF	1.0000	1.00	-5.8758	228	347	381	329	709	502	192	3	5.1
33.0	6	0	OFF	0.9991	0.48	-2.9214	325	416	817	344	1487	726	522	4	23.2
7 - 30		0	ON/OFF	0.9839	0.85	-5.3552	93	531	2091	110	1477	585	404	25	50.6
	10	0	OFF	0.9547	0.63	-4.0219	0	605	703	78	728	437	330	3	37.6
	10	0	On/OFF	0.9502	1.55	-9.1615	37	364	819	67	1328	361	248	34	74.7
	10	0	OFF	0.9900	0.55	-3.1320	71	287	1577	74	1981	426	529	13	31.3

Weibull Analysis and Run Statistics in Oblique Seas for Tbar10 _Stbd_Void-1_Fr57-58

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
29.0	9	25	Locked	0.9737	1.60	-11.2391	10	1130	2365	206	3181	1002	652	26	163.4
29.5	N/A	30	ON	0.9917	0.77	-5.0075	97	668	3849	102	3282	770	669	47	241.7
29.5	N/A	30	ON	0.9799	1.22	-8.0615	0	752	1769	100	1318	650	415	17	105.5
30.5	N/A	30	ON	0.9939	0.97	-6.3039	70	652	2196	96	1819	675	502	26	156.5
33.1	N/A	30	ON	0.9671	0.65	-4.0787	109	554	1553	133	1244	610	478	7	38.1
34.1	N/A	30	ON	0.9899	0.67	-4.4626	77	811	2834	99	4372	954	1265	10	57.1
33.5	6	45	OFF	0.9848	0.37	-2.3057	102	490	2929	104	1891	688	687	7	41.4
12.0	10	315	OFF	0.9816	0.41	-1.9442	129	115	584	131	1022	310	321	7	14.4
13.0	Dark	315	Off	0.9927	1.23	-7.2650	122	372	782	171	905	446	229	12	18.2
13.0	Dark	315	OFF	0.9931	0.70	-4.2338	171	435	861	209	1260	557	416	5	9.8
13.0	Dark	315	OFF	0.9603	0.96	-5.9110	175	463	1100	213	1262	586	375	10	20.1
13.0	Dark	315	OFF	0.9896	0.73	-4.1777	192	304	1104	202	1279	497	336	13	25.3
14.0	Dark	315	Off	0.9840	1.21	-7.0171	89	333	802	120	1146	387	249	18	39.1
22.5	10	315	ON	0.9738	0.66	-3.9987	134	421	1152	153	1612	548	520	7	31.7
30.0	10	315	On/OFF	0.9913	1.06	-6.2296	68	364	935	95	849	392	254	15	30.2
32.0	Dark	315	Off/ON	0.9820	0.45	-2.4928	122	270	2084	123	1434	509	504	12	21.3
33.0	10	315	ON	0.9810	1.19	-7.4285	0	503	878	95	723	419	254	7	22.6
NA	10	315	OFF	1.0000	0.33	-1.2648	106	44	58	107	223	150	64	3	9.8
	Dark	315	Off	0.9936	1.31	-7.1849	48	238	394	101	431	248	123	7	56.5
	10	315	ON	0.9835	0.97	-6.0459	50	514	1674	81	1354	517	366	23	83
13.0	Dark	NA	OFF	0.9773	0.90	-5.6998	170	549	1504	205	1339	654	377	12	24.2
13.0	Dark	NA	OFF	0.9858	1.13	-6.7545	227	397	831	274	1200	575	280	10	20.2
13.0	Dark	NA	OFF	0.9970	0.55	-3.1668	191	324	939	202	1248	515	392	6	12.3
13.0	Dark	NA	OFF	0.9696	0.39	-2.0733	233	196	864	236	859	460	261	6	9.9
13.0	Dark	NA	OFF	0.9907	0.69	-3.6963	272	216	503	286	836	467	203	6	9
NA	10	NA	On/OFF	0.9638	0.49	-1.7518	206	35	69	209	270	237	31	4	8.9

Appendix C Statistical summary by channel for Wave Impact Measurements

Weibull Analysis and Run Statistics in Head Seas for Tbar15_Stbd_Void-1_Fr57-58

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
10.0	10	0	OFF	0.9868	1.29	-8.2476	62	593	1748	91	3083	610	490	57	116.6
10.0	10	0	OFF	0.9886	0.57	-3.2843	112	324	1951	116	1782	513	546	16	28
10.0	10	0	OFF	0.9927	0.81	-4.7979	135	386	1474	144	1299	517	387	19	40
10.0	10	0	OFF	0.9862	0.83	-5.1065	108	456	1765	124	1343	538	381	22	42.6
10.0		0	OFF	0.9919	0.92	-5.8913	72	598	2002	92	2730	659	647	21	42.3
10.0		0	OFF	0.9783	0.96	-6.1675	76	604	1853	101	2151	651	575	19	41.2
10.0		0	OFF	0.9881	1.01	-6.7961	71	816	2519	116	1862	804	556	23	46
11.0		0	OFF	0.9334	1.57	-9.3834	0	392	599	97	616	325	157	7	14
11.0		0	OFF	1.0000	0.38	-2.2586	376	411	529	390	1357	760	523	3	6.3
11.0		0	OFF	0.9993	0.55	-3.1740	129	317	573	149	902	414	339	4	4.3
12.0	10	0	OFF	0.9914	1.29	-8.5615	32	780	2225	72	2481	741	545	47	92.5
14.0	10	0	OFF	0.9618	1.07	-7.4148	0	1011	2436	120	1606	854	535	13	26.2
14.0	10	0	ON	0.9857	0.73	-4.7224	86	667	4097	91	3000	751	633	42	85.5
14.0	7.5	0	OFF	0.9707	1.23	-8.4519	0	981	1059	342	1122	776	397	3	6.1
16.3	8.5	0	ON	0.9943	0.82	-5.9338	191	1387	6757	210	5604	1564	1334	39	234.8
16.3	8.5	0	ON	0.9900	0.81	-5.5073	261	878	3582	283	5530	1154	1112	23	163.6
16.3	8.5	0	ON	0.9956	0.60	-3.8185	202	592	4872	204	5361	971	1106	34	218.1
20.0	8.5	0	Locked	0.9932	1.09	-7.6149	201	1075	3719	230	3654	1216	900	48	323.6
20.0	8.5	0	Locked	0.9945	0.86	-5.9042	211	950	4970	221	5866	1218	1238	64	375.2
20.3	8.5	0	ON	0.9942	0.71	-5.0346	195	1157	8190	200	7577	1445	1402	57	226.2
20.3	8.5	0	ON	0.9921	1.09	-7.5475	166	1026	3483	213	3680	1117	810	44	284.4
20.3	8.5	0	ON	0.9914	1.10	-7.8676	147	1238	4434	206	4306	1294	942	60	287.6
23.5	8.5	0	Locked	0.9931	1.00	-6.9970	177	1081	4781	201	5684	1233	1065	84	380.9
24.8	8.5	0	ON	0.9965	0.78	-5.3951	89	967	6491	93	4826	1143	1174	86	448.0
30.0		0	ON	0.9884	0.84	-5.5188	271	695	3478	277	5889	1061	1160	49	102.7
30.0	7	0	ON	0.9903	0.84	-5.5380	341	717	2996	356	4490	1085	911	28	56.2
30.0	7	0	OFF	0.9796	0.45	-3.2530	242	1400	5131	264	5248	1857	2127	6	18.3
30.0	6	0	OFF	0.9742	0.81	-5.3145	300	690	1924	357	2184	920	560	10	26.7
30.7	10	0	On/OFF	0.9788	1.55	-10.3775	0	794	1483	123	1572	684	406	14	48.6
31.0	7	0	OFF	0.9916	0.56	-3.4322	311	436	2854	314	3142	885	781	18	30.8
31.0	7	0	ON	1.0000	2.75	-19.9438	0	1413	1237	1018	1462	1240	314	2	5.5
31.0	6	0	OFF	0.9914	1.94	-13.8322	0	1257	1834	426	1739	1079	469	8	23.5
31.0		0	ON	0.9843	0.52	-3.3570	363	675	3682	368	7186	1365	1978	11	34.4
33.0	6	0	OFF	0.9758	1.61	-10.6749	43	773	1332	236	1347	704	365	11	63.7
7 - 30		0	ON/OFF	0.9815	0.96	-6.6348	120	1038	4181	136	5774	1202	1357	44	89
	10	0	OFF	0.9635	0.56	-3.7365	35	754	1345	87	1110	638	540	4	50.2
	10	0	On/OFF	0.9930	1.34	-8.6180	34	636	1664	72	1599	604	411	37	81.3
	10	0	OFF	0.9836	0.71	-4.1178	75	320	1374	80	1685	434	485	17	40.9

Appendix C Statistical summary by channel for Wave Impact Measurements

Weibull Analysis and Run Statistics in Oblique Seas for Tbar15_Stbd_Void-1_Fr57-58

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
29.0	9	25	Locked	0.9950	0.83	-5.8764	206	1188	6585	215	6898	1418	1295	63	395.8
29.5	N/A	30	ON	0.9968	0.76	-5.4258	86	1211	7578	92	6883	1360	1350	58	298.3
29.5	N/A	30	ON	0.9897	0.93	-6.2874	98	890	3441	129	2637	931	706	33	204.8
30.5	N/A	30	ON	0.9878	0.96	-6.7607	96	1107	4579	118	3914	1128	872	51	307.0
31.1	N/A	30	ON	0.9498	1.27	-8.3275	0	713	923	206	916	571	290	4	30.5
31.1	N/A	30	ON	0.9789	0.99	-6.4957	0	700	1261	104	1347	586	450	6	37.2
33.1	N/A	30	ON	0.9859	1.06	-7.4442	0	1103	2750	107	2617	972	758	14	76.1
34.1	N/A	30	ON	0.9921	0.80	-5.4736	96	945	4146	116	4576	1057	1078	26	148.6
31.9	N/A	45	ON							406	543	474	97	2	18.0
33.5	6	45	OFF	0.9658	0.77	-5.3527	334	1047	3694	363	7674	1489	1862	14	82.9
35.0	5.5	90	OFF	0.9961	0.73	-4.1579	199	298	663	223	857	462	243	6	12.6
37.0	6	180	ON	1.0000	1.28	-7.4254	0	328	246	162	353	257	135	2	10.1
12.0	10	315	OFF	0.9413	0.52	-2.7961	120	217	1248	121	2506	450	670	12	24.7
13.0	Dark	315	Off	0.9852	0.99	-6.2240	81	551	1551	110	2289	602	548	16	24.3
13.0	Dark	315	OFF	0.9896	0.45	-2.7104	271	390	2447	274	1991	765	604	10	19.6
13.0	Dark	315	OFF	0.9824	0.84	-5.4460	204	655	2012	238	2545	834	687	13	26.2
13.0	Dark	315	OFF	0.9842	0.78	-4.5274	195	322	1333	201	1460	535	399	21	40.9
14.0	Dark	315	Off	0.9905	0.86	-5.0210	96	353	1386	103	1598	452	390	25	54.3
22.5	10	315	ON	0.9862	0.67	-4.5681	292	915	4330	311	3021	1208	899	17	77.1
30.0	10	315	On/OFF	0.9803	1.21	-8.0862	160	801	2569	180	4843	928	796	60	120.6
32.0	Dark	315	Off/ON	0.9792	1.26	-8.4755	91	825	2615	124	4009	869	760	73	129.5
33.0	6	315	Off	1.0000	1.00	-6.3496	0	559	388	228	614	421	274	2	4.5
33.0	10	315	ON	0.9964	0.85	-6.0917	303	1345	5847	326	5869	1639	1317	32	103.5
35.0	6	315	ON	0.9752	0.31	-1.7854	264	315	903	267	1025	593	374	4	14.7
NA	10	315	OFF	0.9809	0.30	-1.4069	129	102	299	130	748	303	299	4	13.1
	Dark	315	Off	0.9930	0.89	-4.9279	84	254	537	112	672	304	192	7	56.5
	10	315	ON	0.9900	1.06	-7.0427	63	772	2379	98	2189	767	563	27	97.5
12.0	10	NA	OFF	0.9994	0.35	-1.4737	199	70	92	201	388	270	102	3	6.4
13.0	Dark	NA	OFF	0.9901	0.69	-4.2679	210	505	2306	219	1989	731	568	17	34.2
13.0	Dark	NA	OFF	0.9763	0.76	-4.6749	207	483	2147	215	3178	737	708	22	44.5
13.0	Dark	NA	OFF	0.9742	0.51	-3.2169	192	540	2259	201	1533	732	545	8	16.4
13.0	Dark	NA	OFF	0.9811	0.82	-4.7988	203	360	1002	223	1030	531	294	10	16.5
13.0	Dark	NA	OFF	0.9900	0.65	-3.8443	198	368	1412	206	2027	604	542	11	16.5
NA	10	NA	On/OFF	0.9728	1.16	-7.0957	37	452	848	105	1084	425	305	8	17.9

Weibull Analysis and Run Statistics in Head Seas for Tbar4_Cntr_Bow_Fr65

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
4.2	8.5	0	ON	0.9837	0.77	-2.9234	118	45	95	122	208	157	36	6	35.9
10.0	10	0	OFF	0.9951	1.91	-11.0269	106	326	718	132	966	395	165	90	184.1
10.0	10	0	OFF							228	311	270	58	2	987.9
10.0	10	0	OFF	0.9841	1.28	-7.0348	120	243	633	139	1010	339	179	30	52.4
10.0	10	0	OFF	0.9923	1.05	-5.3196	186	158	537	193	692	332	119	37	77.9
10.0	10	0	OFF	0.9725	1.51	-8.4340	124	266	608	145	946	361	178	33	63.9
10.0		0	OFF	0.9799	1.13	-5.9006	165	185	588	171	1247	343	196	40	80.7
10.0		0	OFF	0.9968	1.71	-9.2393	142	219	457	171	606	335	110	34	73.8
10.0		0	OFF	0.9761	3.06	-17.3435	51	291	453	121	651	311	95	47	94.1
11.0		0	OFF	0.9888	1.63	-8.1203	178	146	273	209	436	304	70	16	32
11.0		0	OFF	0.9826	4.01	-22.7519	0	291	361	155	362	263	60	11	23.2
11.0		0	OFF	0.9824	2.21	-11.3464	165	169	299	195	505	314	71	34	36.7
12.0	10	0	OFF	0.9942	1.01	-5.2992	208	191	821	210	1305	393	189	79	155.5
14.0	10	0	OFF	0.9924	1.12	-5.7635	193	173	542	200	774	355	147	36	72.5
14.0	10	0	ON	0.9944	1.61	-8.5933	169	210	514	186	762	356	122	67	136.4
14.0	7.5	0	OFF	0.9705	3.98	-23.1585	0	335	427	153	411	303	70	14	28.3
16.3	8.5	0	ON	0.9934	0.83	-4.7377	204	291	1598	207	2037	513	356	63	379.3
16.3	8.5	0	ON	0.9777	1.21	-6.4075	195	200	596	203	939	381	166	42	298.8
16.3	8.5	0	ON	0.9940	0.88	-4.6880	227	211	992	229	1190	444	238	48	307.9
20.0	8.5	0	Locked	0.9884	0.84	-4.8082	221	313	1745	225	1379	533	306	67	451.7
20.0	8.5	0	Locked	0.9974	1.17	-6.8983	196	369	1309	204	2024	545	323	80	469.1
20.3	8.5	0	ON	0.9823	1.30	-7.6419	192	358	1114	205	2154	528	330	79	313.6
20.3	8.5	0	ON	0.9929	1.04	-5.8998	199	297	1203	204	1855	495	316	71	458.9
20.3	8.5	0	ON	0.9940	1.04	-6.1081	199	359	1474	203	1939	554	363	76	364.3
23.5	8.5	0	Locked	0.9928	0.99	-5.9328	198	408	1861	201	2805	614	456	88	399.0
24.8	8.5	0	ON	0.9958	1.04	-6.4622	95	497	2066	107	2117	571	432	82	427.2
30.0		0	ON	0.9860	1.17	-6.4299	298	242	553	321	1015	514	183	14	29.3
30.0	7	0	ON	0.9674	0.95	-4.1124	207	75	162	217	363	272	52	8	16.1
30.0	6	0	OFF							341	511	426	121	2	5.3
30.7	10	0	On/OFF	0.9700	0.83	-4.1598	231	146	375	241	511	357	96	9	31.3
31.0	7	0	OFF							106	314	210	147	2	3.4
31.0		0	ON							113	452	283	240	2	6.3
33.0	6	0	OFF	0.9842	0.72	-4.2387	291	358	803	318	1250	610	336	6	34.8
7 - 30		0	ON/OFF	0.9924	1.84	-10.8155	139	354	756	174	997	451	175	57	115.3
	10	0	OFF	0.9794	2.97	-17.0594	0	311	378	157	357	275	74	6	75.3
	10	0	On/OFF	0.9276	2.61	-15.5669	24	389	677	83	1111	368	160	69	151.6
	10	0	OFF	0.9746	2.05	-11.6101	67	287	543	106	650	320	135	40	96.3

Weibull Analysis and Run Statistics in Oblique Seas for Tbar4_Cntr_Bow_Fr65

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
29.0	9	25	Locked	0.9851	1.42	-9.0032	149	555	1351	213	1531	639	336	35	219.9
29.5	N/A	30	ON	0.9945	1.05	-6.6263	85	548	2158	102	2093	598	435	68	349.7
29.5	N/A	30	ON	0.9876	0.89	-5.3224	120	383	1620	126	2149	507	445	38	235.9
30.5	N/A	30	ON	0.9897	1.43	-8.8873	64	508	1230	109	1813	520	343	34	204.7
31.1	N/A	30	ON							175	395	285	155	2	15.3
31.1	N/A	30	ON	0.9662	0.67	-3.4971	128	186	304	147	515	282	160	4	24.8
33.1	N/A	30	ON	0.9914	0.58	-3.1362	95	228	1104	98	1061	361	348	12	65.3
34.1	N/A	30	ON	0.9945	1.00	-6.0138	83	415	1338	100	1539	468	343	25	142.9
33.5	6	45	OFF	0.9858	0.43	-2.7243	230	542	2524	235	1730	813	638	7	41.4
12.0	10	315	OFF	0.9868	1.79	-9.2726	137	179	356	161	595	295	94	30	61.7
13.0	Dark	315	Off	0.9676	2.30	-12.3777	119	219	391	154	608	312	94	44	66.8
13.0	Dark	315	OFF	0.9781	1.03	-5.1978	211	159	533	215	853	367	170	32	62.8
13.0	Dark	315	OFF	0.9870	1.17	-6.0953	208	180	538	222	819	373	137	37	74.5
13.0	Dark	315	OFF	0.9916	1.22	-6.0714	231	148	437	239	614	364	97	42	81.7
14.0	Dark	315	Off	0.9791	2.76	-16.3656	54	373	597	137	835	384	132	40	86.9
22.5	10	315	ON	0.9926	0.46	-2.6341	171	304	852	179	1433	515	522	5	22.7
30.0	10	315	On/OFF	0.9681	1.71	-10.7104	0	519	952	125	776	444	213	17	34.2
32.0	Dark	315	Off/ON	0.9778	1.97	-12.1768	33	482	918	103	1190	456	233	35	62.1
33.0	6	315	Off							230	355	293	89	2	4.5
33.0	10	315	ON							253	543	380	148	3	9.7
NA	10	315	OFF							181	362	288	95	3	9.8
	Dark	315	Off	0.9898	1.42	-7.1903	207	160	323	231	464	345	81	15	121.1
	10	315	ON	0.9824	1.24	-6.9024	174	262	793	182	1482	421	242	52	187.8
12.0	10	NA	OFF	0.9569	0.91	-4.2030	200	104	321	204	832	305	149	16	33.9
13.0	Dark	NA	OFF	0.9851	1.19	-6.1570	200	174	555	205	1358	366	180	54	108.7
13.0	Dark	NA	OFF	0.9963	1.43	-7.4605	206	182	494	215	829	369	115	66	133.4
13.0	Dark	NA	OFF	0.9892	1.02	-4.8425	224	114	394	227	759	333	108	35	71.6
13.0	Dark	NA	OFF	0.9924	1.70	-8.3229	188	134	291	202	510	306	71	43	70.9
13.0	Dark	NA	OFF	0.9681	1.88	-9.5572	189	163	312	211	521	332	82	30	45.1
NA	10	NA	On/OFF	0.9329	1.75	-9.2255	161	193	362	191	613	329	105	20	44.7

Appendix C Statistical summary by channel for Wave Impact Measurements

Weibull Analysis and Run Statistics in Head Seas for Tbar10_Cntr_Bow_Fr65

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
4.2	8.5	0	ON							216	235	226	13	2	12.0
10.0	10	0	OFF	0.9810	1.77	-11.0550	25	516	1206	111	1408	478	245	89	182
10.0	10	0	OFF							198	301	250	73	2	
10.0	10	0	OFF	0.9856	1.55	-9.3804	104	432	972	142	1376	488	270	33	57.7
10.0	10	0	OFF	0.9876	1.69	-10.2904	77	438	935	121	997	463	234	37	77.9
10.0	10	0	OFF	0.9908	1.72	-10.1836	155	368	778	195	1093	480	200	38	73.6
10.0		0	OFF	0.9915	0.90	-5.1169	174	289	1253	180	1605	465	321	43	86.7
10.0		0	OFF	0.9767	1.21	-6.7972	167	273	754	181	817	414	190	31	67.3
10.0		0	OFF	0.9898	1.71	-10.3117	84	413	897	124	1043	448	218	44	88.1
11.0		0	OFF	0.9403	2.15	-13.0758	0	436	684	109	873	377	173	14	28
11.0		0	OFF	0.9908	1.30	-7.4340	32	302	554	85	548	291	164	9	19
11.0		0	OFF	0.9622	1.39	-7.9445	67	297	645	98	920	331	205	19	20.5
12.0	10	0	OFF	0.9756	1.52	-9.3717	90	482	1266	113	2166	528	348	75	147.6
14.0	10	0	OFF	0.9747	2.47	-15.0993	0	454	765	89	880	400	174	38	76.5
14.0	10	0	ON	0.9898	1.81	-11.2185	58	488	1089	102	1361	490	258	72	146.6
14.0	7.5	0	OFF	0.9642	0.73	-3.9967	111	232	629	130	575	318	186	8	16.2
16.3	8.5	0	ON	0.9955	0.93	-6.0101	197	634	2472	213	2666	799	546	35	210.7
16.3	8.5	0	ON	0.9944	0.78	-4.6255	194	367	1490	203	1395	551	335	20	142.3
16.3	8.5	0	ON	0.9892	0.94	-5.7491	198	448	1627	214	1632	611	341	29	186.0
20.0	8.5	0	Locked	0.9957	0.89	-5.5239	222	493	2135	230	1817	711	469	40	269.7
20.0	8.5	0	Locked	0.9939	1.04	-6.5972	192	566	2087	205	2501	732	492	49	287.3
20.3	8.5	0	ON	0.9875	1.03	-6.2976	207	445	1520	220	1495	630	385	35	138.9
20.3	8.5	0	ON	0.9898	0.81	-5.0452	194	500	2476	202	1844	687	466	39	252.1
20.3	8.5	0	ON	0.9920	0.91	-5.9988	188	732	3051	201	2167	879	586	39	187.0
23.5	8.5	0	Locked	0.9939	1.13	-7.6185	156	846	2686	202	2666	935	641	40	181.4
24.8	8.5	0	ON	0.9864	0.97	-6.5653	68	893	3346	105	2254	893	662	36	187.6
30.0		0	ON	0.9919	1.72	-9.1539	0	206	249	82	258	172	74	4	8.4
30.7	10	0	On/OFF	0.9607	1.53	-8.3959	157	241	389	215	562	361	116	8	27.8
7 - 30		0	ON/OFF	0.9920	0.85	-4.9823	105	354	1263	116	1680	447	362	19	38.4
	10	0	OFF	0.9921	0.96	-4.7513	156	145	290	174	475	281	103	7	87.8
	10	0	On/OFF	0.9814	1.76	-10.7135	102	433	972	134	1397	489	255	64	140.6
	10	0	OFF	0.9471	1.55	-8.8792	138	312	712	163	1074	415	199	36	86.7

Weibull Analysis and Run Statistics in Oblique Seas for Tbar10_Cntr_Bow_Fr65

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
29.0	9	25	Locked	0.9913	0.77	-5.1209	243	798	2368	280	2507	998	755	10	62.8
29.5	N/A	30	ON	0.9862	0.67	-4.3769	95	708	4234	100	2469	862	791	27	138.9
29.5	N/A	30	ON	0.9874	0.40	-2.4159	107	411	3633	108	3354	755	986	11	68.3
30.5	N/A	30	ON	0.9895	1.17	-7.9000	0	877	1794	98	1569	745	490	10	60.2
34.1	N/A	30	ON	0.9353	0.94	-5.8366	0	490	910	95	787	395	268	6	34.3
33.5	6	45	OFF							133	1935	820	974	3	17.8
12.0	10	315	OFF	0.9851	2.27	-12.2879	150	227	389	195	572	349	90	30	61.7
13.0	Dark	315	Off	0.9736	1.93	-11.2267	77	331	655	120	868	368	164	42	63.7
13.0	Dark	315	OFF	0.9813	0.63	-3.2737	258	178	1106	260	1312	461	260	24	47.1
13.0	Dark	315	OFF	0.9968	1.42	-8.0952	191	298	737	213	994	457	185	37	74.5
13.0	Dark	315	OFF	0.9921	1.13	-6.4710	200	314	984	210	1173	495	261	37	72
14.0	Dark	315	Off	0.9807	1.77	-10.4875	116	377	806	152	909	450	198	46	100
22.5	10	315	ON	0.9946	0.56	-3.2750	135	362	652	159	879	448	327	4	18.1
30.0	10	315	On/OFF	0.9807	0.63	-2.8572	90	93	349	92	374	186	107	10	20.1
32.0	Dark	315	Off/ON	0.9883	1.15	-6.7982	88	372	618	159	818	402	230	6	10.6
NA	10	315	OFF	0.9976	1.36	-8.2187	0	419	532	135	570	344	186	4	13.1
	Dark	315	Off	0.9774	2.17	-13.5050	83	508	804	261	888	525	192	15	121.1
	10	315	ON	0.9929	1.13	-7.0339	118	496	1605	140	1915	582	411	44	158.9
12.0	10	NA	OFF	0.9581	1.11	-5.7395	200	175	385	217	767	355	150	11	23.3
13.0	Dark	NA	OFF	0.9911	1.35	-7.9576	174	371	1007	202	1425	509	259	46	92.6
13.0	Dark	NA	OFF	0.9920	1.38	-7.7681	201	275	759	221	1156	448	186	59	119.3
13.0	Dark	NA	OFF	0.9867	1.09	-6.2115	191	291	873	208	1403	462	255	28	57.3
13.0	Dark	NA	OFF	0.9932	1.08	-5.5221	226	163	545	231	699	376	122	41	67.6
13.0	Dark	NA	OFF	0.9869	0.88	-4.7282	228	215	746	238	784	426	169	20	30.1
NA	10	NA	On/OFF	0.9661	2.48	-15.1884	0	462	709	128	895	405	169	18	40.2

Weibull Analysis and Run Statistics in Head Seas for Tbar15_Cntr_Bow_Fr65

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
10.0	10	0	OFF	0.9835	1.35	-8.3497	87	494	1416	105	1714	541	364	62	126.8
10.0	10	0	OFF	0.9955	0.84	-5.1358	116	460	1705	131	1775	566	457	20	34.9
10.0	10	0	OFF	0.9768	1.88	-12.4562	0	763	1343	155	1151	654	289	18	37.9
10.0	10	0	OFF	0.9935	1.14	-7.1408	87	513	1357	120	1824	556	407	21	40.7
10.0		0	OFF	0.9919	0.71	-4.4128	87	487	2156	95	3050	619	709	18	36.3
10.0		0	OFF	0.9803	1.14	-7.0769	48	497	1261	82	1677	504	427	18	39.1
10.0		0	OFF	0.9890	0.93	-5.8638	159	556	1745	188	1828	671	444	18	36
11.0		0	OFF	0.9053	0.57	-3.8602	0	832	980	94	825	570	413	3	6
11.0		0	OFF	1.0000	0.46	-2.9596	0	609	275	86	747	417	467	2	4.2
11.0		0	OFF	1.0000	1.22	-7.6163	0	502	372	240	542	391	213	2	2.2
12.0	10	0	OFF	0.9922	0.76	-4.8342	88	556	2889	94	1999	643	527	34	66.9
14.0	10	0	OFF	0.9886	0.61	-3.6036	84	354	1721	89	1291	468	434	14	28.2
14.0	10	0	ON	0.9938	1.09	-6.8130	110	519	1710	131	1584	594	409	39	79.4
16.3	8.5	0	ON	0.9880	0.65	-4.1903	214	607	2785	229	3395	882	865	15	90.3
16.3	8.5	0	ON							236	1725	981	1053	2	14.2
16.3	8.5	0	ON	0.9719	1.90	-12.8940	0	879	1362	252	1151	749	304	10	64.1
20.0	8.5	0	Locked	0.9831	0.96	-6.3887	206	754	2172	246	2017	882	537	16	107.9
20.0	8.5	0	Locked	0.9795	0.80	-5.3047	195	735	2818	223	2029	874	565	19	111.4
20.3	8.5	0	ON	0.9772	0.45	-2.5016	230	266	1876	233	1620	588	454	11	43.7
20.3	8.5	0	ON	0.9760	1.23	-8.3091	101	848	1865	252	1851	840	513	14	90.5
20.3	8.5	0	ON	0.9913	0.89	-6.0476	170	875	3097	202	2506	976	657	22	105.5
23.5	8.5	0	Locked	0.9882	0.52	-3.0149	200	326	2680	202	2990	692	787	20	90.7
24.8	8.5	0	ON	0.9796	0.73	-4.2472	108	341	1665	111	2114	496	499	24	125.0
30.7	10	0	On/OFF	0.9876	3.97	-19.0092	0	120	130	80	132	109	22	4	13.9
7 – 30		0	ON/OFF	0.9963	1.62	-7.8461	31	127	156	81	205	138	52	4	8.1
	10	0	On/OFF	0.9837	1.13	-7.1191	61	558	1769	87	2820	591	544	39	85.7
	10	0	OFF	0.9892	0.71	-4.2583	102	418	1883	109	2046	542	523	18	43.3

Weibull Analysis and Run Statistics in Oblique Seas for Tbar15_Cntr_Bow_Fr65

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
29.0	9	25	Locked	0.9543	4.44	-26.2257	0	369	411	242	393	338	59	5	31.4
29.5	N/A	30	ON	0.9829	0.42	-2.6731	171	609	4960	173	2683	973	937	11	56.6
29.5	N/A	30	ON	0.9846	0.29	-1.8247	162	518	2643	164	2646	969	1117	5	31.0
30.5	N/A	30	ON							215	540	377	230	2	12.0
33.1	N/A	30	ON							93	130	111	27	2	10.9
34.1	N/A	30	ON							162	180	171	12	2	11.4
12.0	10	315	OFF	0.9773	0.83	-4.5521	97	240	657	115	667	309	177	10	20.6
13.0	Dark	315	Off	0.9849	0.44	-2.5037	123	292	1937	124	1209	485	429	10	15.2
13.0	Dark	315	OFF	0.9886	0.62	-3.7320	216	417	1364	229	1477	622	433	8	15.7
13.0	Dark	315	OFF	0.9896	1.15	-7.1797	131	524	1042	202	1102	582	326	9	18.1
13.0	Dark	315	OFF	0.9782	1.55	-9.5839	112	489	914	225	959	531	232	14	27.2
14.0	Dark	315	Off	0.9859	0.76	-4.3853	97	322	1476	103	1674	422	362	24	52.2
30.0	10	315	On/OFF	0.9872	1.20	-4.7970	74	54	99	84	175	119	31	8	16.1
32.0	Dark	315	Off/ON	1.0000	0.83	-3.8351	87	102	114	109	238	166	66	3	5.3
NA	10	315	OFF	1.0000	0.45	-3.0161	0	758	339	104	932	518	586	2	6.6
	Dark	315	Off	0.9589	0.34	-2.0452	117	395	2769	118	1166	526	403	7	56.5
	10	315	ON	0.9763	0.56	-3.4202	107	430	2515	110	3084	681	853	15	54.2
12.0	10	NA	OFF	1.0000	1.41	-8.6652	0	475	366	250	508	379	182	2	4.2
13.0	Dark	NA	OFF	0.9766	0.78	-4.9691	280	567	2081	295	3048	875	743	16	32.2
13.0	Dark	NA	OFF	0.9948	0.92	-5.5069	193	411	1512	203	1711	593	392	27	54.6
13.0	Dark	NA	OFF	0.9738	0.63	-3.7757	185	408	1537	201	1928	611	530	10	20.5
13.0	Dark	NA	OFF	0.9765	1.20	-7.2087	192	402	805	251	1183	538	264	10	16.5
13.0	Dark	NA	OFF	0.9585	1.89	-12.4885	0	730	993	249	837	615	229	6	9
NA	10	NA	On/OFF	0.9770	0.39	-2.0173	138	185	1033	140	676	350	236	7	15.7

Appendix C Statistical summary by channel for Wave Impact Measurements

Weibull Analysis and Run Statistics in Head Seas for Tbar4 _Stbd_Void-1_Fr62-63

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
10.0	10	0	OFF	0.9932	0.98	-6.1910	61	571	1893	80	1844	599	480	25	51.1
10.0	10	0	OFF	0.9900	0.79	-4.8309	129	446	1465	147	1355	550	398	13	22.7
10.0	10	0	OFF	0.9622	0.79	-4.9736	80	542	1786	120	2004	586	512	13	27.4
10.0	10	0	OFF	0.9792	0.75	-4.4864	110	386	1399	120	1794	522	536	14	27.1
10.0		0	OFF	0.9941	0.71	-4.7715	107	814	3181	127	3465	948	991	14	28.2
10.0		0	OFF	0.9879	0.48	-2.6741	123	262	1620	125	1652	457	466	11	23.9
10.0		0	OFF	0.9924	1.06	-6.8107	60	619	1686	104	1438	611	409	18	36
11.0		0	OFF							476	646	561	120	2	4
12.0	10	0	OFF	0.9844	1.38	-9.0654	44	701	1584	130	1664	660	420	22	43.3
14.0	10	0	OFF	0.9794	0.62	-3.8921	55	550	1801	72	1681	595	585	8	16.1
14.0	10	0	ON	0.9771	0.72	-4.2996	101	396	2173	104	2132	541	511	30	61.1
16.3	8.5	0	ON	0.9806	0.43	-2.9251	204	841	7853	208	6502	1363	1713	14	84.3
16.3	8.5	0	ON							207	1083	722	458	3	21.3
16.3	8.5	0	ON	0.9634	0.44	-2.6872	224	435	2579	226	1344	680	457	9	57.7
20.0	8.5	0	Locked	0.9942	0.93	-6.3650	229	964	2665	295	2568	1107	751	13	87.6
20.0	8.5	0	Locked	0.9939	0.65	-4.1096	212	545	2854	217	2067	792	612	19	111.4
20.3	8.5	0	ON	0.9837	0.61	-3.1304	199	163	859	201	649	363	157	16	63.5
20.3	8.5	0	ON	0.9824	0.60	-3.7851	273	572	2912	281	1919	863	593	14	90.5
20.3	8.5	0	ON	0.9863	0.97	-7.1068	119	1520	4448	213	3822	1483	1094	17	81.5
23.5	8.5	0	Locked	0.9809	0.43	-2.6740	212	512	3937	214	4270	917	1178	11	49.9
24.8	8.5	0	ON	0.9781	0.93	-5.4885	86	370	1137	100	2014	452	459	17	88.6
7 - 30		0	ON/OFF	0.9832	0.52	-1.4709	98	16	31	99	144	113	21	4	8.1
	10	0	OFF							234	257	245	17	2	25.1
	10	0	On/OFF	0.9867	0.96	-6.1817	79	613	1979	102	2787	671	627	22	48.3
	10	0	OFF	0.9917	0.66	-4.4597	135	845	3170	156	2650	965	825	11	26.5

Appendix C Statistical summary by channel for Wave Impact Measurements

Weibull Analysis and Run Statistics in Oblique Seas for Tbar4 _Stbd_Void-1_Fr62-63

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
29.0	9	25	Locked	0.9646	0.68	-2.7772	209	59	214	211	501	276	92	11	69.1
29.5	N/A	30	ON	0.9837	0.52	-3.2994	92	549	4332	94	4037	918	1219	19	97.7
29.5	N/A	30	ON	0.9937	0.48	-3.0015	119	543	2197	127	3036	809	1058	7	43.4
30.5	N/A	30	ON	0.9681	0.30	-1.6375	158	235	1146	159	3515	865	1482	5	30.1
33.1	N/A	30	ON							133	148	141	10	2	10.9
34.1	N/A	30	ON							240	265	253	18	2	11.4
33.5	6	45	OFF							168	740	454	405	2	11.8
12.0	10	315	OFF							203	277	240	52	2	4.1
13.0	Dark	315	Off	0.9864	0.51	-3.1091	101	460	1454	113	1271	548	487	6	9.1
13.0	Dark	315	OFF	0.9925	0.33	-2.0606	317	538	2296	320	2680	1011	987	5	9.8
13.0	Dark	315	OFF	0.9861	1.28	-9.0802	0	1197	1736	302	1937	991	607	5	10.1
13.0	Dark	315	OFF	0.9734	0.76	-4.0672	275	212	634	288	746	463	157	10	19.5
14.0	Dark	315	Off	0.9873	0.94	-5.2654	120	272	786	137	885	370	222	15	32.6
30.0	10	315	On/OFF	0.9780	4.96	-23.6346	0	118	126	85	126	109	17	4	8
	Dark	315	Off							108	432	314	179	3	24.2
	10	315	ON	0.9758	1.11	-7.3315	100	737	1673	204	1906	743	492	12	43.3
13.0	Dark	NA	OFF	0.9843	1.28	-9.1967	24	1332	2640	209	3062	1182	843	11	22.1
13.0	Dark	NA	OFF	0.9798	0.81	-5.2742	178	655	2086	203	1972	796	593	13	26.3
13.0	Dark	NA	OFF							927	951	939	17	2	4.1
13.0	Dark	NA	OFF							679	1153	916	335	2	3.3
13.0	Dark	NA	OFF							211	556	347	184	3	4.5
NA	10	NA	On/OFF							266	320	295	27	3	6.7

Appendix C Statistical summary by channel for Wave Impact Measurements

Weibull Analysis and Run Statistics for Tbar15 _Stbd_Void-1_Fr62-63

Speed	Wave Ht	Rel Hdg Deg	Ride-Control	Corr	Shape Parm	Yintercept	x0 (uin/in)	Chv (uin/in)	Pmax (uin/in)	Min (uin/in)	Max (uin/in)	Avg (uin/in)	Std Dev (uin/in)	impacts	impacts per hour
10.0	10	0	OFF	0.9809	0.57	-3.6073	88	554	4288	90	9267	1052	2042	25	51.1
10.0	10	0	OFF	0.9859	0.40	-2.4454	106	454	3654	107	8350	1179	2546	10	17.5
10.0	10	0	OFF	0.9425	0.23	-1.3535	127	408	3376	129	7391	1662	3204	5	10.5
10.0	10	0	OFF	0.9395	0.46	-2.8441	144	479	2641	147	5363	947	1693	9	17.4
10.0		0	OFF	0.9461	0.37	-2.4338	130	743	7165	131	9256	2003	3621	10	20.2
10.0		0	OFF	0.9801	0.60	-3.0534	92	166	620	96	985	284	289	9	19.5
10.0		0	OFF	0.9800	0.94	-5.1614	59	240	522	83	563	269	181	8	16
12.0	10	0	OFF	0.9499	0.53	-3.3246	87	557	5019	88	9427	1341	2767	24	47.2
14.0	10	0	OFF	0.9958	0.36	-2.1223	109	375	2902	111	3361	773	1125	8	16.1
14.0	10	0	ON	0.9791	0.70	-4.5655	109	687	2957	121	4409	870	1099	16	32.6
16.3	8.5	0	ON	0.9947	0.63	-4.5361	274	1343	5048	305	6682	1725	1927	10	60.2
16.3	8.5	0	ON	0.9822	0.52	-3.1737	201	435	813	226	985	568	361	4	28.5
16.3	8.5	0	ON	0.9846	0.44	-2.6332	297	384	1729	301	2684	820	856	7	44.9
20.0	8.5	0	Locked	0.9800	0.67	-4.9211	211	1473	5950	243	3573	1620	1273	13	87.6
20.0	8.5	0	Locked	0.9857	1.30	-9.5745	0	1609	3400	203	3467	1388	899	14	82.1
20.3	8.5	0	ON	0.9868	0.97	-6.1468	200	569	1283	257	1671	699	428	9	35.7
20.3	8.5	0	ON	0.9890	1.36	-9.7995	84	1373	2809	284	2454	1268	724	14	90.5
20.3	8.5	0	ON	0.9890	0.80	-5.7672	290	1395	5414	328	4607	1619	1206	19	91.1
23.5	8.5	0	Locked	0.9521	0.63	-4.2869	196	905	3840	211	3721	1204	1308	12	54.4
24.8	8.5	0	ON	0.9954	0.59	-3.5229	100	389	2489	103	2950	581	688	20	104.2
7 - 30		0	ON/OFF	0.9802	0.42	-2.0253	85	119	571	86	601	235	202	7	14.2
	10	0	On/OFF	0.9808	0.47	-3.1267	106	735	6017	109	5011	1029	1337	15	32.9
	10	0	OFF	0.9241	0.29	-1.8847	109	601	4350	110	9394	1752	3744	6	14.4
29.0	9	25	Locked	0.9744	0.64	-3.9425	176	452	946	207	1454	588	499	5	31.4
29.5	N/A	30	ON	0.9560	0.32	-2.1887	96	912	17132	97	6660	1427	1834	13	66.9
29.5	N/A	30	ON	0.9295	0.74	-5.1791	0	1089	2071	108	2464	898	905	5	31.0
30.5	N/A	30	ON	0.9534	0.24	-1.2638	106	186	719	107	2746	777	1313	4	24.1
33.5	6	45	OFF	0.9702	0.27	-1.3793	134	158	524	135	1677	535	761	4	23.7
12.0	10	315	OFF							119	141	130	15	2	4.1
13.0	Dark	315	Off							306	488	413	95	3	4.6
13.0	Dark	315	OFF							716	9428	5072	6160	2	3.9
13.0	Dark	315	OFF							325	9029	3484	4818	3	6
13.0	Dark	315	OFF	0.9946	0.53	-2.9055	284	231	427	297	887	497	267	4	7.8
14.0	Dark	315	Off	0.9709	1.20	-6.1333	86	167	291	128	392	227	96	7	15.2
22.5	10	315	ON							116	204	160	62	2	9.1
30.0	10	315	On/OFF	0.9452	0.44	-1.4991	81	31	93	82	134	108	24	5	10.1
	Dark	315	Off							100	326	213	159	2	16.1
	10	315	ON	0.9891	0.52	-3.3872	112	668	3313	120	2558	850	864	10	36.1
13.0	Dark	NA	OFF	0.9654	0.46	-3.5968	178	2333	8203	219	9251	2796	3610	6	12.1
13.0	Dark	NA	OFF	0.9907	1.15	-7.5732	103	725	1205	243	1460	714	437	6	12.1
13.0	Dark	NA	OFF							238	1603	723	764	3	6.1
13.0	Dark	NA	OFF							368	1180	774	574	2	3.3
13.0	Dark	NA	OFF							355	1121	738	542	2	3

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