THE 29th AMERICAN TOWING TANK CONFERENCE
ANNAPOLIS, MARYLAND, AUGUST 2010

Appendices: History of the Naval Academy Hydromechanics Laboratory

Appendix 1: Press Release from Public Affairs Office and Dedication Ceremony Photographs, August 1977
Appendix 1a: Program for the 1977 ATTC Hydromechanics Lab Dedication Ceremony

Appendix 2: Details of the Hydromechanics Laboratory Carriage Propulsion and Rail Systems
1. Carriage Propulsion System
2. The Rail System
3. The 2007 Rail Survey and Leveling

Appendix 3: List of Trident Scholars who used the Naval Academy Hydromechanics Laboratories

Appendix 4: Abstracts of Recent Midshipman Research Projects

Appendix 5: Example Research Projects in the Coastal Tank

Appendix 6: Additional References to Research associated with the Naval Academy Hydromechanics Laboratory

Appendix 7: List of Hydromechanics Laboratory Reports Catalogued by Pam Majors

Appendix 8: Photos of Isherwood Hall Ship Hydromechanics Laboratory and Professor Compton's double flap wavemaker concept sketch

Appendix 9: Photos of Rickover Hall Construction and NAHL Operations

Appendix 10: List of Hydromechanics Laboratory Staff Members

For Videos of the NAHL Extreme Wave Research see the separate file NAHLExtremeWaveResearch.pdf

United States Naval Academy

Appendix 1: Press Release from Public Affairs Office PAO-4375-77 29 August 1977

Public Affairs Office
Room 112 Administration Building Phone 301 - 267-2291
Annapolis,Maryland 21402

The U. S. Naval Academy's new, 380-foot towing tank was dedicated last week (August 24) in a unique ceremony, during which vials of water from a score of similar installations around the country and several foreign nations were emptied in to it by officials of those facilities.

The participants were in Annapolis to attend the 18th American Towing Tank Conference, which has met every three years since 1938. More than 250 representatives of various towing tank facilities attended the meeting, co-sponsored by the Naval Academy, the Office of Naval Research and the Naval Sea Systems Command.

Located in the Rickover Engineering Studies Complex, the Academy's new tank, which holds 1.2 million gallons of water to a depth of 16 feet, is capable of creating various sea states, wave heights and patterns. Models of different ship hull designs, some as long as 25 feet, are towed through the tank to study their performance under a variety of conditions such as those met at sea

On hand for dedication of the Academy Towing Tank were past and present faculty members who were instrumental *in* developing its design over the past decade, including Rear Admiral D. L. Kauffman, USN (Ret.), who was Naval Academy Superintendent when the tank was first proposed, Rear Admiral R. W. King, USN (Ret.) head of the Division of Engineering and Weapons, when the concept was first put forward, Captain J. R. Wales, current head of the Division of Engineering and Weapons, and Captain J. J. Shanley, CEC ROICC. Professor Bruce Johnson, now Director of the Hydromechanics Laboratory at the Academy, first began pressing for a new towing tank 11 years ago, and emceed the ceremony which saw that idea reach fruition. (See photo of Admiral Kauffman making his remarks on the next page)

The new facility will be used for midshipmen instruction and for research by midshipmen and faculty members in

various academic areas, such as Naval Architecture, Marine Engineering, Ocean Engineering, Mechanical Engineering, Oceanography and others.

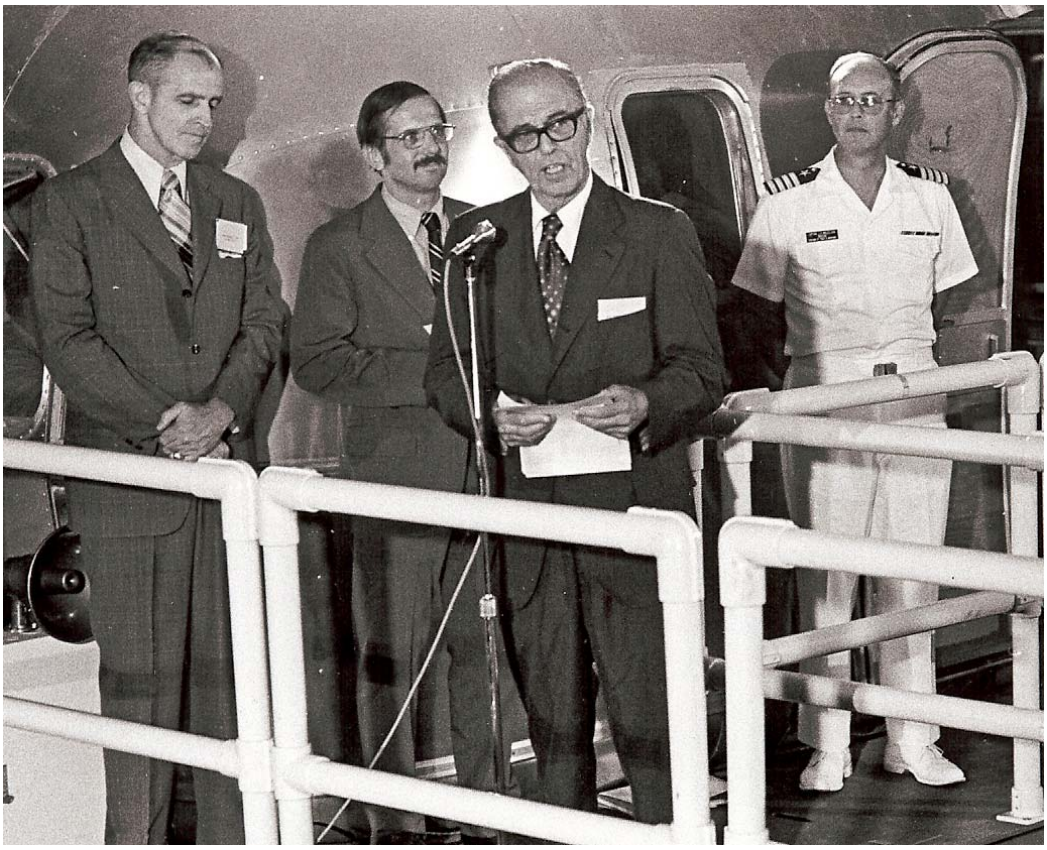
As early as the 17th Century, such scientists as Newton began investigating the best shape for ship hull designs in order to develop the least resistance to movement through the sea.

Benjamin Franklin became interested in the subject during one of his visits to Europe and *in* 1764 tested models to verify observations he had made in Holland.

Designs developed from models played a large part in development of sailing ship hulls, in particular the first "clipper" ship design~ produced in the early 19th Century in Aberdeen, Scotland. Naval ship designs have been developed through the use of model hulls by the British Admiralty since the Froude era and the Dutch Royal Navy built its first experimental tank in 1873. Since 1900, towing tanks have been in wide use around the world.

The major site of U. S. Navy towing tank experiments is the David Taylor Naval Ship Research and Development Center at Carderock, Md., a laboratory operated by the Naval Material Command and possessing the largest facilities existing today in the field of hydromechanics research. (See photo of Dr. Cummins mixing in DTMB water into the NAHL tank.)

The Dedication finished with a ”Mixing of the Waters” ceremony involving water from over 30 worldwide towing tanks. William Crago, representing the British Towing Tank Panel, poured the first vial, with water from five British facilities including the Froude Tank, the world's first modern experimental towing tank, constructed in 1871, which is still in use. (Naval Academy Photos follow)



RADM King, Professor Johnson, RADM Kaufman delivering remarks and Captain Wales

Mixing of the Waters Ceremony

Mr William Crago, pouring Froude Water from British Tanks

Dr. William Cummins, Technical Director DTMB

Mr. Sidney Mathews Director, Ottawa Canada Tank

Appendix 1a: Program for the 1977 ATTC Hydromechanics Lab Dedication Ceremony

The following agencies and contractors were instrumental in bringing this outstanding teaching and research facility to completion

Chesapeake Division Naval Facilities Engineering Command, Washington Navy Yard and Annapolis Branch	Project Administration
Division of Engineering and Weapons, U. S. Naval Academy	Conceptual Design and Technical Management
Warnecke/Ewing Joint Venture Washington, D. C.	Rickover Hall Architect/ Engineer
Norair Engineering Washington, D. C.	Basin Construction
J. E. Bateson Baltimore, Maryland	Rickover Hall Construction
AAI Corporation Cockeysville, Maryland	Carriage Design and Data Link Specifications
ABA/Electromechanical Systems Inc. St. Petersburg, Florida	Carriage, Drive System, and Data Link
ITT Gilfillan Van Nuys, California	Optical Data Transmission System
CADCOM, Inc. Annapolis, Maryland	Digital Systems Specification and Integration
Computer Sciences Corporation Falls Church, Virginia	Computer, Data Acquisition and Software Systems
MTS Systems Corporation Minneapolis, Minn.	Wavemaker, Beach, and Wavemaker Computer Control
HYDRONAUTICS, Incorporation Laurel, Maryland	Dynamometry and Instrumentation
AKROEX, Inc. Annapolis, Maryland	Installation Engineering

DEDICATION CEREMONY

OPENING	PROF BRUCE JOHNSON
DEDICATION PRAYER	CAPT J. W. CONTE, CHC, USN
REMARKS	RADM D. L. KAUFFMAN, USN, RET
REMARKS	RADM R. W. KING, USN, RET
PRESENTATION OF FACILITY ...	CAPT J. J. SHANLEY, JR.,CEC, USN
DEDICATION	CAPT J. R. WALES, USN
"MIXING OF THE WATERS"	U. S. AND FOREIGN GUESTS
CLOSING	PROF BRUCE JOHNSON

18th ATTC EXECUTIVE COMMITTEE

Dr. Bruce Johnson, USNA, Chairman
Dr. Jack Hoyt, USNA
Dr. C. P. Leone, Sao Paulo, Brazil
Mr. S. T. Mathews, Ottawa, Canada
Dr. T. Y. Wu, Cal Tech.

18th ATTC ORGANIZING COMMITTEE

Dr. Bruce Johnson, USNA, Chairman

Max Altman	Robert Keane, NAVSEC
Roger Compton	LCDR Sam Lowrie, CF
Stanley Doroff, ONR	Bruce Nehrling
LCDR William Harris	LCDR Ronald Ruys
John Hill	CDR Henry Schmidt
Jack Hoyt	CAPT John Wales

18th ATTC TECHNICAL COMMITTEE CHAIRMEN

Resistance & Flow	Prof Louis Landweber, U. of Iowa
Cavitation	Prof Blaine Parkin, Penn State
Seakeeping	Prof J. R. Paulling, U. of Calif.
Maneuvering	Mr. William Smith, DTNSRDC
Propulsion	Mr. Raymond Wermeter, DTNSRDC
Systems & Techniques	Mr. Peter Ward Brown, Davidson Lab

MENU

Maryland Crab Soup

Tossed Salad

Chicken Cordon Bleu

Green Beans Almondine

Rolls

Raspberry Sherbert

Coffee - Tea

Rosé d'Anjou (Alexis Lichine)

PROGRAM

INTRODUCTION & ACKNOWLEDGEMENTS - Prof Bruce Johnson

REMARKS - RADM J. W. Lisanby, USN, COM NAVSEC

Appendix 2: Details of the Hydromechanics Laboratory Carriage Propulsion and Rail Systems

1. Carriage Propulsion System

Selection of a carriage propulsion system involved conducting the trade off between three candidates for powering the high and low speed carriages (Schroeder 1971). The un-powered low speed carriage was to be towed by the high speed carriage. The candidates included a linear induction motor (LIM) approach, on-board electric motors powering drive wheels, and off-board electric motors driving a tape or cable attached to the carriages. The LIM concept was rejected because of the state-of-the-art considerations including no off-the-shelf designs available, speed control and accuracy considerations and a 10-1 speed range from the then current generation of LIM's. The on-board motor was rejected because of unattainable accelerations required relative to the weight of the motors and carriages.

The selected solution was to use a dual cable drive with two 200 HP DC motors overloaded by 400% during the brief acceleration and deceleration portions of the high speed carriage travel. The propulsion system operates both carriages using a single speed control and mechanical drive system as shown in the included Figure 1 from Schroeder 1971. Furthermore, it has excellent acceleration and deceleration capabilities to maximize the data run, and it removes the primary source of noise and vibration from the carriages. The two electric motors and gear box are mounted on a concrete foundation which is isolated from the towing tank foundation to minimize the transmission of noise and vibration into the basin. The electric motors and SCR controllers are housed in a screen room having a concrete block exterior to provide RFI shielding and acoustic isolation from the towing tank test environment.

A continuous loop drive system was selected in preference to a drum hoist type in order to provide the carriages with propulsion and speed control in both directions of travel with a single power source. One of the problems with this system is that unequal drive drum diameters can cause severe load differentials in the twin cables. This problem was eliminated by joining the twin cables at the carriages and anchoring them with load equalization sheaves. Structural stretch of the cable was minimized by pretensioning to around 7000 lbs. However, providing adequate traction between the cable and the drive drum required five 180-degree wraps around the 40 inch drive drum and this necessitated using a smaller diameter five-wrap idler drum just inside the drive drum to insure the return cable can clear the drive drum. The return cable is supported on approximately 25-foot centers by idler sheaves running on low friction roller bearings. The brackets for these sheaves are supported on vibration isolation mounts to minimize the transmission of cable vibration to the foundation. The spacing of these idler sheaves was varied to avoid sympathetic vibration of the catenaries.

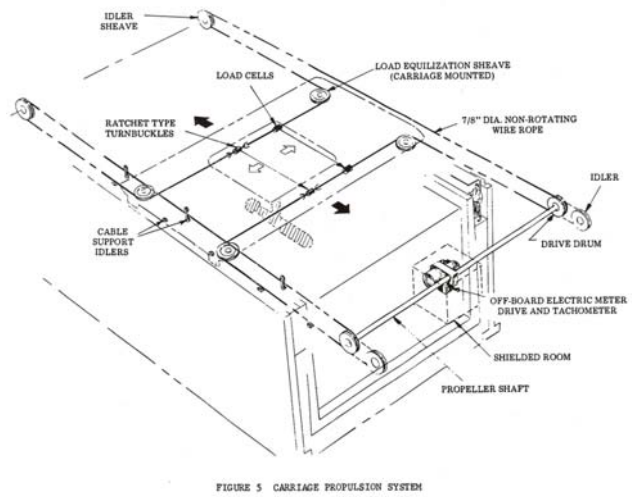


Figure 1 - Carriage propulsion system in 380 foot tank

An unintended consequence of this method was that the same right hand lay of the cable strands was used for both sides of the tank rather than having an opposite lay cable on the other side to minimize cable drift caused by asymmetric stretching. The result was that the turnbuckle/loadcells at the carriage migrated one way during high accelerations down the tank and migrated a small amount in the other direction during carriage returns, resulting in a net migration towards one side of the high speed carriage.

Figure 2 - Turnbuckle on HSC

Figure 3 - Idler wheel setup on carriage drive

This was corrected by inserting a “clutch” on one side of the propeller shaft to allow the motor to drive only one side of the cable and return the turnbuckle to its starting point. Approximately four times per year, depending on the carriage speeds and duration over that period, the cables are reset.

2. The Rail System

The primary requirement of the rail system is that it provide accurate alignment of the carriage relative to the water surface and furthermore that it maintain this alignment of the carriage relative to the water surface in the presence of operational loads and environmental conditions for long periods of time. Mounting adjustable rails on separate building pilings has proven a good solution, especially considering that this part of the Naval Academy grounds were made from landfill and susceptible to movement. The first time the rails were re-aligned was in 2007, thirty years after their installation. A survey of the relative rail height about the water surface is shown in Section 3.

Most towing tank facilities throughout the world use either a crane rail or rectangular bar as a means of guiding carriage suspension systems and providing wheel traction for the on-board electric motors. When off-board propulsion systems are considered, the need for a driven wheel and hence a flat rail is eliminated. Other types of suspension systems such as slippers, air bearings, and linear roller bearings are compatible with a commercially available round rail system made by Thompson Roundway Bearings. Their largest off-the-shelf rail was a four-inch diameter round rail of 1060, 60 case hardened and ground in 16 foot lengths with the option of pinning the ends together. The rail joints were not pinned, however, so that individual rails could be replaced, if damaged beyond repair.

The rail support structure for the round rails is by Thompson Roundway waymounts on 21 inch centers. These waymounts provide independent alignment of the rail in the vertical and horizontal planes by means of screw adjustments. In order to obtain a probable wave height error of ± 0.01 inch, the rail alignment error should not exceed ± 0.002 inch. When first installed, a laser alignment system combined with a water level system was used to align the rails to the desired tolerance. tolerance. In later years the rail height was surveyed using the still water surface as a reference plane and capacitance wave probes suspended from the carriage. The 2007 alignment check is covered in the next section.

Figure 4 - Slipper installation on the HSC

Figure 5 - Double Roundway bearings on LSC

Figure 6 - New rollers on HSC

Appendix 2 Section 3 Notes on 380 Carriage Rail Survey and Leveling

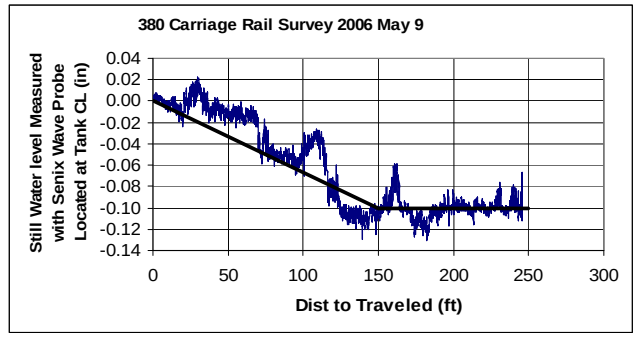
Summer 2007

John Zseleczky, Bill Beaver, Don Bunker

Background

Over the years a common observation had been made on model test results from the NAHL 380' towing tank. As the model proceeded down the tank, the water level appeared to drop. My first experience with this (John Z) was in the late 1980's when testing a fully restrained planing boat model. The downward vertical force on the model increased at the far end of the tank. At that time it was believed that the carriage was plowing air down the tank and the dynamic air pressure caused a drop in water level and decrease in buoyancy (we are only talking about 1/8" of water which is about 0.005 psi). That may have been the case to some extent but in the last few years it was noticed that heave records for ship models, even at very low speeds, also showed a downward trend toward the end of the tank. some point it was realized that at very low speeds there was no reason for the water level to be changing. We tried turning the wavemaker sump pumps on and off and it made no measurable difference. Instead, it was hypothesized that the carriage rails might not be perfectly level.

In 2006, we measured the water elevation carefully using an acoustic wave probe on the carriage as the carriage moved down the tank at 1.5 fps. Several runs were made and it was found that the data were very repeatable and the relative elevation change could be estimated using a straight line fit over one part of the tank and a constant value over the remaining part. An Excel spreadsheet was made up which integrated the velocity data to deduce distance moved down the tank. This was used for the X axis of the plot below. A "tare" correction could then be made to new model heave data using the straight line fits to obtain heave records without the characteristic drop that we had been living with.

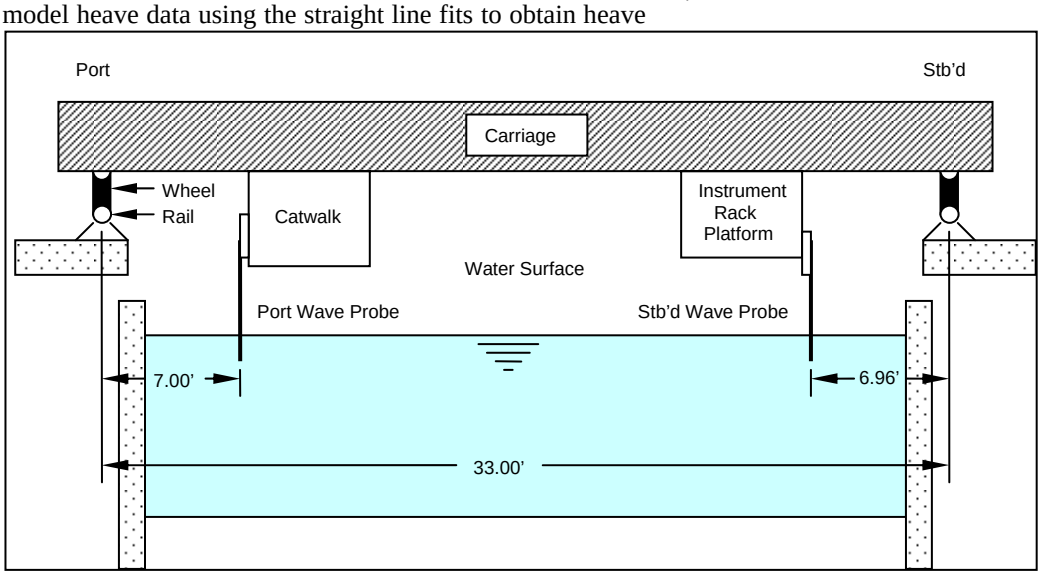


Setup for Accurate Survey of Rail Elevation

In the summer of 2007 we decided to make a careful survey of the rail elevation and then attempt to adjust the rails. The plan was to use the still water surface in the towing tank as a perfectly level two-dimensional reference. A Senix acoustic wave probe and an RBR capacitance wave probe were tested side by side in a trial run. The acoustic probe was found to have more noise so capacitance probes were used for all future measurements. The probes measured the relative height of the water surface as the carriage rolled down the tank at 0.5 ft/sec. Two probes were required because the port and starboard carriage rails are completely independent. The exact height of the rail at any given location was not considered important, we were looking for changes in relative height. At any instant, given two relative heights at the wave probes, the relative heights at the rails could be calculated.

The sketch below shows a transverse section of the carriage in the towing tank which was set up in the plane of the rear carriage wheels. The probes were spaced as far apart as possible

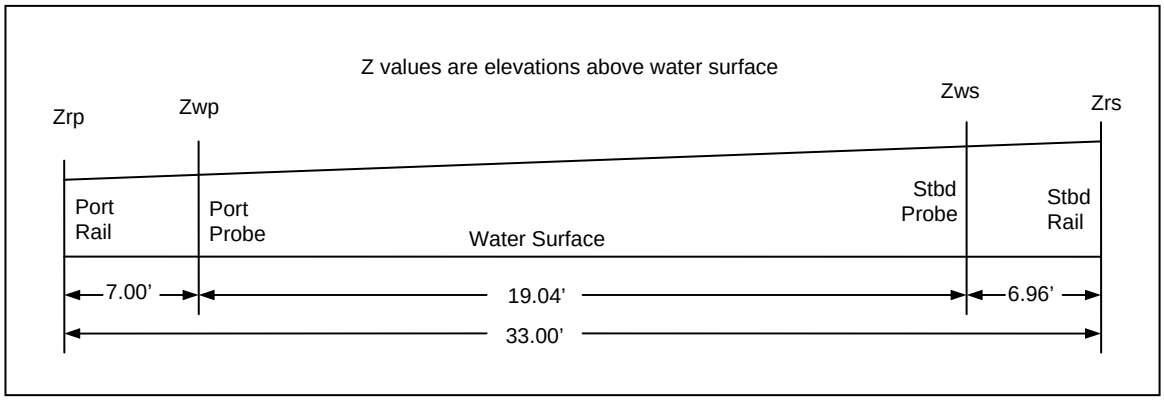
.



Transverse section of 380' towing tank in plane of rear wheels of high speed carriage

The sketch below shows how the relative rail elevation was calculated using the water surface elevation measured at the port and starboard wave probes. The "Z" elevation values in the sketch and equations are defined as:

Zrp – height at rail, port
Zwp – height at wave probe, port
Zrs – height at rail, starboard
Zws – height at wave probe, starboard



Calculation of relative rail elevation based on probe measurements of water surface

$$\frac{Zws - Zwp}{19.04} = \frac{Zrs - Zrp}{33.0}$$

1.733 (Zws-Zwp) = $Zrs - Zrp$

$Zrs = Zrp + 1.733\ (Zws - Zwp)$

$$\frac{Zws - Zwp}{19.04} = \frac{Zws - Zrp}{(19.04 + 7.00)}$$

1.368 ($Zws - Zwp$) = Zws - Zrp

$Zrp = Zws - 1.368\ (Zws - Zwp)$

The RBR capacitance wave probes were calibrated in place using the staff with the NC machined spring-ball detents. Seven point calibrations over +/- 2 inches had max errors of 0.007 inches. The bottom of the probes were set six inches below the water surface for calibrations and for surveys.

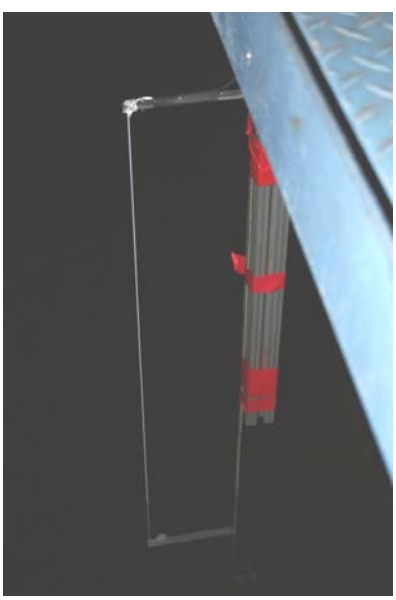
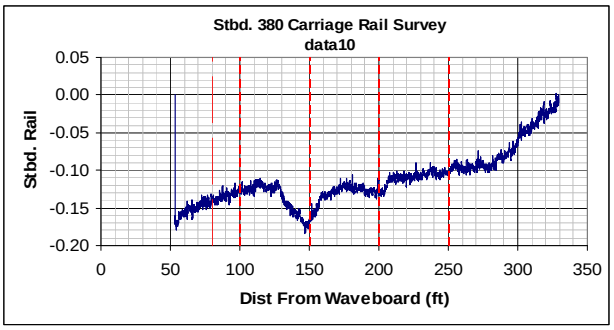


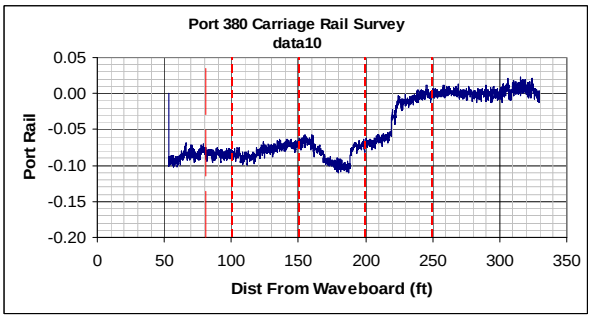
Photo shows capacitance wave probe suspended using 80/20 bar clamped to aft end of instrument rack. Sensing wire was lined up in plane of carriage wheels.

The figures below show the relative rail elevations before any adjustments were made. Repeat records overlaid each other within 0.01 inches. Since the measurements were made using wave probes, and the water surface elevation never changed, a negative value on the plots represents an <u>increase</u> in rail elevation.

The wave probe measurements were sampled at 50 Hz. For each sample, the rail elevation at that instant was calculated using the measurements from both wave probes. This doubled the noise on the calculated signal so a five point sliding average filter was used to smooth the data before plotting.

It can be seen from the survey records that the port rail elevation varied in by 0.10 inches and the starboard rail elevation varied by 0.16 inches.The dashed vertical lines on the records show the firing points of the optic trips which are normally used for tachometer speed calibration. Using the velocity integration method to calculate distance traveled, an offset value was required to make the first trip occur at exactly 250 ft, where the reflector is physically located. Note that the other trips also line up where they should be. This gives confidence that the velocity integration method works correctly. We typically backed the carriage up before starting a survey run in order to cover the normally used portion of the rails, so the offset was different for each run.





Rail survey before making any adjustments

Rail Elevation Adjustment

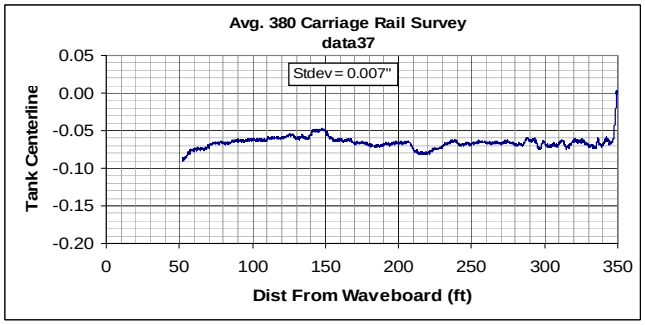
Each rail is made up of four inch diameter steel rods that are 16 feet long. The rails are not connected at the ends and there is a gap of about 0.02 to 0.08 inches between ends. There is a wedge underneath each joint to keep the rod ends from deflecting. The rail adjusters are spaced at about 2 foot intervals over 380 feet

Closeup of rail adjusters from both sides

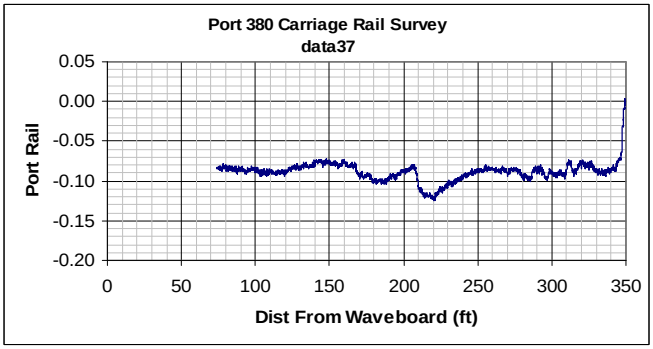
There is also a bolt that pulls the rail down to the red base

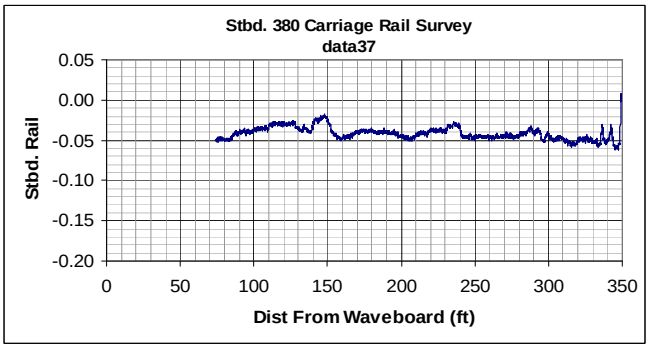
Final Rail Survey

The figures in the next column show the final surveys of the port and starboard rails. It can be seen that the port and starboard rails now vary in height by a maximum of 0.04 inches. It is really more important to evaluate the elevation change at the center of the carriage where most models are towed. This can be determined by averaging the elevations of the two rails at each instant. The Excel survey spreadsheet was used to do this and the calculated record is shown on a following plot. It appears that the elevation at the center of the carriage now varies by 0.03 inches, with a standard deviation of 0.007 inches. The rails are still not perfect but the reduction in variation from 0.10 inches to 0.03 inches is considered a significant improvement.



Final Rail Surveys





Appendix 3: List of Trident Scholars who used the Naval Academy Hydromechanics Laboratories

BRIAN JOSEPH DOHERTY, 1965 "The Effect of Macromolecular Solutions on Drag and Turbulent Flow Noise"*Faculty Advisor: Assoc. Prof. Bruce Johnson*

RICHARD HENRY BARCHI, 1966 "The Effect of Polymeric Additives on Turbulence Intensity in a Two-Dimensional Boundary Layer" *Faculty Advisor: Assoc. Prof. Bruce Johnson*

EDWARD ANTHONY McKENNEY, 1966 "The Influence of Polymer Additives on Hydrodynamic Flow Noise" *Faculty Advisor: Assoc. Prof. Bruce Johnson*

ROBERT MICHAEL NUTWELL, 1966 "Reduction of Drag in Hydrofoil Ships" *Faculty Advisors: Asst. Prof Tad Kowalski and Cdr. James R. Wilkins*

GREGORY FRANK DRYER, 1967 "Measurement of Velocity Fluctuations in a Turbulent Boundary Layer With and Without Injection of a Polymer Additive" *Faculty Advisor: Assoc. Prof. Bruce Johnson*

RICHARD FRANCIS ELLIOTT, 1968 "The Swimming of Slender, Flexible, Fish-Like Bodies" *Faculty Advisor: Assoc. Prof. John P. Uldrick*

ROBERT EASTMAN SHOLARS, 1968 "An Investigation of the Flow and Resistance Characteristics of Long, Slender Hulls" *Faculty Advisor: Assist. Prof. Roger Compton Consulting Advisor: Assoc. Prof. Bruce Johnson*

NATHAN CLARK WILLIAMS, 1968 "A Comparison of Random Signal Analysis Techniques for Turbulence and Flow Noise Measurements" *Faculty Advisors: Assoc. Prof. Bruce Johnson and Asst. Prof. John O. Geremia*

JOHN WALKER FISHER, 1972 "Time-Dependent Shear Stress Beneath a Shoaling Wave"*Faculty Advisors: Professors Bruce Johnson and Michael McCormick*

WAYNE ALLEN THORNTON, 1974 "Drag Reduction of a Hull by Electrolysis" *Faculty Advisor: Professor Michael McCormick*

MARK HENRY ROLFES, 1980 "Wave Force and Structure Response: A Comparison of Theory and Experiment Using Regular and Irregular Sea States" *Faculty Advisor: Assoc. Prof. Tom Dawson*

STEPHEN WILLIAM SURKO, 1982 "Performance Optimization of a Pneumatic Wave-Energy-Conservation Device" *Faculty Advisor: Professor Michael McCormick*

JEFFERY WAYNE HOYLE, 1985 "Optimization of Bow-Bulb Forms for Resistance and Seakeeping Characteristics: A Comparison of Existing Computer Software Predictions with Experimental Results" *Faculty Advisors: Prof. Bruce Johnson and Assoc. Prof. Bruce Nehrling*

JOHN VICTOR DE NUTO III, 1986 "An Investigation of the Hydrodynamic Characteristics of Non-Axisymmetric Bow Shapes for Submarines" *Faculty Advisors: Professor Roger Compton and Assoc. Prof. Howard A. Chatterton*

JENNIFER CULBERTSON, 1987 "A Trade-off Study of Sonar Performance and Powering Requirements for Conventional Sonar Domes" *Faculty Advisor: Prof. Bruce Johnson*

DEBORAH DENISE KLATT, 1987 "Analysis of Glint Patterns Using Remote Sensing Techniques" *Faculty Advisors: LCDR John Gleason, Prof. Alan Strong, Ms. Louise Wallendorf*

THOMAS KOLOMAN KISS, 1988 "The Effects of Transom Geometry on the Resistance of Large Surface Combatants" *Faculty Advisor: Professor Roger Compton*

DAVID BRYANT WALKER, 1989. "Viscous Drag Reduction for Slender Surface Craft" *Faculty Advisors: Profs Maido Saarlas, Roger Compton and Dr. David Coder, DTMB*

BRIAN LLEWELLYN DAVIES, 1991 "Model Testing of Low-crested Breakwaters" *Faculty Advisor: Assistant Professor David L. Kriebel,*

CASEY JOHN MOTON, 1991 "Open-water Resistance and Seakeeping Characteristics of Ships with Ice-breaking Bows" *Faculty Advisors: Professors Roger H. Compton and Bruce C. Nehrling,*

KYLE TRAVIS TURCO, 1993 "Development of an Interface System for the Design of Submersible Internal Arrangements and Hull Forms" *Faculty Advisors: Professor Bruce Johnson and Lieutenant Commander William A. Davison, USN, Ms. Nancy Anderson Harris*

MICHAEL CONNERY BECKETTE, 1996 "Economic Tradeoffs of Beach Renourishment"*Faculty Advisors: Professor Bruce Johnson and Associate Professor David L. Kriebel*

CHAD ARNOLD BOLLMANN, 1996. "Wave Interaction with Vertical Wave Barriers" *Faculty Advisor: Associate Professor David L. Kriebel,*

TULLIO CELANO, III, 1998, "The Prediction of Porpoising Inception for Modern Planing Craft" *Faculty Advisor, Professor Roger Compton*

JON P. SILVERBERG, 2003 "Methods of Ship Performance Prediction and Design with Respect to Tank Testing and Computational Fluid Dynamics" *Faculty Advisor: Assistant Professor Paul H. Miller,* NAOE

THOMAS SHAPIRO, 2004 "The Effect of Surface Roughness on Hydrodynamic Drag and Turbulence" *Faculty Advisors Professors Michael Schultz and Karen Flack*

JASON MURPHY, 2010 "A Novel Approach to Turbulence Stimulation for Ship-Model Testing" *Faculty Advisors: Professors Michael Shultz and Greg White*

Note that the large increase in the number of Midshipman Independent Research Projects such as those in Appendix 4 was the result of increasing the efficiency of Hydromechanics Lab setup, testing and analysis methods. These projects, some spanning two semesters, can frequently match the research level of the earlier Trident Scholar Projects using the Hydromechanics Laboratory. Thus, Trident Scholar projects have trailed off since the mid 1990s

Appendix 4: Abstracts of Recent Midshipman Research Projects,Prepared by Professor Michael Schultz, Associate Director, NAHL

Fall AY-2003 – Midn 1/C Alexandra Myers conducted an independent research project entitled "Comparison of Three Roughness Function Determination Methods". In this study, Midn Myers gathered experimental data using a novel disk drag measurement system at NSWC-Carderock. She compared the results obtained with this system to those obtained by Professor Schultz using two standard drag determination methods. Her research indicated that the disk drag measurement device produces results that agree with the results of the standard methods, with the advantage of its much lower cost and smaller size. The following midshipman co-authored journal paper resulted from this research:

M.P. Schultz & A. Myers (2003), "Comparison of Three Roughness Function Determination Methods," Experiments in Fluids, Vol. 35, pp. 372-379.

Fall AY-2004 – Midn 1/C Karin Wareing carried out research entitled "Effect of Helical Strakes on the Near-Wake of a Circular Cylinder". She set up and used a stereo particle image velocimeter (PIV) to investigate the alteration in the vortex structure behind a cylinder as a result of adding a helical appendage or strake. These devices are most commonly seen on automobile antenna aerials in which they are employed to reduce vortex induced vibrations and, therefore, reduce aerodynamic loads. Midn Wareing's results showed that the strake did not significantly change the alternating vortex pattern behind the cylinder or its characteristic frequency. Instead the major effect of the strake was to break up the spanwise coherence of the vortex by altering its phase along the span.

Fall AY-2004 – Midn 2/C Jonathan Connelly investigated the design, construction, and testing of an AC-current based, ocean wave energy conversion system. He built and tested several prototype magnet-coil AC generators and a buoyancy system in order to maximize the heave response amplitude in the prevailing wave climate. The long term goal is to develop a cost-effective system for harnessing the energy of the sea. Midn Connelly was the recipient of the 2004 NAOE Departmental Outstanding Independent Research Award for this research. He is the only 2/C to have ever received the award.

J.S. Connelly, M.P. Schultz, & K.A. Flack (2006), "Velocity-Defect Scaling for Turbulent Boundary Layers with a Range of Relative Roughness," Experiments in Fluids, Vol. 40, pp. 188-195.

K.A. Flack, M.P. Schultz, & J.S. Connelly (2007), "Examination of a Critical Roughness Height for Wall Similarity," Physics of Fluids, Vol. 19, Art. No. 095104, 9 pp.

Fall/Spring AY-2004 (co-advised by Professors Michael Schultz and Prof. Karen Flack) – Midn 1/C Thomas Shapiro, a Trident Scholar, conducted research entitled "The Effect of Surface Roughness on Hydrodynamic Drag and Turbulence". The goal of the study was to identify the appropriate length scales for modeling the effect of roughness on drag and to find the maximum roughness height for which current boundary layer models are valid. The overarching aim of this ongoing study, sponsored by ONR, is to obtain a better ability to predict the skin friction drag of a surface of any texture. The following midshipman co-authored journal paper resulted from this research:

K.A. Flack, M.P. Schultz, & T.A. Shapiro (2005), "Experimental Support for Townsend's Reynolds Number Similarity Hypothesis for Rough Walls," Physics of Fluids, Vol. 17, Art. No. 035102, 9 pp.

Fall/Spring AY-2005 (co-advised co-advised by Professors Michael Schultz and Prof. Karen Flack) – Midn 1/C Jonathan Connelly studied mean velocity scaling in turbulent boundary layers over smooth and rough walls. This investigation included turbulence measurements over the widest range of relative roughness ever carried out in a single facility. These results are of practical importance since current computational codes model rough wall flows based on mean flow similarity with smooth walls. If this is not valid, their predictions are inherently flawed. Midn Connelly's results indicate that, contrary to the published results of several recent studies, classic scaling of the velocity defect collapses both the smooth and rough wall profiles. He has also shown that the new scaling developed by the Princeton group of Zagarola & Smits for smooth walls based purely on theoretical grounds is very effective at collapsing both the smooth and rough wall profiles. These results demonstrate that current computational codes should be capable of accurate predictions of drag for surfaces with a wide range of roughness. Midn Connelly was the recipient of the 2005 NAOE Departmental Outstanding Independent Research Award for this research. The following midshipman co-authored journal papers resulted from this research:

J.S. Connelly, M.P. Schultz, & K.A. Flack (2006), "Velocity-Defect Scaling for Turbulent Boundary

Layers with a Range of Relative Roughness," Experiments in Fluids, Vol. 40, pp. 188-195.

K.A. Flack, M.P. Schultz, & J.S. Connelly (2007), "Examination of a Critical Roughness Height for Wall Similarity," Physics of Fluids, Vol. 19, Art. No. 095104, 9 pp.

Spring AY-2008 (co-advised co-advised by Professors Michael Schultz and Prof. Dave Kriebel) – Midn 1/C Ian Gill studied possibility of drag reduction on palm trees trunks via growth rings. This work was inspired by the observations in Thailand after the tsunami by Prof. Dave Kriebel. He noted that palm trees withstood very strong flooding currents while other similar-sized, stronger concrete columns failed. Midn Gill compared the drag force and flow field around a palm model with a plain cylinder and observed no significant differences. The observation was, therefore, most likely due to the compliance of the palm tree which gave it the ability to "go with the flow" rather than fail and was not a drag reduction effect. Midn Gill was the recipient of the 2008 NAOE Departmental Outstanding Independent Research Award for this research.

Fall AY-2009 – Midn 1/C William Revell conducted research on the use of superhydrophobic surfaces (i.e. very water repellant) for turbulent drag reduction. The use of water-repellant walls with microtopography has shown promise in inducing fluid slip at the wall leading to drag reduction in laminar flows. However, few, if any, data are available for the turbulent flow regime, which dominates engineering applications. Preliminary results of this research have shown no appreciable drag reduction for these surfaces in the turbulent flow regime, although further work is planned.

Fall/Spring AY-2010 (co-advised by Professors Michael Schultz and Prof. Greg White) – Midn 1/C Jason Murphy, a Trident Scholar, is presently carrying out research entitled "A Novel Approach to Turbulence Stimulation for Ship-Model Testing". The research is focused on applying computational tools to provide a more rational approach to the sizing and placement of flow tripping devices for ship-model towing tank experiments. At present, the sizing and placement of these devices is guided by experience and simple empirical rules. While this approach is typically adequate for large, high-speed models, it falls short in the case of smaller, slower-moving models since it does not address the physics of the problem. It is hoped that a more physical approach to the problem will give rise to improved accuracy in extrapolation from ship-model tests for smaller models.

Appendix 5: Example Research Projects Conducted in the Coastal Tank

NFESC CONTINUES THE LONG-STANDING TRADITION OF WORKING WITH THE U.S. NAVAL ACADEMY IN THE FIELD OF OCEAN ENGINEERING 27 Oct 2009

The outstanding capabilities of the U.S. Naval Academy (USNA) staff, technicians, students and facilities continue to support the unique technical capability of the Naval Facilities Engineering Service Center (NFESC) in many ways. This cooperative effort has been going on for decades and some of the key products of the NFESC-USNA Ocean Engineering teamwork are outlined below. Sponsors for this important work include:

- Office of Naval Research (ONR)
- NAVFAC Engineering Innovation & Criteria Office
- Chief of Naval Installations (CNI)
- California State Lands Commission
- And others

WATERFRONT SECURITY

It is vitally important that the some $300B worth of U.S. Navy ships and 100,000+ sailors be protected when in

harbor. The USNA performed critical wave tests, towing tests, wind tunnel tests and provided support in developing three key waterfront boat barriers:

- Port Security Barrier (PSB)
- Near Port Security Barrier (N-PSB)
- Transportable Anti-Boat Barrier (TABBS)

Figure 1, for example, shows a scale model test of the Port Security Barrier conducted at USNA facilities. Figure 2 shows a PSB model tested in a current equal to 1 knot at full scale.

Figure 1 - NFESC Engineer participating in a USNA scale model test of the Port Security Barrier (PSB)

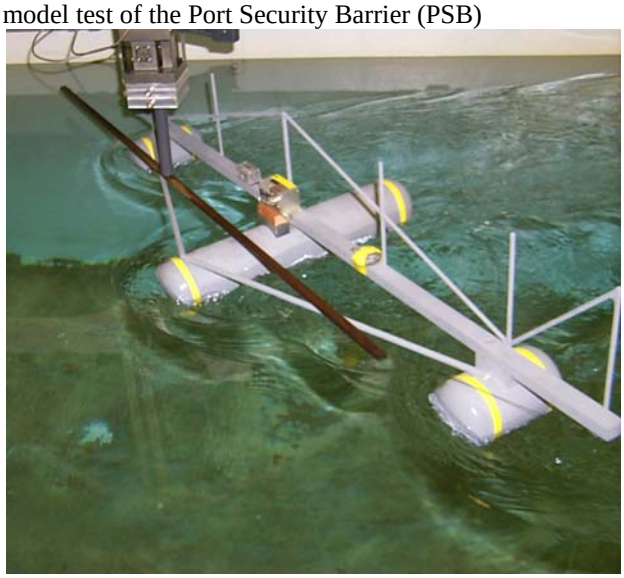


Figure 2 - PSB model tested at USNA to determine Forces in a steady current

Some reports resulting from this work include

Henry, J. and Kriebel, D.2001 “Physical Scale-Model Testing of the Port Security Barrier PSB and N-PSB Systems”, NFESC TR-6041-OCN, 14 Dec. 2001.

McCoy, J., Seelig, W. and Taylor, R., 2003“Transportable Anti-Boat Barrier Design Criteria – Executive Summary”, NFESC TM-6011-OCN, 01 July 2003.

Miller, P.,2002 “Composite Materials Port Security Barrier Feasibility Study”, USNA, Report EW-04-02, Sept. 2002.

Nixon, L., Taylor, R., Seelig, W. and Slaughter, S.,2004 U.S. Patent 6,681,709, "A Port Security Barrier System", January 27, 2004.

Seelig, W., “Connector Loads in Port Security Barrier and TABBS Gates”,2004 NFESC TM-6014-OCN, 27 April 2004.

Seelig, W., and Taylor, R. “Waterfront Boat Barrier Design Criteria”,2003 NFESC TR-6050-OCN, 29 Aug 2003.

Seelig, W. and McCoy, J., 2002“N-PSB Storm Mooring Design, U.S. Naval Submarine Bases, Bangor, WA and Kings Bay, GA”, NFESC Report SSR-6344-OCN, 13 Aug. 2002.

Seelig, W. and Slaughter, S.,2001 “Waterfront Boat Barrier Design, Southern Entrance, U.S. Naval Submarine Base, Kings Bay, GA”, NFESC SSR-6294-OCN, Dec. 2001.

SHIP MOORING

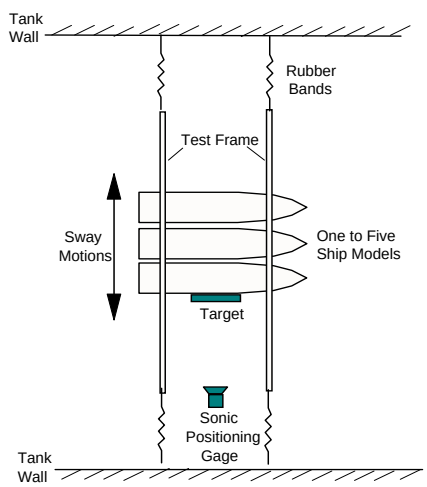


Figure 3 - USNA Mooring Tests on Multiple Moored Ships

Home ported or visiting aircraft carriers, submarines and surface ships routinely moor at piers and wharves when in harbors. These ships must be safely moored to ensure the ships remain at berth, even in sometime extreme conditions. The USNA has performed a number of scale model tests that have significantly improved the Navy's mooring technology. Figure 3 shows a model tests setup in which the characteristics of multiple moored ships were evaluated. Selected references include:

Kriebel, D., Rollings, S. and Hipp, B., "Added Mass and Damping Characteristics for Multiple Moored Ships", NFESC CR-6129-OCN, 18 Jan 1999.

Kriebel, D. and Zseleczky, J., "Evaluation of Viscous Damping Models for Single-Point Mooring Simulation," USNA Report EW-9-90, 1990.

Seelig, W. (ed), "Mooring Design", UFC 4-159-03, 14 Apr 2005.

Seelig, W. , "Mooring Design and Inspection Criteria", report prepared for Calif. State Lands Commission, NFESC Report TR-6009-OCN, Jan. 1999.

Seelig, W., Headland, J. and, Kriebel, D., "Broadside Current Forces on Ships", Proceedings, Civil Engineering in the Oceans V, ASCE, 1992.

PASSING SHIP EFFECTS

A ship in transit can produce massive dynamic forces and moments on a nearby moored ship (Figure 3). One of the best ways to study this phenomena is through the use of scaled physical model tests where conditions can be carefully monitored, the influence of parameters systematically investigated and tests repeated.

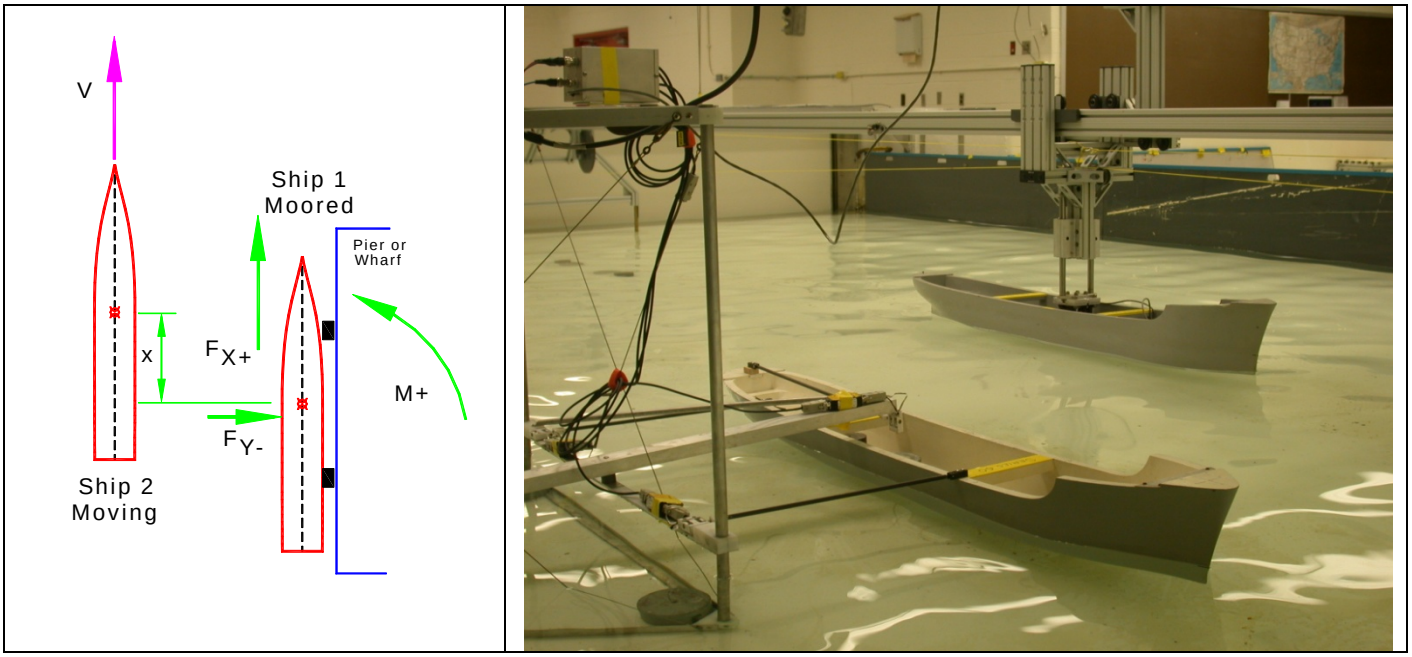


Figure 4 - Passing ship influencing a moored ship; model tests conducted at USNA

Kriebel, D., Seelig, W. and Eskijian, M., "Mooring Loads Due to Perpendicular Passing Ships", NFESC TR-6069-OCN, 16 Aug 2007.

Kriebel, D., Seelig, W. and Eskijian, M., "Mooring Loads Due to Parallel Passing Ships", NFESC TR-6056-OCN, 30 Sep. 2005.

Seelig, W., Kriebel, D. and Eskijian, M., "Recent Developments in Passing Ship Effects on Moored Ships", ASCE, Abstract submitted to Ports '04.
Seelig, W., "Evaluation of Passing Ship Effects on Moored Ships", NFESC TM-6008-OCN, Sept. 2003.
Seelig, W., "Passing Ship Effects on Moored Ships", NFESC TR-6027-OCN, 20 Nov. 2001.

SHIP WAVES

As a ship moves through the water it generates waves (Figure 5), which have been studied extensively for deep water. However, a ship in shallower water may produce drastically different ship wave characteristics. Understanding these waves is needed to improve port safety, minimize shore erosion and for use in channel design. Scale model and full scale tests at the USNA investigated ship wave effects ranging from deep to shallow water.

References on Ship Waves

Kreibel, D. and Seelig, W., "An Empirical Model for Ship-Generated Waves", Waves 2005 Conference, July 2005.
Kreibel, D. and Seelig, W., "Universal Approach to Determining Ship Wave Characteristics", Coastal Engineering Conference, 2002.
McCormick, M. E. and Bhattacharyya, R., "A Surveillance Aspect of Ship Wave Measurements", Naval Engineers Journal, Vo. 93, Num. 1, pp. 85- 88, Feb. 1981.
Seelig, W. and Kriebel, D., "Ship-Generated Waves", NFESC TR-6022-OCN, 29 Nov. 2001.
Zseleczky, J., "Shallow Water Wave Measurements for a Series 60 Model", USNA, Division of Engineering and Weapons, Preport HL-01-02, Apr. 2001.
Zseleczky, J., "EHP Model Tests of USNA Model YP 81-5 with an Extended Afterbody and Stern Wedges", USNA, Division of Engineering and Weapons, Preport EW-12-94, June 1994.
Zseleczky, J. and Hays, B. , "FFG-7 Model Powering Tests With and Without A Stern Wedge", USNA, Division of Engineering and Weapons, Preport EW-28-84, Dec. 1984.

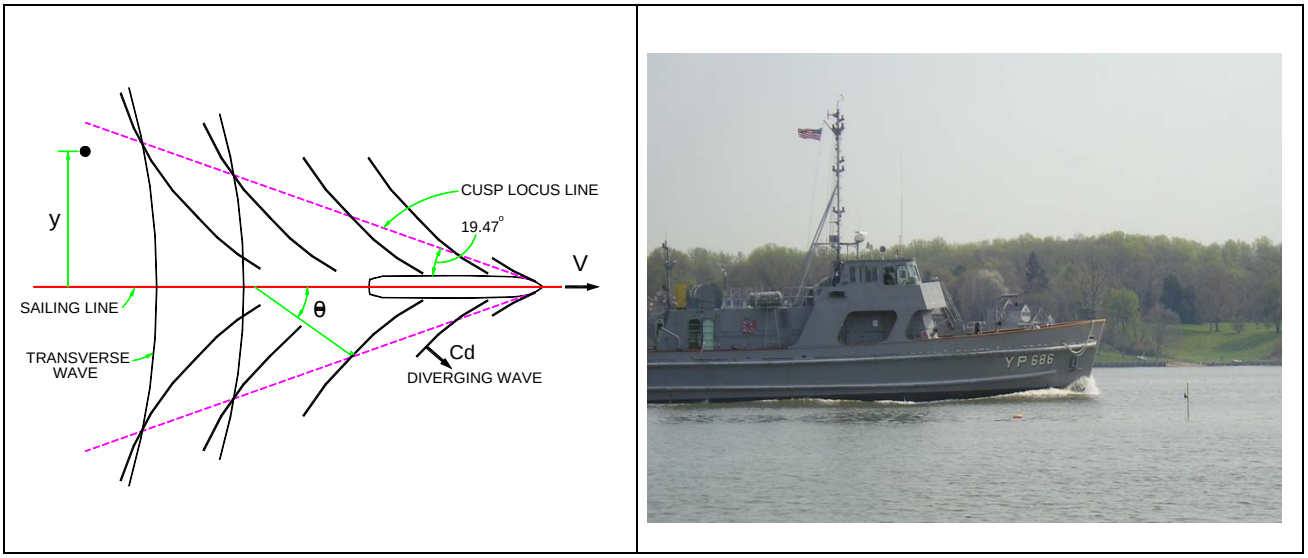


Figure 5 - Full scale and model scale measurements of ship waves

MOBILE OFFSHORE BASE

Physical Model Test

Several sets of physical model tests were performed on a generic module of a Mobile Offshore Base (MOB). In one test series, the MOB module was towed using a shallow draft in both head and following seas to assess its dynamic motions in transit conditions. In a second set of tests, the MOB module was ballasted to a deep draft and tested in severe seas, up to sea state 8, in order to assess the reduced air gap that results from dynamic heave and pitch motions coupled with nonlinear wave runup and upwelling. Data from both studies were provided to other contractors performing numerical modeling studies of the MOB.

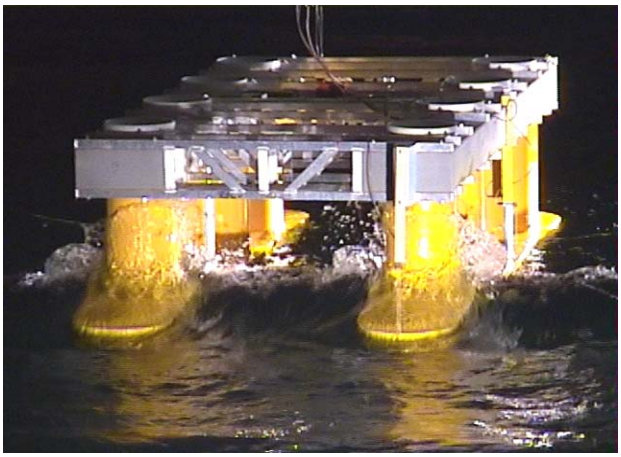


Figure 6 - Mobile Offshore Base

Falzarano, J., Kalyan, U., Rodriguez, W., Vassilev, R., and Kriebel, D., MOB SBU Transit Draft Dynamics and Stability Analytical Study," 3rd Intl. Conf. on Very Large Floating Structures," Honolulu, 1999, pp. 562-566.

Kriebel, D. and Wallendorf, L., "Transit Tests on a MOB Module," US Naval Academy Division of Engineering and Weapons Report EW-11-00, 30 September 2000.

Kriebel, D. and Wallendorf, L., 2001, "Air Gap Model Tests on a MOB Module," Proc. 10th Intl. Conf. on Offshore and Polar Engineering, Stavanger, Norway, June 2001.

Kriebel, D., 2001, "Wave Amplification and Air Gap Tests on a MOB Module," Proc. 24th US-Japan Marine Facilities Panel, US-Japan Cooperative Program in Natural Resources, Honolulu, HI.

Kriebel, D. and Wallendorf, L., 1999, Physical Model Tests on a Generic MOB Module," Prof. Conf. On Very large Floating Structures, Honolulu, HI, Sept. 1999

AIRCRAFT CARRIER, SUBMARINE AND SHIP BERTHING

When an aircraft carrier, submarine or ship berths at a pier/wharf the incoming kinetic energy of the ship is stopped by the fenders. How 'hard" does the vessel hit and what is the peak load in the fender(s)?

It turns out a significant amount of work has been performed on this topic over past decades. Unfortunately, a key parameter, the added mass of water entrained with the ship, has never been properly quantified.

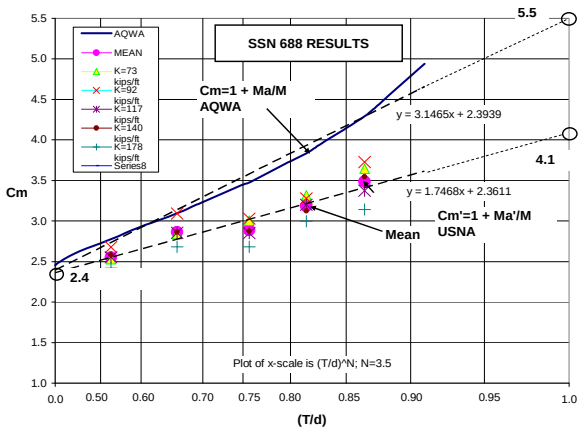
Therefore, the NAVFAC Engineering Innovation & Criteria Office Special Assistant for Waterfront & Harbors tasked NAVFAC ESC and the U.S. Naval Academy to develop berthing tools/methods.

A combination of numerical simulations, re-analysis of past data by others and physical model tests were conducted. For example, many thousands of numerical simulations were conducted and 244 physical model tests of berthing submarines (Figure 7) were conducted in the USNA Coastal Basin in July 2009 and aircraft carrier tests are planned late in 2009. To date the results are highly promising and show that simple methods provide highly reliable results.

Note that vessel berthing is important at U.S. Navy waterfront facilities around the world. Therefore, this project was used as an excellent opportunity for NAVFAC Intern training. For example, NAVFAC Atlantic Intern Ashley Severin ran the 244 submarine berthing tests (Figure 7). "She was great!" reported Professor Kriebel of USNA. "Ashley ran the tests and immediately emailed me tests results in real time. Together we got all the 244 tests run and got the engineering information the customer needed in less than 2 weeks from start of testing. Amazing!", said Kriebel.

Another NAVFAC Atlantic intern is being lined up for the planned aircraft carrier tests later in 2010.

Ashley Severin, NAVFAC Atlantic Intern, Running USNA Submarine Berthing Tests



Berthing Added Mass Coefficients for Submarines

Figure 7 - Submarine scale model berthing tests and results July 2009

Seelig, W., Kriebel, D, Severin, A, "Added Mass for Berthing U.S. Navy Vessels – Executive Summary", NFESC TR-6074-OCN, 14 Oct. 2009 (draft).

Seelig, W. and Kriebel, D., "Interim Technical Guidance: Submarine Berthing Peak Fender Load Calculations", 17 July 2009 (draft).

Appendix 6: Additional References to Research associated with the Naval Academy Hydromechanics Laboratory Water Channel Facilities

1. K.A. Flack & M.P. Schultz (2010), "Hydraulic Roughness Scales in the Fully Rough Regime," accepted and in final form for *ASME Journal of Fluids Engineering*.
2. M.P. Schultz & K.A. Flack (2009), "Turbulent Boundary Layers over a Systematically-Varied Rough Wall," *Physics of Fluids*, Vol. 21, Art. No. 015104, 9 pp.
3. R.J. Volino, M.P. Schultz, & K.A. Flack (2009), "Turbulence Structure in a Boundary Layer with Two-Dimensional Roughness," *Journal of Fluid Mechanics*, Vol. 635, pp. 75-101.
4. M.P. Schultz & K.A. Flack (2007), "The Rough-Wall Turbulent Boundary Layer from the Hydraulically Smooth to the Fully Rough Regime," *Journal of Fluid Mechanics*, Vol. 580, pp. 381-405.
5. M.P. Schultz (2007), "Effects of Coating Roughness and Biofouling on Ship Resistance and Powering," *Biofouling*, Vol. 23, pp. 331-341.
6. K.A. Flack, M.P. Schultz, & J.S. Connelly (2007), "Examination of a Critical Roughness Height for Wall Similarity," *Physics of Fluids*, Vol. 19, Art. No. 095104, 9 pp.
7. R.J. Volino, M.P. Schultz, & K.A. Flack (2007), "The Turbulence Structure in Rough- and Smooth-Wall Boundary Layers," *Journal of Fluid Mechanics*, Vol. 592, pp. 263-293.
8. J.S. Connelly, M.P. Schultz, & K.A. Flack (2006), "Velocity-Defect Scaling for Turbulent Boundary Layers with a Range of Relative Roughness," *Experiments in Fluids*, Vol. 40, pp. 188-195.
9. K.A. Flack, M.P. Schultz, & T.A. Shapiro (2005), "Experimental Support for Townsend's Reynolds Number Similarity Hypothesis for Rough Walls," *Physics of Fluids*, Vol. 17, Art. No. 035102, 9 pp.
10. M.P. Schultz & K.A. Flack (2005), "Outer Layer Similarity in Fully Rough Turbulent Boundary Layers,"*Experiments in Fluids*, Vol. 38, pp. 328-340.
11. M.P. Schultz (2004), "Frictional Resistance of Antifouling Coating Systems," *ASME Journal of Fluids Engineering*, Vol. 126, pp. 1039-1047.
12. M.P. Schultz & K.A. Flack (2003), "Turbulent Boundary Layers over Surfaces Smoothed by Sanding,"*ASME Journal of Fluids Engineering*, Vol. 125, pp. 863-870.
13. M.P. Schultz & A. Myers (2003), "Comparison of Three Roughness Function Determination Methods,"*Experiments in Fluids*, Vol. 35, pp. 372-379.
14. M.P. Schultz (2002), "The Relationship between Frictional Resistance and Roughness for Surfaces Smoothed by Sanding," *ASME Journal of Fluids Engineering*, Vol. 124, No. 2, pp. 492-499.

Figure 1: Low Turbulence water channel used for PIV based research

Figure 2 Low Turbulence water channel pumps

Figure 3: Low Turbulence water channel cooling system to maintain constant Reynolds Number flow for PIV traverses

Appendix 7 List of Hydromechanics Laboratory Reports Catalogued by Pam Majors

HYDROMECHANICS LABORATORY RESEARCH REPORT LIBRARY

Copies of all reports listed exist in lab archives except where noted.

HYDROMECHANICS LABORATORY RESEARCH REPORTS
2009 - 2000

EW-02-09 Effective Horsepower and Seakeeping Tests on a Model of the USNA Yard Patrol Replacement YP(R) Hull – Nehrling March 2009

EW-03-07 Seakeeping Tests on a Mobile Landing Platform (MLP) Model In Regular Waves – Zseleczky/Nehrling 2007 (1 copy)

EW-01-07 Effective Horsepower and Seakeeping Tests on a High Speed Sealift (HSSL) SWATH Model – Beaver March 2007

EW-04-03 Effective Horsepower Model Testing of an 18th Century Sailing Warship; USS Constitution (IX-21) - White/Hill; May 03 (Report Not Found - No Copy Available)

EW-03-01 Slow-Speed and Zero-Speed Seakeeping Model Tests Of 220 LT MCM (XH) HYSWAS Hull Form – White/Harris; Jul 01 (Report Not Found - No Copy Available)

EW-09-00 USS CONSTITUTION Grand Parade Of Sail Tall Ship 2000 – Harris/Enzinger; Aug 00 (2 copies)

RESEARCH REPORTS
1999 - 1997

EW-01-99 Effective Horsepower and Seakeeping Tests on a Trimaran Model – Harris; Mar 99 (2 copies)

EW-09-98 Motions of an Unmanned Underwater Vehicle (UUV) In Wind and Waves Zseleczky; Aug 98 (1 copy)

EW-13-98 Effective Horsepower and Seakeeping Tests of a Catamaran research Vessel Harris; Dec 98 (2 copies)

EW-02-97 Measurements of Breaking Wave Loads on A Moving Partially Submerged Cylinder - Zseleczky; Mar 97 (1 copy)

EW-12-97 Methods For Minimizing Variations in Drag and Speed for Diver Propulsion Vehicles – Nuckols (1 copy)

RESEARCH REPORTS
1996

EW-01-96 Intact Stability Criteria Revision Project -Part IV- Physical Model/FREDYN 5.01 Correlation - Compton/Nehrling/Shaughnessy; Jan 96 (1 copy)

EW-04-96 Towline Force Measurement for a 1/7th Scale Model of the ASDS Submersible – Zseleczky; Feb 96 (2 copies)

EW-09-96 Ship Stability Criteria Revision Project: Intact and Damaged Model Testing of a HAMILTON Class Cutter (WHEC) at Zero Speed in Wind and Waves – Compton/Nehrling/Shaughnessy; Aug 95 (2 copies)

EW-17-96 Resistance and Seakeeping Model Tests of a Hard Chine Planing Hull - Zseleczky; June 96 (1 copy)

EW-18-96 Resistance and Seakeeping Model Tests of a Wave Piercing Hull - Zseleczky; June 96 (1 copy)

RESEARCH REPORTS
1995 - 1994

EW-20-95 Force and Moment Measurements on a Series of Low Length/Beam Submarine Models - Phase II - Zseleczky; Jul 95 (Report Not Found - No Copy Available)

EW-07-94 Intact Stability Criteria Revision Project -Part II- Model Testing of a U.S. Coast Guard Cutter's Roll Dynamics for FREDYN Data Base Building – Shaughnessy/Nehrling/Compton (2 copies)

EW-08-94 Intact Stability Criteria Revision Project -Part III- Model Testing of a U.S. Coast Guard Cutter's Roll Dynamics for FREDYN Data Base Building - Shaughnessy/Nehrling/Compton (1 copy)

EW-11-94 Intact Stability Criteria Revision Project -Part IV- Physical Model/FREDYN Correlation - Compton/Nehrling/Shaughnessy (Report Not Found - No Copy Available)

EW-12-94 EHP Model Tests of USNA Model YP-81-5 with an Extended Afterbody & Stern Wedges - Zseleczky (2 copies)

EW-20-94 Extreme Roll Motions of a Navy Frigate Model in Large Beam Seas – Zseleczky/Wallendorf; Oct 94 (2 copies)

RESEARCH REPORTS
1993 - 1991

EW-02-93 A Jack Up Semi-Submersible for UTC Operations - Mayer/Wallendorf (Report Not Found - No Copy Available)

EW-07-93 Experimental Studies of Ship Stability in Beam Winds & Waves - Compton/Midn Chong/Midn Escamilla (1 copy)

EW-11-93 Still Water Performance of a Series of Hard Chine Prismatic Planing Hulls - ENS Scott (Report Not Found - No Copy Available)

EW-18-93 An Experimental Investigation of a Line Array of Charges Descending and Being Towed - Granger/Enzinger/Shaughnessy/Bunker (Report Not Found - No Copy Available)

EW-19-93 Intact Stability Criteria Revision Project -Part I- Model Test Predictions of Sea Trial Performance of Two U.S. Coast Guard Cutters: Zero Speed Pitch and Roll Motions in Wind and Waves - Shaughnessy/Nehrling/Compton (1 copy)

EW-13-92 SWATH "T-AGOS 19" Ruddelizer Loading in Irregular Waves – Compton/Shaughnessy (Report Not Found - No Copy Available)

EW-22-92 Force & Moment Measurements on a Series of Low Length/Beam Submarine Models - Zseleczky/Gillerlain (2 copies)
EW-04-91 Resistance & Thrust Measurements of a Dive Propulsion Vehicle – Zseleczky (1 copy)
EW-06-91 Systematic Series of Icebreaking Bow Shapes: Open Water Resistance & Head Seas Response Measured Data Base - Enzinger/Bunker/Midn Moton (Report Not Found - No Copy Available)
EW-11-91 Comparative Testing of Pontoon-Based Flotation Systems for The Bradley Fighting Vehicle – LT John Braun USN (1 copy)
EW-19-91 An Eval of Small Scale Model Tests in Assessing Sub Stability Under Ice – Waters (2 copies)
EW-20-91 An Experimental Validation of Roll Gyradius Assumptions & Roll Decay Model Test Procedure - Anderson (2 copies)

RESEARCH REPORTS
1990 - 1989

EW-02-90 The Effects of Transom Geometry on the Resistance of Large Surface Combatants - Kiss/Compton (1 copy)
EW-03-90 Effective Horsepower Model Tests of the USCG 120' Heritage Class WPB with Stern Tunnels – Zseleczky (1 copy)
EW-04-90 U.S. Army PACK Air Cushion Vehicle Model Tests - Zseleczky/ENS Roberts (Report Not Found - No Copy Available)
EW-08-90 Resistance and Seakeeping Database for USCG 157 Ft. WLM – Compton (2 copies)
EW-09-90 Evaluation of Viscous Damping Models for Single Point Mooring Simulation – Zseleczky/Kriebel (1 copy)
EW-01-89 Open Water Powering and Seakeeping Experiments on an Ice Breaking Hull Form- Nehrling (Report Not Found - No Copy Available)
EW-04-89 Resistance and Seakeeping Database for a U.S. Coast Guard 180 Ft. WLB – Compton (1 copy)
EW-05-89 Analysis Methods for Evaluating Motions and Accelerations of Planing Boats in Waves - Zseleczky/McKee (Report Not Found - No Copy Available)
EW-06-89 Model Tests to Evaluate the Capsize Resistance of a Motor Lifeboat in Breaking Waves- Zseleczky/Cohen (Report Not Found - No Copy Available)
EW-07-89 Report of the New Facilities and Techniques Committee to the 22nd ATTC – Zseleczky (Report Not Found - No Copy Available)

RESEARCH REPORTS
1988 - 1987

EW-05-88 Effective Horsepower Model Tests of the U.S. Coast Guard 47' Motor Lifeboat (MLB) – Zseleczky (1 copy)
EW-07-88 Seakeeping Model Testing of the U.S. Coast Guard 47' Motor Lifeboat (MLB) -Zseleczky (1 copy)
EW-09-88 A Study of the Bow Spray Phenomenon on the YP676 Class – Hudgens (Report Not Found - No Copy Available)
EW-15-88 Ship Survivability: An Experimental Study- Compton (1 copy)
EW-16-88 An Experimental Investigation into the Stability and Motions of a Damaged SWATH Ship - Nehrling/Enzinger (1 copy)
EW-18-88 Experimental Study of Wave Group in Deep Water Random Waves – Dawson/Kriebel/Wallendorf (2 copy)
EW-02-87 The Effects of Waves on Transverse Stability- Gonzales (1 copy)
EW-03-87 An Experimental Analysis of the Effects of Pitch Gyradius on Added Ship Resistance in Waves – Kiss (1 copy)
EW-07-87 An Experimental Investigation of the Kinematics of Breaking Waves – Duncan/Wallendorf/Johnson (Report Not Found - No Copy Available)
EW-05-87 Hydrodynamic Resistance of a Diver – Enzinger (1 copy)
EW-10-87 A Comparison of Testing Methods for Added Resistance Due to Waves - Gregus (1 copy)
EW-14-87 Model Tests to Compare Capsize Resistance of the USCG 44' MLB and Proposed 47' MLB in Breaking Waves - Zseleczky/Wallendorf/Duncan (Report Not Found -No Copy Available)

RESEARCH REPORTS
1986

EW-01-86 Laboratory Status Report (1 copy)
EW-03-86 Evaluation of a Proposed Buoyancy Support System for USS Constitution – Chatterton (Report Not Found - No Copy Available)
EW-04-86 Resistance and Seakeeping Data Base for USCG 210 WMEC - Hill (Report Not Found - No Copy Available)
EW-10-86 Investigation of Trim Instability in a High Speed Planing Craft (1 copy)
EW-12-86 Evaluation of Using the Fast Yacht Program to Duplicate the Hull Form of an Existing Ship Design (USCG B-AL Icebreaker) - Fitzgerald (Report Not Found - No Copy Available)
EW-13-86 Grounded Stability Experiments on a Polar Icebreakers - Nehrling/Enzinger (1 copy)
EW-19-86 Effective Horsepower Tests of a U.S. Coast Guard 44' Motor Lifeboat – Sheedy/Kiss (1 copy)
EW-28-86 Resistance and Seakeeping Data Base for a USCG 180 Ft WLB - Parts I & II – (Report Not Found - No Copy Available)

RESEARCH REPORTS
1985

EW-01-85 A Theoretical and Experimental Study of the Motions of Hinged-Barges in Long Crested Seas - M. McCormick (1 copy)
EW-02-85 Laboratory Status Report (2 copies)

EW-03-85 Interim Report on Yacht Roll Gyradius Study - B. Hays (2 copies)
EW-04-85 Powering Experiment in Deep and Shallow Water for a USCG Tug Barge Combination - Nehrling/Enzinger (2 copies)
EW-05-85 Laboratory Status Report (Report Not Found - No Copy Available)
EW-06-85 Laboratory Status Report (2 copies)
EW-07-85 Seakeeping Model Tests of a USCG Patrol Boat (WPB) Zseleczky (2 copies)
EW-08-85 (See Trident Papers - J. Hoyle)
EW-09-85 Laboratory Status Report (Report Not Found - No Copy Available)
EW-10-85 Resistance Test on USCG Icebreaker Series – Enzinger (1 copy)
EW-11-85 Evaluation and User's Manual for a Planing Hull Performance Prediction Computer Program - M. Hanrahan (Report Not Found - No Copy Available)
EW-16-85 Evaluation and User's Manual for an Auto-Regressive Modeling Program for Time Series Data Analysis Employing the Akaike Information Criterion - J. MacStravic (Report Not Found - No Copy Available)
EW-17-85 Resistance and Seakeeping Data Base for USCG 327' WHEC – Chatterton (Report Not Found - No Copy Available)
EW-19-85 Laboratory Status Report (Report Not Found - No Copy Available)

RESEARCH REPORTS
1984

EW-01-84 Laboratory Status Reports (2 copies)
EW-02-84 Resistance and Seakeeping Data Base for a USCG 210 Ft WMEC with MidBody Section Added Part I - Chatterton (2 copies)
EW-03-84 Resistance and Seakeeping Data Base for a USCG 270 Ft WMEC – Chatterton (Report Not Found - No Copy Available)
EW-06-84 The Effects of a Bow Bulb and Various Stern Wedges on the EHP of FFG-7 Class Frigates - Bruce Johnson & John Zseleczky (1 copy)
EW-10-84 Laboratory Status Report (2 copies)
EW-15-84 Evaluation of the Kort Nozzle Design for the U.S. Coast Guard 140 WYTM Cutter - T. Langan (1 copy)
EW-16-84 Laboratory Status Report (2 copies)
EW-17-84 The Effect of Bow Shape on Deck Wetness in Head Seas - Dr. Lloyd (Report Not Found - No Copy Available)
EW-21-84 Small Model Resistance Tests and Icebreaker Hull Forms - Chatterton/Enzinger (1 copy)
EW-22-84 Approximations to the Probability Density of Maxima and Minima of the Response of a Nonlinear System – Dalzell (Report Not Found - No Copy Available)
EW-24-84 Laboratory Status Reports (2 copies)
EW-25-84 Powering Experiments in Deep and Shallow Water for a Modified USCG 160' WLIC – Nehrling (2 copies)
EW-26-84 Effective Horsepower Model Tests of a USCG Patrol Boat (WPB) – Zseleczky (2 copies)
EW-27-84 Evaluation and User's Guide for the Holtrop-Mennen Approximate Power Prediction Method – Chatterton (2 copies)

RESEARCH REPORTS
1984

EW-28-84 FFG-7 Model Powering Tests With and Without a Stern Wedge - Zseleczky/Hays (2 copies)
EW-29-84 Summary of Motions Tests Using 1.7 Meter Models of Single & Twin Strut SWATHS Vessels – Chatterton (1 copy)
EW-30-84 Computer Aided Stability Demonstration and Evaluation Program "Boats" – ENS Lynn Thomas (2 copies)

RESEARCH REPORTS
1983

EW-01-83 An Experimental Study of a High Rotational Speed Propulsor (Lehman Report) (2 copies)
EW-03-83 Laboratory Status Report (2 copies)
EW-04-83 Guide to EN459 Video Tape Series (1 copy)
EW-09-83 Experimental Studies of Variable Geometry Bilge Keels – Salsich (2 copies)
EW-13-83 Laboratory Status Report (2 copies)
EW-15-83 An Experimental Comparison of Zero-Speed Seakeeping Characteristics of a Single and Double Strut SWATHS – Midn McPhereson/Midn Voigt (1 copy)
EW-16-83 Experimental Study of the Effects of Hull Form Changes on the U.S. Coast Guard 210 Ft Medium Endurance Cutter - Midn Kammerer/Midn Bevington (2 copies)
EW-18-83 Investigation of Capsizing in Breaking Waves of the U.S. Coast Guard 44 Ft Motor Life Boat - Chatterton (2 copies)
EW-22-83 Laboratory Status Report (2 copies)
EW-24-83 The Design of an Experimental Apparatus to Measure the Motions of a Towed Submersible Environmental Sensor Vehicle - R. Granger (1 copy)
EW-25-83 Investigation of Resistance and Static Stability Characteristics of a Small Waterplane Area - Twin Hull (SWATH) Vehicle – Chatterton (2 copies)
EW-26-83 Powering Comparison Experiments in Deep and Shallow Water for a U.S. Coast Guard 160' WLIC (Aids to Navigation Vessel) – Nehrling (2 copies)
EW-28-83 On the Correlation Functions Associated with Deep Water Wave Spectra - M. McCormick (1 copy)
EW-30-83 Laboratory Status Report (1 copy)
EW-36-83 A State-of-the-Art Evaluation of Small Waterplane Area Twin Hull (SWATH) Vessel Research - Calderhead/Chatterton (1 copy)

RESEARCH REPORTS
1982

EW-04-82 Intact Stability Investigation of the U.S. Coast Guard 41 Ft Utility Boat –Chatterton (2 copies)

EW-05-82 Investigation of Capsizing in Breaking Waves of the U.S. Coast Guard 41 Ft Utility Boat - Salsich/Chatterton (1 copy)
EW-06-82 Bilge Keel Trace Verification Study for FFG-7 - Salsich (1 copy)
EW-07-82 Laboratory Status Report (2 copies)
EW-09-82 A State-of-the-Art Review of Irregular Wave Generation and Analysis – Johnson (1 copy)
EW-10-82 Nonlinear Large-Amplitude Low-Frequency Ship Motions – Salvesen (2 copies)
EW-16-82 Resistance tests of a Diver - Laboratory Staff (2 copies)
EW-18-82 Laboratory Status Report (2 copies)
EW-20-82 USNA YP Replacement Model Test Program: Effective Horsepower Tests for YP81-7 – Compton (2 copies)
EW-22-82 Model Tests of Unconventional Icebreaker Hull Form - Chatterton (2 copies)
EW-23-82 Preliminary Studies of Line Pull Needed to Free Stranded Ships - T. Dawson/J. Davitt (1 copy)
EW-24-82 Turning Diameter Tests of the SWATH T-AGOS Models - Righter (2 copies)
EW-25-82 The Effects of a Bow Bulb and a Stern Wedge on a Large Waterplane, Transom Sterned Hullform - Vol I thru III - Righter/Compton (1 copy of each report)
EW-26-82 Laboratory Status Report (2 copies)
EW-28-82 Compliant Surface - Rigid Surface Resistance Tests - Enzinger (2 copies)

RESEARCH REPORTS
1981 – 1980

EW-02-81 An Experimental Analysis of the Effects of Pitch Gyradius on Ship Motion in Head Seas – Compton (2 copies)
EW-03-81 USNA YP Replacement Model Test Program - Compton/Hoyt (1 copy)
EW-05-81 A Preliminary Study for a Three-Component Laser Doppler System in Water for USNA Facilities - R. Granger (2 copies)
EW-11-81 Stability Investigation of U.S. Coast Guard Fast Surface Delivery (FSD) Sled (1 copy)
EW-00-80 Amphibious Assault Vehicle Model Test Program – Donald Bunker (1 copy)
EW-04-80 Some Experimental Results with Ship Model Acceleration Waves - S.M. Calisal (1 copy)
EW-05-80 Experimental Stability Investigation of the Fast Surface Delivery Sled – Watkins (1 copy)
EW-06-80 Model Tests of Proposed U.S. Coast Guard DDI Icebreaker – Enzinger (2 copies)

RESEARCH REPORTS
1979 - 1968

EW-2-79 HYSWAS: A Hybrid Technology Comes of Age – Midn Houseman/Midn Linn (1 copy)
EW-16-79 The Status of Naval Seakeeping Research – Edward V. Lewis – NAVSEA Research Professor (1 copy)
EW-7-78 Experimental Prediction of EHP Requirements for a Proposed YP Hull Design – R. Watkins (1 copy)
EW-12-78 Model Tests of Five Tuned Sphere Configurations – M. Malinick/R. Altmann (1copy)
EW-13-78 Model Tests of Three Free Floating Buoys – J. Hoyt (1 copy)
EW-1-77 Wave Probe Studies – John Hill March 77 (1 copy)
EW-02-77 Experimental Naval Architecture at the U.S. Naval Academy – Compton (1 copy)
EW-06-77 An Intact Hydrostatic Analysis of YP660 Compton/Enzinger/Miller/Nehrling (1 copy)
EW-05-68 The Conceptual Design of a High Performance Towing Tank for the U.S. Naval Academy - Compton/Dyer/Johnson Dec 68 (2 copies)

STUDENT RESEARCH REPORTS

Wave Force and Structure Response: A Comparison of Theoretical and Experimental Results Using
Regular and Irregular Waves - Midn Marc Rolfes 1980 (Report Not Found - No Copy Available)

A Quantitative Measure of Swim Fin Efficiency – Midn Michael Mara 1981 (1 copy)

Performance Optimization of a Pneumatic Wave Energy Conversion Device - Midn Steve Surko 1982 (Report Not Found - No Copy Available)

Optimization of Bow-Bulb Forms for Resistance and Seakeeping Characteristics: A Comparison of Existing Computer Software Predictions Methods with Experimental Results - Midn Jeff Hoyle 1985 (1 copy)

A Bulbous Bow Design Methodology for High-Speed Ships - Hoyle - 1986 SNAME Presentation (Report Not Found - No Copy Available)
An Investigation of the Hydrodynamic Characteristics of Non-Axisymmetric Bow Shapes for Submarines - Midn John DeNuto 1986 (1 copy)
A Trade-Off Study of Sonar Performance and Powering Requirements for Unconventional Sonar Domes – Midn Culbertson 1987 (1 copy)
The Effects of Transom Geometry on the Resistance of Large Surface Combatants - Midn Tom Kiss 1988 (1 copy)
Project SQUID A Human-Powered Submersible Design – Midn Richard Miller Jr 1988 (1 copy)
Viscous Drag Reduction for Slender Surface Craft - Midn David B. Walker 1989 (1 copy)
The Effect of Shallow Water on The Series 60-0.60 Hull – Midn James Schwappach 1989 (1 copy)
Open-Water Resistance and Seakeeping Characteristics of Ships with Icebreaking Bows - Midn Casey Moton 1991 (1 copy)
Development of an Interface System for the Design of Submersible Internal Arrangements and Hull Form – Midn Turco 1993 (1 copy)

Design, Testing and Analysis of a Semi-Captive Sailing Yacht Dynamometer for the 380' NAHL Towing Tank – Midn Brian Shimkaveg/Midn Dexter Hoag 1996 (1 copy)

The Prediction of Porpoising Inception for Modern Planing Craft - Midn Tullio Celano III 1998 (1 copy)

Powering Experiments in Deep and Shallow Water: A Comparison Between the USCGC Hamilton Class and a Trimaran with Varying Side Hull Positions – Midn Olmstead 1998 (1 copy)

Riblets on Single Shells – Midn Dennis McKelvey 1998 (1 copy)

Model Test Comparison Between a Trimaran and a Monohull in Regular and Irregular Waves – Midn Olmstead 1999 (1 copy)

Model Trimaran Seakeeping Tests in Regular and Irregular Head Seas at Varying Sidehull Transverse

Positions – Midn Patrick Cantwell 1999 (1 copy)

Performance Analysis of YP Series Propeller and Potential Application of Supercavitating Propeller Concept to YP Series Propeller – Midn Loke May 1999 (1 copy)

EN496: Independent Research Project: A Study of Submerged Parasitic Bodies on a Parent Hull – Midn Ethan Fiedel 2001 (1 copy)

Calm Water Testing Of the HYSWAS Concept "Streetfighter" – Midn Peter Mitalas 2001 (1 copy)

EN496: Independent Research Project: Design of a Solar-Powered Trimaran – Midn Travis Chapman 2002 (1 copy/CD)

Performance Prediction of the Mk II Navy 44 Sail Training Craft with respect to Tank Testing, Velocity Prediction Programs, and Computational Fluid Dynamics – Midn Jon Silverburg 2003 (1 copy)

Developing a Safe and Efficient Surface Maneuvering Envelope for Submarines – Midn Seth Krueger 2005 (1 copy)

Experimental Determinations of Hydrodynamic Ciefficients for Heave Motions – Midn Emily Williams 2005 (1 copy)

Simulation of Ship Motions in a Seaway: Uncoupled, Non-liner Roll and Heave Motions in Regular, Beam Seas – Midn David Hodapp 2005 (1 copy)

Empirical Predictions of a Foil Assisted Catamaran – Midn Kenan Knieriem 2005 (1 copy)

Determining the Ideal Location of Turbulent Stimulants on a Flat Plate – Midn A. Oliveira 2006 (1 copy)

Turbulent Flow Stimulation on a Thickened Panel: An Investigation of Turbulence Stimulation Devices – Midn Rebecca Islin 2006 (1 copy)

Submarine Motions Near the Free Surface: Experimental Determination of Vertical Forces in Regular Head Seas – Midn Michael Shaughnessy 2006 (1 copy)

HYDROMECHANICS LABORATORY TECHNICAL NOTES

Sept 86 Trim and Resistance Estimates for the USCG 44' MLB Replacement Based on Small Model Tests (LBP=2.7') - J. Zseleczky (1 copy)

Hydrostatic Righting Arm Measurements for Models of the U.S. Coast Guard 44' and 47' Motor Lifeboats - J. Hudgens (Report Not Found - No Copy Available)

HL-88-1 Low Speed Resistance Measurements for the USCG 110' WPD - J. Zseleczky - Jan 1988 (1 copy)

HL-88-2 Generation of a B-Surface Model of the Ship Stability Model Used to Instruct the EN200 Class - S. Hays - Jan 1988 (1 copy)

HL-88-3 Data Summary of Model Tests on the Relative Motion of a Free-to-Surge Cylinder in Irregular Waves - L. Wallendorf - April 1988 (1 copy)

HL-88-4 Hydro Lab Data Acquisition System - L. Wallendorf/D. Kingsley - April 1988 (1 copy)

HL-88-5 Sonar Performance and Powering Requirements for Unconventional Sonar Domes - Progress Report - S. Hays - April 1988 (1 copy)

HL-88-6 Preliminary Resistance Test of Laminar Flow Submersible - Hoyt- Dec 1988 (1 copy)

HL-89-1 USNA Transom Series: Still Water Test Data Base - Original Series with A_T/A_X = 0.051" - Compton/Kiss (Report Not Found - No Copy Available)

HL-89-2 Wave Spectra Used for Ship Model Testing at the USNA Hydro Lab - Zseleczky/Wallendorf - Mar 1989 (1 copy)

HL-89-3 Instructions for Using the EHP Test Raw Data Expansion Spreadsheet - Hudgens - Aug 1989 (1 copy)

HL-89-4 Calibration Statistics Calculated by the Hydro Lab's PDP 11/50 Computer - Zseleczky - Oct 1989 (1 copy)

HL-90-2 Conversion of Hull Offsets to Fastship Surface Files Waters/Shaughnessy/Neumlist - June 1990 (1 copy)

HL-90-3 Conversion of Hull Offset to Fastship Surface Files - Waters/Shaughnessy - Nov 1990 (1 copy)

HL-91-1 Force and Moment Measurements on a Low L/B Submarine Model With Non Circular Cross-Section - Zseleczky - Dec 1991 (1 copy)

HL-92-1 Concept Lines Development for Fast Sealift, 35Kt. Concept (NAVSEA Design 4B) - Waters - Oct 1991 (1 copy)

HL-92-2 Bow Section Modifications for Midterm Fast Sealift Hullform - Waters - Oct 1992 (Report Not Found - No Copy Available)

HL-92-3 Sallying of 460' WAGB-20 Replacement Icebreaker Model - Waters - Oct 1992 (1 copy)

HL-93-1 Skeg Design for Near-Term Strategic Sealift (CSP/S-24 Option 14) Hullform Evaluation – Waters – March 1993 (1 copy)

TR-93-1 Drag Measurements on Plates Towed Behind a Submerged Cylindrical Body - Zseleczky - July 1993 (1 copy)

TR-93-2 Full Scale Trials of a Small Ocean Wave Buoy in a Laboratory Wave Tank - Zseleczky - September 1993 (1 copy)

HL-96-1 Repeat Model Tests to Measure Extreme Wave Loading on a Moored Rectangular Barge - Zseleczky/Enzinger - July 1996 (1 copy)

HL-01-02 Shallow Water Wave Measurements For A Series 60 Model – Zseleczky – April 2001 (1 copy)

HL-01-03 Series 64 Model Tests – Harris – June 2001 (1 copy)

HL-01-05 Model 27-B-1 Maintenance Manual – DC2 Wright – May 2005 (Report Not Found - No Copy Available)

SNAME PAPERS

HYSWAS: A Hybrid Technology Comes of Age – Midn Doug Houseman and Midn Larry Linn - April 1979 (1 copy)

The Use of Small Models in the Ship Design Process Howard Fireman/John Hoyt/Jeffrey Hough/Audrey Lones - Oct 1982 (Report Not Found - No Copy Available)

Performance Characteristics For a Series of Commercially Available Marine Propellers – Donald Hankley/Stephen Denny – February 1983 (1 copy)

The Resistance of a Systematic Series of Semi-Planing Transom Stern Hulls – Roger H. Compton - Oct 1985 (1 copy)

Determination of Hydrodynamic Drag for a Diver-Assist Remote Operated Vehicle (ROV)
– Midn Alan Czeszynski - 1987

Hydro-Numeric Design at the U.S. Naval Academy: An Integration of Design and Analysis Tools – Bruce Hays/Bruce Johnson/Dennis Kingsley/Michael Meinhold – February 1988 (1 copy)

Seakeeping Predications for U.S.C.G. Hard Chime Patrol Boats – White/Savitsky – June 1988 (1 copy)

The Resistance of a Transom Stern, Hard Chine Semi-Planing Craft - Richard B. Eitel - Dec 1988 (Report Not Found - No Copy Available)

The Stem Spray Problem of the YP676 Class - Part I - Hudgens - April 1989 (1 copy)

The Stem Spray Problem of the YP676 Class - Part II - Midn John Wolfe - April 1989 (1 copy)

An Experimental Study of SWATH Stability - Midn James Darrell - April 1989 (1 copy)

The Effect of Shallow Water on the Series 60-0.60 Hull - Midn James Schwappach - April 1989 (1 copy)

The Integration of Modular Pontoon Systems and Air-Cushion Technology for Application to U.S. Army
Logistics-Over-The-Shore-Missions – Wilkins/Dowty – October 1989

An Engineering Approach to Prediction of Added Resistance in Waves During Early Stages of Ship Design - Lawrence Leibman/Siu Fung/John Slager 1990 (1 copy)

Comparative Testing of Pontoon-Based Flotation Systems for The U.S. Army's Bradley Fighting Vehicle - Midn Anthony Case, LCDR James Called Wayne Nobles Jr. 1990 (1 copy)

Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) in Small Shipyards -Christopher Barry/Larry Mercier 1990 (1 copy)

Early Stage Navy Ship Design for Producibility - Robert Riggins/James Wilkins Jr 1990 (1 copy)

One-Compartment Damage vs. Survivability Proposed Probabilistic Damage Criteria for Dry Cargo Ships
Richard Sonnenschein 1990 (1 copy)

The Resistance of Transom Stern Round Bilge, Semi-Planing Hull -Midn David E. Bogner - April 1990 (1 copy)

WLM Buoy Tender Replacement USNA Ship Design Class - .J. Brady/Kent Leka/Matt Polk 1990 (1 copy)

The Effects of Shallow Water on a Destroyer-Type Hull Both With and Without a Large, Bow-Mounted Sonar Dome Midn Peter Young 1991 (1 copy)

47' Motor Lifeboat Dynamic Inclining Tests - Midn William Abrams 1991 (1 copy)

Surface Effect Ship (SES) Developments Worldwide - David Lavis/Kenneth Spailding Jr 1991 (1 copy)

Trouble on The Waterfront - John Bussell 1991 (1 copy)

Analysis of Racing Oar Blade Mechanics - Midn David Schroder 1992 (1 copy)

Wingship Development - Stephan Hooler/Margrethe Lidemann/Roger Schaffer 1992 (1 copy)

Comments on The Structural Design of High Speed Crafts – Koelbel Jr. 1993 (1 copy)

The Evolution of Modern Ship Propulsion Systems - Thomas Dalton 1994 (1 copy)

Analysis of a Rowing Oar Blade's Relationship with Water - Midn Lambert 1995 (1 copy)

Design and Construction of a Triple Screw 65 ft. High Speed Sport Yacht -Gary Van Tassel 1995 (1 copy)

The Model Testing of Planing Hulls: Effects of Experimental, Methods Midn Richard Lawson 1995 (1 copy)

SNAME PAPERS

USS Constitution (IX-21) The and Now - Roger Compton/Howard Chatterton Jr 1997 (1 copy)

Experimental Investigation of a Supercavitating Hydrofoil - Midn Earon Rein 2000 (Report Not Found - No Copy Available)

Calm Water Testing Of The HYSWAS Concept "Streetfighter" - Midn Peter Mitalas 2001 (1 copy)

Experimental Investigation of a 3-Inch Chord Model of a Supercavitating Hydrofoil – Midn Earon Rein 2001 (1 copy)

NON-HYDROMECHANICS LABORATORY REPORTS

Series 63 Round Bottom Boats – Davidson Laboratory April 1963 (1 copy)

Powering Predicitions forUnited States Coast Guard Proposed Icebreaker Designs Represented by Models 5140, 5141, and 5142 – William Day Jr January 1968 (1 copy)

Powering Predictions For U.S.C.G. Proposed Icebreaker Design By Model 5169 – U.S. Coast Guard 1969 (1 copy)

Icebreaking Model Tests of the 140 Ft WYTM – U.S. Coast Guard September 1975 (1 copy)

Description and Operation of Hydronautics Modular-Force Gages Models H1-M-4 – Hydronautics Incorprated August 1976 (1 copy)

Landing Vehicle Assault (LVA) Motion Characteristics in Oblique Seas : Seas and Coastal Swells – Ralph Stahl January 1978 (1 copy)

Seakeeping Considerations in Design and Operation of Hard Chime Planning Hulls –Savitsky/Koelbel Jr May 1978 (1 copy)

LFTSUR – A Computer Program For Determining Hydrodynamic Pitch, Meanline Shape, and Pressure Distribution For Marine Propellers – McMahon July 1979

Ice Model Tests in Shallow Water of Four Candidate Hull Forms For an Arctic/Great Lakes Icebreaker – ARCTEC Inc March 1980 (1 copy)

Developmental Tests of a Pre-Prototype Landing Craft Personnel – Large LCP(L) MK12 – Hankley April 1980 (1copy)

Powering Predicitions for The USCG 296 Ft Class (WAGB) Icebreaker Represented by Model 5392 with Stock Propellers 4682 and 4683 – DTNSRDC June 1981 (1 copy)

Preliminary Study of The Spray and Wake Characteristics of High Speed Craft – NAVSEA Norfolk September 1981 (1 copy)

Feasibility Study for The United States Coast Guard Advanced Vehicle Concept (Planing Hull) - Naval Sea Combat Systems Engineering Station Norfolk June 1983 (1 copy)

Propeller Disk Wake Survey Data for the Inital Contract Design Hull Form of the DDG51 Represented by Model 5422 – David Taylor Research Center November September 1985

Analysis of Wake Survey Data For The DDG51 Represented by Model 5415 - David Taylor Research Center November September 1985

EHP Model Tests of a Replacement Icebreaker – Frank Debord Jr/John Kuhn – Offshore Technology Corp March 1986 (1 copy)

Correlation of Model Experiments With Ship Powering Data for The USS SPRUANCE (DD-963), USS CALLAGHAN (DDG-994), USS VINCENNES (CG-49), and USS TICONDEROGA (CG-47) Represented by Model 5359 – David Taylor Research Center November 1988 (1 copy)

A Study of The Factors Influencing the Rough Water Effectiveness of Personal Flotation Devices – David Taylor Research Center July 1988 (1 copy)

Resistance and Seakeeping Database for USCG 157 Ft WLM – U.S. Coast Guard July 1991 (1 copy)

Resistance and Seakeeping Model Tests of Two U.S. Coast Guard Notional Designs of 110 Ft and 120 Ft WPB Hulls – U.S. Coast Guard January 1993 (1 copy)

Additional Resistance and Seakeeping Model Tests of a U.S. Coast Guard 120 Ft Notional WPB Design – U.S. Coast Guard 1993 (1 copy)

Beam Sea Rolling of USCG 120 Ft Notional WPS Design Model in Regular Waves – U.S. Coast Guard 1994 (1 copy)

Experimental Study of An Automatic Pitch Control System On a Swath Model – U.S. Coast Guard – 1994 (1 copy)

The Effects of Aspect Ratio, Section Shape, and Reynolds Number On The Lift and Drag Of a Series Of Model Control Surfaces – U.S. Coast Guard 1994

Directional Stability Tests Of Two Prismatic Planing Hull – U.S. Coast Guard 1994 (1 copy)

Directional Stability Tests Of a 30 Degree Deadrise Prismatic Planing Hull – U.S. Coast Guard 1994 (1 copy)

Free Running Model Turning Tests of The U.S. Coast Guard 47 Ft Motor Life Boat – U.S. Coast Guard February 1995 (1 copy)

Experimental Determination of The Added Inertia and Damping Of a 30 Degree Deadrise Planing Boat in Roll – U.S. Coast Guard 1995 (1 copy)

Experimental Determination of the Added Inertia and Damping of Planing Boats in Roll – U.S. Coast Guard 1995 (1 copy)

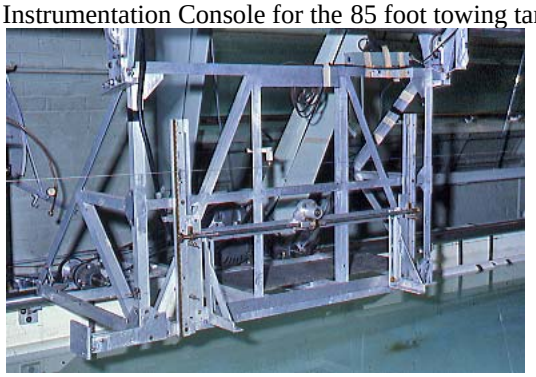
A Design Tool for The Selection of a Hydrodynamically Optimized Configuration for Powered Trimaran Vessels – Webb Institute of Naval Architecture May 1996 (1 copy)

Modernization of The Robinson Model Basin – Webb Institute Of Naval Architecture June 1999 (1 copy)

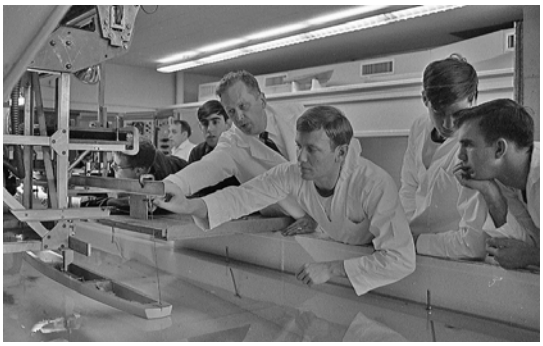
Performance of Leading Edge Tubercles – Steven Stone – Webb Institute – June 2006 (1 copy)

Appendix 8: Photos of Isherwood Hall Ship Hydromechanics Laboratory

Professor Bruce Johnson and Lt Tom Dyer at the Instrumentation Console for the 85 foot towing tank



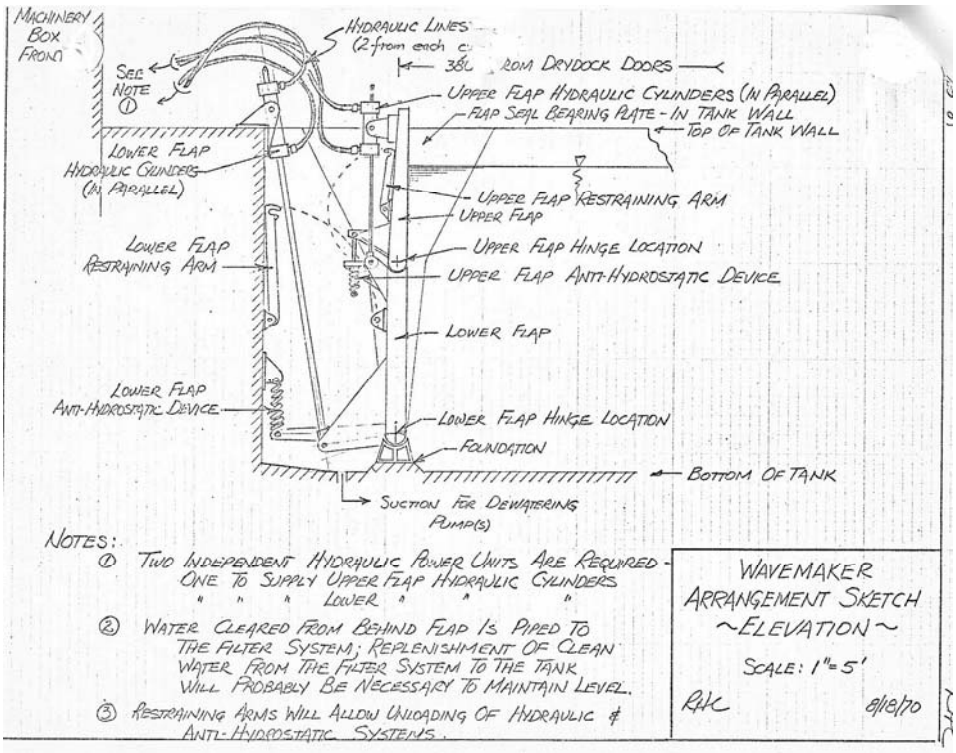
85 Foot tank towing self powered towing carriage (belt drive in lower left of photo)



Professor Paul Van Mater instructs midshipmen in 1971

Carl and Wendy Van Duyne in their 470 in the Isherwood Hall Stability Tank (1972 CSYS project). Note the floodable destroyer model in the background

Professor Compton's 1970 sketch of a proposed double flap wavemaker. This concept became the basis for a number of large amplitude wavemakers built since that time. To produce large wave amplitudes, the best regular waves with the least harmonic distortion appear to be generated by using waveboard motions in the same direction as the particle velocity at the crest of the generated wave. This is achieved by piston wavemakers, double flap wavemakers, tilted axis plungers with the front face nearly vertical and deep single flaps restricted to 10 degrees either side of vertical.



For videos of NAHL Extreme Wave Research see the Acrobat file of the same name on the CD.

Appendix 9: Photos of Rickover Hall Construction and NAHL Operations

Phase I January 1972

Phase I HydroLab Construction Early 1972

Phase I, Drydock area, September 1972

Phase II Construction, Lab Floor Raised Decking July 1973

Phase II 380 foot towing tank, August 1973

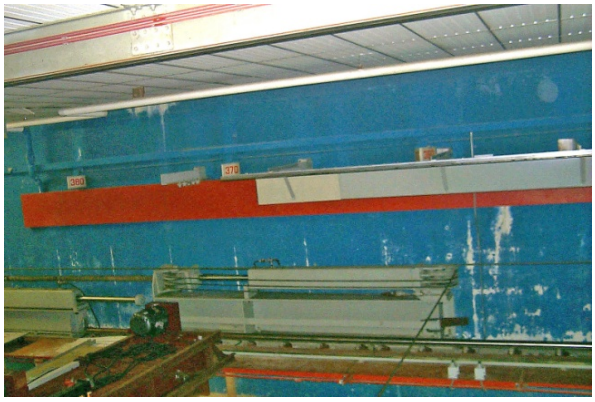
Phase II 380 foot towing tank, November 1973

120 Foot Tank, November 1973

120 foot tank, August 1975

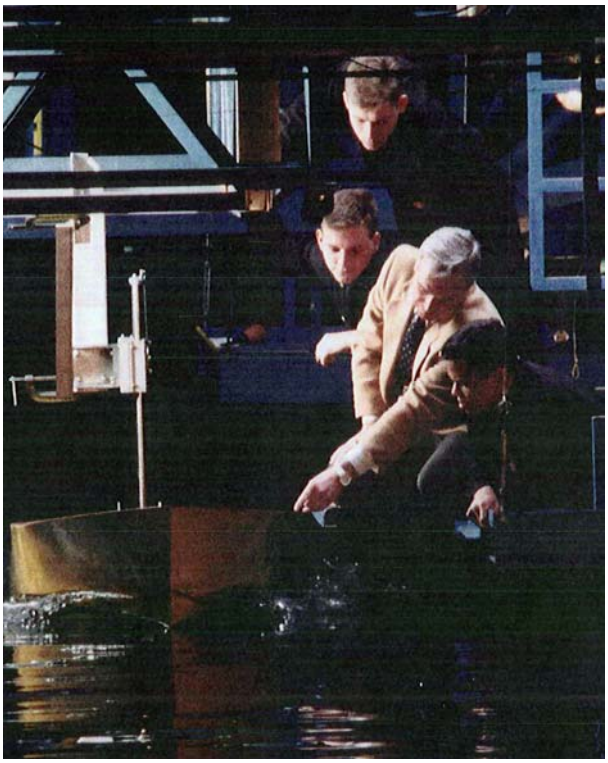
Circulating Water Channel 1977

Coastal Tank 1977



Arresting cable and tertiary hydraulic stopper 1977

Underwater lighting system for 380 foot tank for video project. Note the two walkways port side and a single walkway along the tank on the starboard side. The swimming lane wave dampers are held above the water for wave tests.

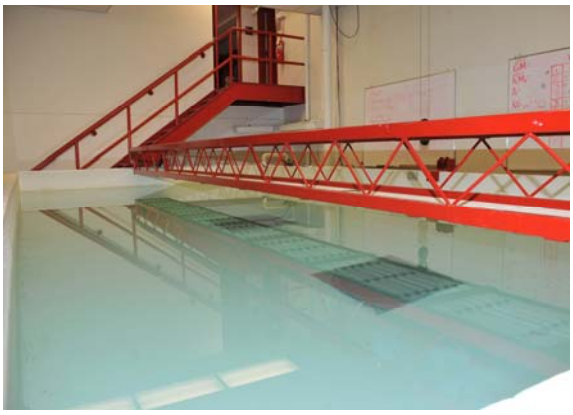


Professor Compton instructing Experimental Naval Architecture class

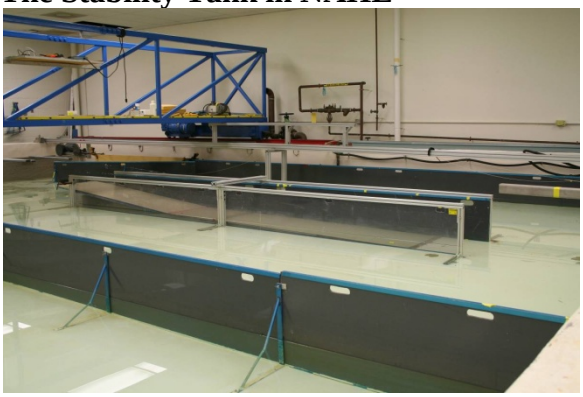
Offshore Platform Test for OE majors

Typicical Lab Test in 120 foot towing tank

Planing boat test in 120 foot tank

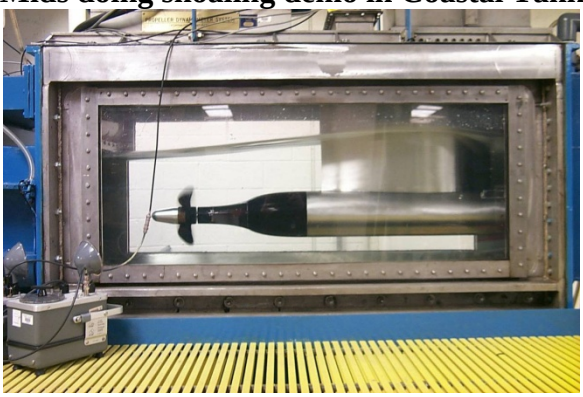


The Stability Tank in NAHL



Coastal Tank setup for shoaling waves

Mids doing shoaling demo in Coastal Tank



Propeller test in Circulating Water Channel

Appendix 10: List of Hydromechanics Laboratory Staff Members

Isherwood Hall 1951-1976

Hydro Lab Directors

Thomas C. Gillmer 1951-1967
Bruce Johnson 1967-1972
Roger Compton 1972-1976

Lab Technicians

Ebb Bosworth
Steve Enzinger
Bob Popp

Rickover Hall NAHL

Project Officer/Director

Tom Dyer 1965-1968
Bruce Johnson 1968-1976

Rickover Hall 1976-

Directors

Bruce Johnson 1976-1987
Roger Compton 1987-1996
David Kriebel 1996-2002
Greg White 2002-

Director of Research

Howard Chatterton 1981-1986

Branch Heads

Ronald J. (Max) Altmann 1976-1980
John Hill 1980-2007
John Zseleczky 2007-

Staff Engineers

Bill Beaver
Nancy Anderson Harris
Bruce Hays
Susan White Hays
John Hill
Carvel Holton
John Hoyt
Mark Pavkov
Joe Salsich
Jim Shaughnessy
Louise Wallendorf
Randy Watkins
Tom Waters

Staff Engineers (con't)

Ron White
John Zseleczky

Staff Technicians

Don Bunker
Tindall Dennison
Steve Enzinger
Norm Tyson
Dan Rhodes

Secretaries

Darlene Batten
Nancy Dunbar
Pam Majors
Ronnie Marousak
Becky Plummer

NAVSEA EITs

Diane Burton
Steve Dukowski
Alan Engle
Jeff Falzarano
Howard Fireman
Mike Fitzgerald
Audrey Greenhill
Mike Hanrahan
Ron Hebron
Jeff Hough
Julie Hudgens
Ina Jolicoeur
Dennis Kingsley
Paul Klouse
Jim McStravick
Doug Olivari
Mike Osborne
Mike Paulsen
Dave Stirrett
Jose Vega
John Yashan
Hoon Yoon