

**2009 IEEE
Electric Ship
Technologies
Symposium**

**April 20-22, 2009
Baltimore, Maryland**

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**IEEE ELECTRIC SHIP
TECHNOLOGIES
SYMPOSIUM**

**April 20-22, 2009
Sheraton Inner Harbor Hotel
Baltimore, Maryland**



Welcome Message

Welcome to all the participants in the third IEEE Electric Ship Technologies Symposium, ESTS 2009. ESTS 2009 continues the focus set by the first conference in 2005 of bringing together the Navy, industry, and university researchers from around the world to discuss technical challenges for making future electric ships more capable and less costly. The range of technology options is impressive ranging from propulsion hardware to controls software with much in between. With the needs for increasing capability and fuel economy, this is an exciting time to be developing electric ship technology.

ESTS 2009 is co-sponsored by six IEEE societies (Power & Energy, Power Electronics, Industry Applications, Ocean Engineering, Dielectrics and Electrical Insulation, and Vehicular Technology), two IEEE inter-societies councils (Systems & Sensors) and the IEEE TA New Technology Directions Committee. Additionally we have technical sponsor participation from IEEE USA, ASNE (American Society of Naval Engineers) and IMarEST (Institute of Marine Engineering, Science and Technology). At the time of this letter, sponsorships from the U.S. Office of Naval Research and industrial companies are pending.

The symposium is focusing on the progress and future of electric ship technologies. By mixing oral paper presentations with invited special and panel discussions and standards working group activities we have worked to establish a forum for the exchange of a broad spectrum of viewpoints (end users, designers, manufacturers, researchers, etc.) by bringing together the knowledge of the entire scientific and technical community working in the field.

The organizers have worked to structure this meeting so it can be valuable to all participants. We hope that you will use the breaks and social events for informal interactions with your colleagues. We appreciate your participation to help make this a seminal event in the development of electric ships.

Dr. Noel Schulz
ESTS General Chair, 2009
TVA Professor, Mississippi State University

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Marine Engineering, Greece*

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Scott Sudhoff – *Purdue University, USA*

Giorgio Sulligoi – *University of Trieste, Italy*

Mischa Steurer – *Florida State University/CAPS, USA*

Al Tucker – *Consultant to ONR, USA*

Fred Wang – *Virginia Tech University/CPES, USA*

ESTS 2009 PROGRAM

April 20, 2009

7:00 PM Welcome Reception

April 21, 2009

7:00 AM Breakfast

**8:00 AM Opening Remarks and
Keynote Address**

**8:45 AM – A1L-A
PLENARY 1: Electric Ships Realities
and Challenges**

Chair: David Clayton, NavSea

**All Electric Cruise Liners: Evolution of Electrical
Systems in the Last Decade***

Aldo da Rin

**An Overview of Electric Ships in the
Energy Exploration Development and
Transportation Sector***

Peter G. Noble

**Feasibility Study of Noise Pattern Analysis Based
Ground Fault Locating Method for Ungrounded DC
Shipboard Power Distribution Systems**

Yan Pan, Michael Steurer, Thomas Baldwin

**High Energy Safety Concerns and Issues for
Electrical Shipboard Power Distribution
System in US Navy Ship Designs***

Thomas C. Dalton, Khosrow Moniri

10:30 AM Coffee Break

10:45 AM – A2L-A

All Electric Ship

Chair: Tim McCoy, ConverTeam US

**Statistically Robust Design for the All-Electric Ship
from a Network Theoretic Perspective**

Josh A. Taylor, Franz S. Hover

*Presentation only, no paper appears in the proceedings.

A Modern and Open Real-Time Digital Simulator of All-Electric Ships with a Multi-Platform Co-Simulation Approach

*Jean-Nicolas Paquin, Wei Li, Jean Bélanger,
Loic Schoen, Irene Peres, Cristina Olariu,
Hugo Kohmann*

Geographically Distributed Thermo-Electric Co-Simulation of All-Electric Ship

*M. Omar Faruque, Venkata Dinavahi,
Michael Sloderbeck, Michael Steurer*

Small-Signal Methods for Electric Ship Power Systems

Jian Sun

Fault Current Limiter Allocation in Electric Ship Power Systems

C.L. Su, C.Y. Su, C.C. Lee, C.J. Chen

10:45 AM – A2L-B Analysis

Chair: *Mohamed Bellkhatat, Northrop Grumman*

Investigation of Accelerating Numerical-Field Analysis Methods for Electric Machines with the Incorporation of Graphic-Processor Based Parallel Processing Techniques

*Alan J. Adzima, Philip T. Krein,
Tim C. O'Connell*

Analytical Model-Based Analysis of High-Speed Flywheel Energy Storage Systems for Pulsed Power Applications

*Salman Talebi, Behrooz Nikbakhtian,
Hamid A. Toliyat*

Estimating Transient Response of Simple AC and DC Shipboard Power Systems to Pulse Load Operations

Saurabh Kulkarni, Surya Santoso

Cognitive Engineering Studies of DSS and Dealing with Uncertainty in Load for Real-Time Adaptive Power System Reconfiguration

*Venkata K. Pendurthi, Noel N. Schulz,
Stephanie Doane, Anurag K. Srivastava*

Maritime Automation, and Emergency Handling – Software: Design, System Integration and Quality

*Stefan Elgåfoss, Torbjørn Skramstad,
Vibeke Dalberg*

*Presentation only, no paper appears in the proceedings.

10:45 AM – A2L-C

Electrical Machines

Chair: *Chris Hodge, BMT UK*

Effects of Magnet Shape on Torque Characteristics of Interior Permanent Magnet Machines

Lusu Guo, Leila Parsa

A Survey of Real-Time Power-Loss Minimizers for Induction Motors

Ali M. Bazzi, Philip T. Krein

Design and Comparison of an Optimized Permanent Magnet-Assisted Synchronous Reluctance Motor (PMA-SynRM) with an Induction Motor with Identical NEMA Frame Stators

Robert Vartanian, Hamid A. Toliyat

Ship Brushless-Generator Shaft Misalignment Simulation by Using a Complete Mesh-Model for Machine Voltage Signature Analysis (MVSA)

Claudio Bruzzese, Angelo Rossi, Ezio Santini, Varo Benucci, Andrea Millerani

Neural Network Based Modeling of Audible Noise for High Frequency Injection Based Position Estimation for PM Synchronous Motors at Low and Zero Speed

Ahmad Arshan Khan, Osama Mohammed

12:30 PM Lunch

2:00 PM – A3L-A

Medium Voltage DC

Chair: *Mischa Steurer, CAPS*

Using Functional Failure Mode and Effects Analysis to Design the Monitoring and Diagnostics Architecture for the Zonal MVDC Shipboard Power System

R.R. Soman, E.M. Davidson, S.D.J. McArthur

Modeling, Simulation and Experimental Validation of a Generation System for Medium-Voltage DC Integrated Power Systems

G. Sulligoi, A. Tassarolo, V. Benucci, M. Baret, A. Rebora, A. Taffone

Small Signal Stability Analysis of a Shipboard MVDC Power System

Seetharama R. Rudraraju, Anurag K. Srivastava, Suresh C. Srivastava, Noel N. Schulz

*Presentation only, no paper appears in the proceedings.

Real-Time Simulation-Based Design of a Power-Hardware-in-the-Loop Setup to Support Studies of Shipboard MVDC Issues

M. Andrus, M. Steurer, C. Edrington, F. Bogdan, H. Ginn, R. Dougal, E. Santi, A. Monti

An Innovative Generation Control System for Improving Design and Stability of Shipboard Medium-Voltage DC Integrated Power System

Vittorio Arcidiacono, Antonello Monti, Giorgio Sulligoi

2:00 PM – A3L-B

Simulation

Chair: *Chris Daffis, NSWCCD*

A Comparison of Co-Energy and Lorenz Force Based Simulations of Rail Guns

C.G. Hodge, J.O. Flower, A. Macalindin

Advances in High-Speed Real-Time Multi-Rate Simulation Techniques for Ship Power Systems

Roy Crosbie, John Zenor, Dale Word, Richard Bednar, Narain Hingorani

Advanced Simulation Concept for Onboard Ship Grids Featuring Complex Multiterminal Power-Electronic Systems

Carsten Heising, Martin Oettmeier, Roman Bartelt, Volker Staudt, Andreas Steimel

Simulation Environment for Onboard Subsystems of an Electric Ship

Tomasz Haupt, Gregory Henley, Bhargavi Parihar, Noel Shultz

Distributed Dynamic Energy Resource Control

Wayne W. Weaver, Philip T. Krein

2:00 PM – A3L-C

Power Converters

Chair: *Zareh Soghomonian, BMT Syntek*

Zero-Sequence Current Dynamics in Parallel-Connected Voltage Source Converters

Yu Zhang, Zhenhua Jiang

Floating Capacitor Voltage Regulation in Diode Clamped Hybrid Multilevel Converters

James A. Ulrich, Ashish R. Bendre

*Presentation only, no paper appears in the proceedings.

Output Voltage Regulation in Matrix Converter Fed Power Electronic Transformer for Power Systems Application in Electric Ship

Shabari Nath, K.K. Mohapatra, Ned Mohan

Double Sided Spray Cooled Bi-Directional Power Conversion Module

Brian L. Rowden, Derik W. Trowler, Juan C. Balda

Design and Implementation of a 6kW Three-Phase Active Buck Rectifier

*Jeffrey W. Czapor, Edward W. Hankey,
Ashish R. Bendre, John W. Bess, Sven R. Englund*

3:45 PM Coffee Break

4:00 PM – A4L-A

Reconfiguration & Survivability

Chair: Terry Ericson, ONR

Real-Time Implementation of an Intelligent Algorithm for Electric Ship Power System Reconfiguration

Pinaki Mitra, Ganesh K. Venayamoorthy

DC Zonal Electrical System Fault Isolation and Re-Configuration

Rob Cuzner, Aaron Jeutter

A Reconfiguration Algorithm for a DC Zonal Electric Distribution System Based on Graph Theory Methods

Julia P. Certuche-Alzate, Miguel Vélez-Reyes

Genetic Algorithm Based Damage Control for Shipboard Power Systems

Tushar Amba, Karen L. Butler-Purry, Milad Falahi

Algorithm Development for Evaluating the IPS Survivability Due to its Topology

*Svetlana V. Poroseva, Nathan Lay,
M. Yousuff Hussaini*

4:00 PM – A4L-B

Modeling

Chair: Patrick Chapman, U of Illinois

A Linear Programming Approach to Shipboard Electrical System Modeling

*Ricky R. Chan, Scott D. Sudhoff, Yonggon Lee,
Edwin L. Zivi*

*Presentation only, no paper appears in the proceedings.

Design and Optimization of an Hybrid Sailboat by a Power Modeling Approach

Florian Dupriez-Robin, Luc Loron, Fabien Claveau, Philippe Chevrel

Modelling Method for Complex Induction Machines Used in Naval Applications Using an Advanced Simulation Concept

Carsten Heising, Martin Oettmeier, Roman Bartelt, Jie Fang, Volker Staudt, Andreas Steimel

Modeling and Simulation of Shipboard Power System Protection Schemes Using Coordination of Overcurrent Relay

Ankush Saran, Anurag K. Srivastava, Noel N. Schulz

High Power Clean DC BUS Generation Using AC-Link AC to DC Power Voltage Conversion, DC Regulation, and Galvanic Isolation

Ian C. Evans, Rudy Limpaecher

4:00 PM – A4L-C

Modular Power

Chair: Herb Ginn, MSU

A Compact Bi-Directional Power-Conversion System Scheme with Extended Soft-Switching Range

Liang Jia, Sudip K. Mazumder

Possible Applications of Plug-in Hybrid Electric Ships

Sven De Breucker, Eefje Peeters, Johan Driesen

Integration of a Bi-Directional DC-DC Converter Model Into a Large-Scale System Simulation of a Shipboard MVDC Power System

Il-Yop Chung, Wenxin Liu, Mike Andrus, Karl Schoder, Siyu Leng, David A. Cartes, Mischa Steurer

Optically-Modulated Active-Gate Control (OMAG) for Switching Electrical Power-Conversion Systems

Sudip K. Mazumder, Tirthajyoti Sarkar

Soft-Switching Capability Analysis of a Dual Active Bridge Dc-Dc Converter

Zhiyu Shen, Rolando Burgos, Dushan Boroyevich, Fred Wang

5:45 PM Break

7:00 PM Dinner

*Presentation only, no paper appears in the proceedings.

April 22, 2009

7:00 AM Breakfast

8:00 AM – B1L-A

PLENARY 2: Integrated Power Systems

Chair: Lynn Petersen, US Navy

The State-of-the-Art of Integrated Electric Power and Propulsion Systems and Technologies on Ships

Timothy J. McCoy, John V. Amy Jr.

The Evolution of DC Electrical Distribution Architectures, Systems and Components to Support Next Generation Integrated Power Systems for Naval Platforms*

*Zareh Soghomonian, Edward Bowles,
James Zgliczynski*

Integrated Electric Power System Supervision for Reconfiguration and Damage Mitigation

*Murat Yasar, Adam Beytin, Gaurav Bajpai,
Harry G. Kwatny*

Integrated Simulation of Communication, Protection, and Power in MVDC Systems

*Antonello Monti, M. Colciago, P. Conti,
M. Maglio, R.A. Dougal*

ABS Rules for Integrated Power Systems (IPS)

Mike Roa

10:00 AM Coffee Break

10:15 AM – B2L-A

Protection

Chair: John Amy, BMT Syntek

Modeling and Simulation of MVDC Shipboard Power System and Protection in the Matlab Simulink Environment*

Hymiar Hamilton, Noel Schulz

Circuit Breaker Protection Considerations in Power Converter-Fed DC Systems

*Rob Cuzner, Doug MacFarlin, Don Clinger,
Michael Rumney, Gene Castles*

Designing Microprocessor-Based Protection Hardware for Ultra-Critical Applications

David McGinn, Vijay Muthukrishnan, Wei Wang

*Presentation only, no paper appears in the proceedings.

System Study of Fault Current Limiter for Shipboard Power System

Bart Diaz, Thomas H. Ortmeyer, Bruce Pilvelait, Mike Izenson, Weibo Chen, Nathan Spivey

Analysis of Fault Events in MVDC Architecture

A. Ouroua, J. Beno, R. Hebner

10:15 AM – B2L-B

Power Semiconductors

Chair: *Sharon Berman-Curtin, DARPA*

Investigation of the Turn-Off Characteristics of a GTO Thyristor in an Inductive-Based Pulse Forming Network

John G. Ciezki, Thomas E. Salem

Modeling and Simulation of 2 kV 50 A SiC MOSFET/JBS Power Modules

Zheng Chen, Rolando Burgos, Dushan Boroyevich, Fred Wang, Scott Leslie

SiC Power Device Technology for Electric Ship*

Anant Agarwal, Jerry Melcher

IGCTs vs. IGBTs for Circuit Breakers in Advanced Ship Electrical Systems

Richard F. Schmerda, Slobodan Krstic, Edward L. Wellner, Ashish R. Bendre

Comparison of Current Sharing Among Paralleled Devices in Wire-Bonded and Planar Power Modules

Tong Liu, Khai D.T. Ngo, G.Q. Lu, Rolando Burgos, Fred Wang, Dushan Boroyevich

10:15 AM – B2L-C

Shipboard Power Systems

Chair: *Giorgio Sulligoi, U of Trieste*

Dynamic Load Shedding for Shipboard Power Systems Using the Non-Intrusive Load Monitor

Arun Shrestha, Edward L. Foulks, Robert W. Cox

Mitigation against Overvoltages on a DC Marine Electrical System

S.D.A. Fletcher, P.J. Norman, S.J. Galloway, G.M. Burt

Design, Modelling and Stability Analysis of an Integrated Shipboard DC Power System

Alexander L. Julian, Robert M. Cuzner

DC Power System Stability

C.G. Hodge, J.O. Flower, A. Macalindin

*Presentation only, no paper appears in the proceedings.

**On Studying the Power Supply Quality Problems
Due to Thruster Start-Ups**

*J.M. Prousalidis, P. Mouzakis, E. Sofras,
D. Muthumuni, O. Nayak*

12:00 PM Lunch

**1:00 PM – B3L-A
Faults Detection**

Chair: *Boris Jacobson, Raytheon*

**Detection and Location of Intermittent Faults by
Monitoring Carrier Signal Channel Behavior of
Electrical Interconnection System**

Charles Kim

Fault Location for DC Marine Power Systems

*David Thomas, Mark Sumner, David Coggins,
Xiaohui Wang, Jing Wang, Rinze Geertsma*

**A Sequence-Based Control Scheme for
Voltage-Source Converters in Naval and
Commercial Microgrids**

S.K. Mazumder, K. Acharya

**Machine Learning Techniques for Diagnosing and
Locating Faults Through the Automated Monitoring
of Power Electronic Components in Shipboard
Power Systems**

*A.J. Mair, E.M. Davidson, S.D.J. McArthur,
S.K. Srivastava, K. Schoder, D.A. Cartes*

**1:00 PM – B3L-B
Electrical Components**

Chair: *Antonello Monti, U SC*

**Gearing Ratios of a Magnetic Gear for
Marine Applications**

Nicolas W. Frank, Hamid A. Toliyat

Novel Undervoltage Release Concept

Edward Wellner, Richard Schmerda, Alvin Zemlicka

**Improved Input Power Conditioning for Fractional
Horsepower Shipboard Valve Actuators**

*Edward J. Hankey, Jeffrey W. Czapor,
Ashish R. Bendre, John W. Bess, Sven R. Englund*

**Initial Development of a Solid-State Fault Current
Limiter for Naval Power Systems Protection**

*Jack Bourne, Marcelo Schupbach, Joe Carr,
H. Alan Mantooth, Juan Balda*

*Presentation only, no paper appears in the proceedings.

1:00 PM – B3L-C

Propulsion

Chair: Scott Sudhoff, Purdue U

**State of the Art in Electric Propulsion –
Viewpoint on Redundancy**

Sami Kanerva, Jan-Fredrik Hansen

Power Split e-CVT Ship Propulsion System

*Claudio Rossi, Piero Corbelli, Luca Zarri,
Domenico Casadei*

**Economic Benefits of Hybrid Drive Propulsion
for Naval Ships**

*Gene Castles, Greg Reed, Ashish Bendre,
Robert Pitsch*

**Compact DC Power and Propulsion Systems –
The Definitive Solution?**

M. Butcher, R. Maltby, P.S. Parvin

2:20 PM Coffee Break

2:40 PM – B4L-A

Insulation and Thermo Analysis

Chair: Albert Tucker, Consultant

**Measurement of Partial Discharge in Machine
Winding Insulation During Short-Rise Time
Pulse Voltage**

C.D. Taylor, S. Grzybowski

**Accelerated Electrical Degradation of Machine
Winding Insulation**

S.R. Chalise, S. Grzybowski, C.D. Taylor

**Notional All-Electric Ship Thermal Simulation
and Visualization**

*F.G. Dias, J.A. Souza, J.C. Ordonez, J.V.C. Vargas,
R. Hovsopian, J.V. Amy Jr.*

**System-Level Thermal Modeling and
Co-Simulation with Hybrid Power System
for Future All Electric Ship**

Ruixian Fang, Wei Jiang, Jamil Khan, Roger Dougal

2:40 PM – B4L-B

Tests, Evaluation and Certification

Chair: Joseph Maurio, NGC

**A Platform for the Testing and Validation of
Dynamic Battery Models**

Michael Knauff, Dagmar Niebur, Chika Nwankpa

*Presentation only, no paper appears in the proceedings.

A Medium Voltage DC Testbed for Ship Power System Research

M. Bash, R.R. Chan, J. Crider, C. Harianto, J. Lian, J. Neely, S.D. Pekarek, S.D. Sudhoff, N. Vaks

Development of an Experimental Medium Voltage DC Bus for Power Hardware-in-the-Loop Testing of Shipboard Power System Equipment*

Mischa Steurer, Chris Edrington, Ferenc Bogdan, Subhashish Bhattacharya

**2:40 PM – B4L-C
Generation and Storage
Chair: Fei Wang, CPES**

Impact of Pulse Loads on Electric Ship Power System: With and Without Flywheel Energy Storage Systems

Saurabh Kulkarni, Surya Santoso

Fuel Cell Propulsion System for Marine Applications

L. Luckose, H.L. Hess, B.K. Johnson

Power Sharing Control of Fuel Cell/Gas-Turbine Hybrid Power Systems

Atideh Abbasi, Zhenhua Jiang

4:00 PM Closing

*Presentation only, no paper appears in the proceedings.

