IEEE ELECTRIC SHIP TECHNOLOGIES INITIATIVE

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Abstract - Electric Ship Technologies has been identified by IEEE Technical Activities Board (TAB) as one of the 10 emerging technological challenges that cut across the fields of multiple IEEE societies as well as engineering societies outside IEEE. The goal of this integrated initiative is to enhance technological advances utilization for all related applications by combining advanced research and development accomplishments in universities and research laboratories with well established engineering practices and industrial standards. To promote this initiative; the bi-annual Electric Ship Technologies Symposium was established. Simultaneously, the IEEE Industry Applications, Power Engineering and Power Electronics societies sponsored formation of the working groups to accelerate revision of existing and development of the new IEEE standards for Electric Ship Technologies. IEEE PES formed a new Marine Systems Committee (MARSYS) to coordinate activities in the development of new standards for marine industry. Paper provides review of the ESTS symposiums and describes the status of the IEEE technical society's standardization activities. It also reviews international standards applicable to ships.

Index Terms— Marine Industries, IEEE Standards, Power Electronics, Electric Ship, ESTS, PEBB.

I. INTRODUCTION

The goal of the Electric Ship Technologies Fast-track Initiative is to enhance technological advances and utilize all related applications by combining the collective expertise of various entities and engineering societies who otherwise individually address only part of overall problem. To address this challenge IEEE took following actions:

1. A bi-annual Electric Ship Technologies Symposium was established as the permanent forum for the exchange of broad spectrum of view points (end users, designers, manufacturers, etc,). It brings together the knowledge of the entire scientific and technical community by mixing traditional oral presentations with invited special panel's standards working group activities.
2. IEEE Industry Applications, Power Engineering and Power Electronics societies formed working groups for revision and harmonization with IEC of existing standards as well as the accelerated development of the new IEEE standards for Electric Ship Technologies. IEEE PES formed a new Marine Systems Committee (MARSYS) which will coordinate with other IEEE societies' activities in the development of new standards for marine industry.

II. ESTS – IEEE ELECTRICAL SHIP TECHNOLOGIES SYMPOSIUM

The first ESTS 2005 symposium was co-sponsored by six IEEE societies: PES (Power Engineering Society), PELS (Power Electronics Society), IAS (Industry Applications Society), OES (Ocean Engineering Society), DEIS (Dielectrics and Electrical Insulation Society) and VTS (Vehicular Technology Society). ASNE (American Society of Naval Engineers) and IMarEST (Institute of Marine Engineering, Science and Technology) were also technical cosponsors. The ESTS 2007 was supported by two more IEEE inter-societies co-sponsors: IEEE Systems Council and IEEE Sensors Council. The ESTS 2009 in April of 2009 have all the same sponsors and co-sponsors.

By mixing traditional oral paper presentations with invited speakers and panel discussions, ESTS symposiums have established a permanent forum for the exchange of a broad spectrum of view points for the entire scientific and technical community working in the field all around the world. The symposiums were focusing on the progress and future of electric ship technologies in the following areas:

- Integrated Electric Power Systems
- Systems and Components Specifications
- Design Tools for Analysis, Synthesis, Modeling, and Simulation
- Electrical Propulsion (Machines, Drives, Propulsors)
- Electrical Power Conversion, Distribution, and Storage
- Power Quality and Pulsed Power
- Protection, Reconfiguration, and Survivability

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- Tests, Evaluation, and Certification
- Electrical Ship Standards

The plenary sessions with invited experts had open dialogues in such subjects as:

- Industrial Electric Ship Technologies and Standards Today
- Dialog with Electric Ship Technologies Users
- Electric Ship Total System Engineering
- DC Power Systems

Proceedings of ESTS symposiums are available at IEEEXplore website: **http://ieeexplore.ieee.org/Xplore**

III. IEEE ELECTRIC SHIP STANDARDS ACTIVITIES

The most recent standards activities related to Electric Ship Technologies are:

IEEE Industry Applications Society IAS developed new IEEE Std 1662™-2008 "Guide for the design and application of Power Electronics in Electrical Power Systems on Ships" It is revising IEEE Std. 45™-2002 "Recommended Practice for Electrical Installations on Shipboard" and developing new standards: P1709™ "Recommended Practice for 1 to 35 KV Medium Voltage DC Power Systems on Ships" and P1713™ "Electrical Shore-to-Ship Connections".

IEEE Power Engineering Society PES extended activities of its working group i8 "Guide for Control Architecture for High Power Electronics (1 MW and Greater) used in Electric Power Transmission and Distribution Systems". This working group is developing new standard P1676 ""Guide for Control Architecture for High Power Electronics (1 MW and Greater) used in Electric Power Transmission and Distribution Systems" PES continues its work on revising standards for Static voltage regulators and Medium Voltage Variable Speed Drives.

PES formed a new Marine Systems coordinating committee to collaborate with other IEEE societies in development of new standards for industry.

Power Electronics Society PELS reaffirmed 6 old electronic transformers standards and is revising the IEEE Std. 1515 -2000 "Recommended Practice for Electronic Power Subsystems: Parameter Definitions, Test Conditions, and Test Methods" and IEEE Std. 1573-2003 "Recommended Practice for Electronic Power Subsystems: Parameters, Interfaces, Elements, and Performance"

IV. IEEE Std 1662-2008™

The IEEE Std 1662™-2008 "Guide for the design and application of Power Electronics in Electrical Power Systems on Ships" is published by IEEE. E-ISBN: 978-0-7381-5840-2, ISBN: 978-0-7381-5841-9

Digital Identifier: 10.1109/IEEESTD.2009.4804134

The guide recommends a methodology for analysis and specifications parameters of power electronics equipment for ship's electrical power systems. Guide applies to Power Electronics equipment rated above 100 kW such as:

- Inverters, Rectifiers
- Converters DC to DC, DC to AC, Frequency, cyclo- and others
- Power Factor and reactive power (static or dynamic VAR) support
- Solid State Circuit Breakers
- Current-Limiters
- Motor Drives
- Active Harmonic Filters
- Uninterruptible Power Supply (UPS)
- High Power Electric Propulsion
- Energy Storage & Pulse Load Systems
- Other equipment with built-in power electronics such as radars, etc.

The guide is organized into nine clauses and four annexes:

- Clause 1 overviews scope, purpose, and organization of the guide
- Clause 2 lists the normative references for using this guide
- Clause 3 provides definitions and acronyms
- Clauses 4 identifies major Power Electronics applications on Ships
- Clauses 5 and 6 identify General and Design requirements for Power Electronics on Ships
- Clause 7 provides recommendations for technical information, data, and models for optimal system design.
- Clause 8 provides guidelines for analyzing and designing power electronics and subsystems for ships
- Clause 9 provides guidelines for testing, inspection and certification of Power Electronics
- Annex A is an informative bibliography of related publications
- Annex B includes practical semiconductor's derating recommendations and stress limits
- Annex C addresses Marine Systems grounding
- Annex D describes various Models for Design and Analysis

Stakeholders for this guide are evaluators and designers of power electronics systems for marine applications, ships end-users, shipbuilders, port operators, classification societies, machinery and equipment manufacturers, research institutes, and universities. It applies to all power electronics equipment rated above 100 kW.

The IEEE Std 1662™-2008 analyses ship's Power Electronics performance requirements from a common frame of reference of economics and reliability of ships electrical power system as shown in Tables 1 and 2:

Table 1 Summary of system driven requirements from overall ship size, weight, and economic analysis

Requirements from overall ship size, weight, and economic analysis
System voltages
Power rating
Duty cycle
Efficiency
No-Load Losses
Overload
Size and weight
Reliability and maintainability requirements
Selection of parts
Heat dissipation requirements
Environmental design requirements
Ambient temperatures
Cooling arrangements
Airborne Noise
Structure-borne noise
Vibration
Electromagnetic effects
Electromagnetic interference
Electromagnetic Self-compatibility
Electromagnetic compatibility
Electromagnetic pulse
Data communications standards and capability
Control power supply voltage

Table 2 Summary of system driven requirements from ship system dynamic transient behavior

Requirement from ship system dynamic transient behavior
Grounding
Overload
Stress limits and derating factors
Power quality requirements
Protection requirements
Over voltage protection
Over current protection
Short circuit protection
Inrush (charging) current
Surge voltage withstanding capability
Dynamics requirements
Additional functionality
Basic data available guidelines

The following design requirements identified in the guide:

6.1 Size and weight
6.2 Reliability and maintainability requirements
6.3 Dynamics requirements
6.4 The stability margin
6.5 Software
6.6 Isolating means
6.7 Fuses
6.8 Solid state power electronics switches and circuit breakers
6.9 Heat dissipation requirements
6.10 Environmental design requirements
6.11 Electromagnetic effects
6.12 Data communication standards and capability
6.13 Control circuits and communications wiring
6.14 Enclosures
6.15 Design for safety
6.16 Fire-fighting measures
6.17 Regenerated power
6.18 Nameplate
6.19 Clearance and creepages
6.20 Power cable terminations
6.21 Network and control cable terminations
6.22 Quality assurance

The guide states that Power Electronics equipment and all associated components shall be designed and manufactured for a minimum service life of 20 years. This should include availability of spare parts and appropriately trained field service personnel.

The guide identifies all necessary elements of the shipboard electric power system design such as:

a) Life Cycle Cost Analysis and Report
b) Partial load efficiency calculations, generating plant sizing analysis, and fuel calculations
c) Electrical Load Analysis
d) Hull current analysis
e) Acoustic/other signature analysis in coordination with the overall ship design team
f) Electric System Concept of Operations (ES CONOPS) and survivability analysis
g) Propulsion and In-zone electrical one-line diagrams
h) Harmonic analysis
i) Short circuit/fault current analysis
j) Description of future power growth capability
k) Description of protection systems
l) Weight report
m) Support for auxiliary system designs
n) Risk assessment
o) Machinery arrangement input to overall ship design team
p) Master Equipment List inputs to overall ship design team

The guide discusses and specifies the analysis and design of power electronics in electrical power systems for various marine applications and provides guidelines for synthesizing and designing power electronic equipment and subsystems for such applications. The summary of the guide's recommendations is shown in Table 3:

Table 3 Modeling and simulation recommendations for analysis

Equipment-level analysis		Nature & time scale	Recommended converter-level models
Power balance	steady-state load flow	Steady-state, static	Active and reactive power, efficiency or loss characteristics
Power quality	Harmonics	Steady-state, operating & switching frequencies	Converter: Ideal switch switching model or equivalent harmonic source model Others: Equivalent circuit considering nonlinearity
	Voltage sag/swell	Transient	Converter: Ideal switch switching model with protection/control limit Others: Equivalent circuit considering nonlinearity
	Unbalance	Steady-state and transient	Converter: Ideal switch switching model with protection/control limit Others: Equivalent circuit considering nonlinearity
	EMC, EMI	Steady-state, high frequency (kHz to 100MHz)	Detailed circuit model including parasitic, detailed switches; Or frequency-domain behavioral source models with equivalent interconnect equivalent impedance models
Dynamic performance	Regulation	Steady-state (Hz to 100s Hz)	Average/linearized model of power converter (other equipment), detailed controls; transfer function
	Small-signal stability	Steady-state (Hz to 100s Hz)	Average/linearized model of power converter (other equipment), detailed controls; transfer function or equivalent impedance
Transients	Start and stop	transient	Detailed circuit, switching device models, with detailed control
	Faults	transient	Detailed circuit, switching device models, with detailed control and protection
	Large-signal stability	transient	Detailed circuit, switching device model, with detailed control and protection/limits
Thermal management	Loss calculation	Steady-state and temporary	Circuit model with loss characteristics,
	Thermal analysis	Steady-state and temporary	2-D or 3-D thermal models; 1-D equivalent thermal network model
Mechanical & structural			3-D mechanical model, and acoustics model (optional)
Shock & vibration			IEC, IEEE 45, MIL-STD-167, and MIL-STD-901
Reliability	Failure modes & Protection	Transient	Detailed circuit, switching device models, with detailed control and protection
	Failure rate and life time	Steady-state	Individual component/equipment failure models

IEEE Std 1662™-2008 recommends a special testing for medium voltage power electronics and additional testing for vessels in some special marine sectors. It also includes a list of normative and informative standards from international standards organizations which are applicable to power electronics equipment on ships.

V. IEEE P1709™

In 2007 the new IEEE "DC Power Systems" Working Group P1709 began work on another new standard "RECOMMENDED PRACTICE FOR 1 TO 35 KV MEDIUM VOLTAGE DC POWER SYSTEMS ON SHIPS".

MVDC power systems used in industrial and commercial applications today are limited size, special purpose systems and technical information about these systems is very limited since major suppliers of such systems handle it as proprietary information. Thus there are no existing standards specifically for MVDC Power Distribution systems with voltages above 3KV. International Association of Classification Societies UR E11" Unified requirements for systems with voltages above 1 kV up to 15 kV" Rev. 2, July 2003 is covering mostly AC issues and very briefly DC..

The P1709 working group developed a Notional functional diagram of a MVDC power system for ships is shown on Figure 1.

The functional blocks are defined as follows:

- "Power Generation" " is primarily a power source which converts prime energy from fuel into MVDC (e.g. gas turbine + PM generator + rectifier)
- "Shore Power Interface" is primarily a power source which adapts electric energy from the utility system on shore to MVDC
- "Pulse Load" is a stand-alone load center which primarily draws intermitted pulses of power from the system
- "Energy Storage" is a stand-alone power source which primarily provides power to the system when needed but also draws power from the system to recharge.

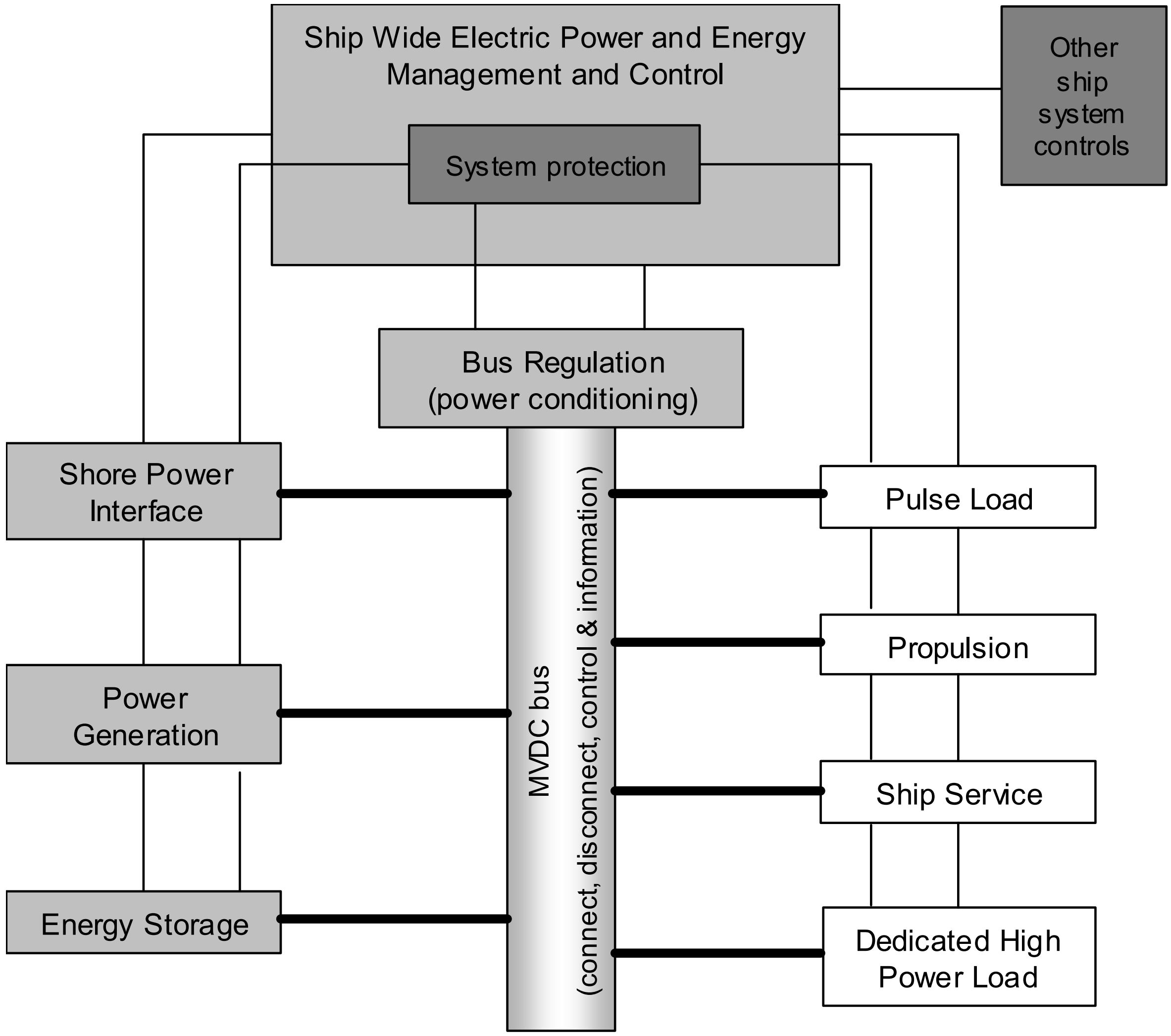

Figure 1 – Functional MVDC block diagram

- "Propulsion" is a load center that primarily draws power from the system for propulsion of the vessel. It may also provide power during certain maneuvers such as crash back
- "Ship service" is a load center that primarily draws power from the system to power ship services within zones (e.g., dc/dc converter for in-zone distribution of LVDC, dc/ac inverter for in-zone distribution of LVAC).
- "Dedicated High Power Load" is a stand-alone load center which draws 1 MW or more of power in steady-state operation .
- "MVDC bus" is functional block which allows interrupting and isolating sections of the MVDC system (e.g., mechanical disconnect, solid-state DC breaker).

Each functional block in the system can **connect**, **disconnect**, and **isolate** itself from the system through its own means (e.g., a "Power generation" module will have at least a disconnect switch at its DC output). Interruption, Isolation, and Configuration are actually independent functions. One device may fulfill one or more of these functions.

As any other electrical power system MVDC power system must safely generate, store, and deliver electrical power of the proper quality and continuity needed by the served loads. Functionally, the MVDC system consists of different modules and alternate paths of DC power connections (e.g. cables and bus-bars) between them.

Application of MVDC for marine application should be based on the assumption that all generators, loads, and storage are connected to the dc bus via power electronics converters, dc/ac, and dc/dc or ac/dc. Such an approach allows limiting fault currents, relative ease of connection of different size generators, storage and loads. Generally, all loads requiring independent ground will be connected to the medium voltage dc bus via converters. It is proposed that MVDC systems, will use commercially available PEBBs with each PEBB have its own intelligence to be programmable and self protecting to the appropriate extent possible. Automatic control should ensure smooth insertion and removal of generators and sharing of loads as desired.

An example, of how this functional diagram maps into a specific design is illustrated in Figure 2

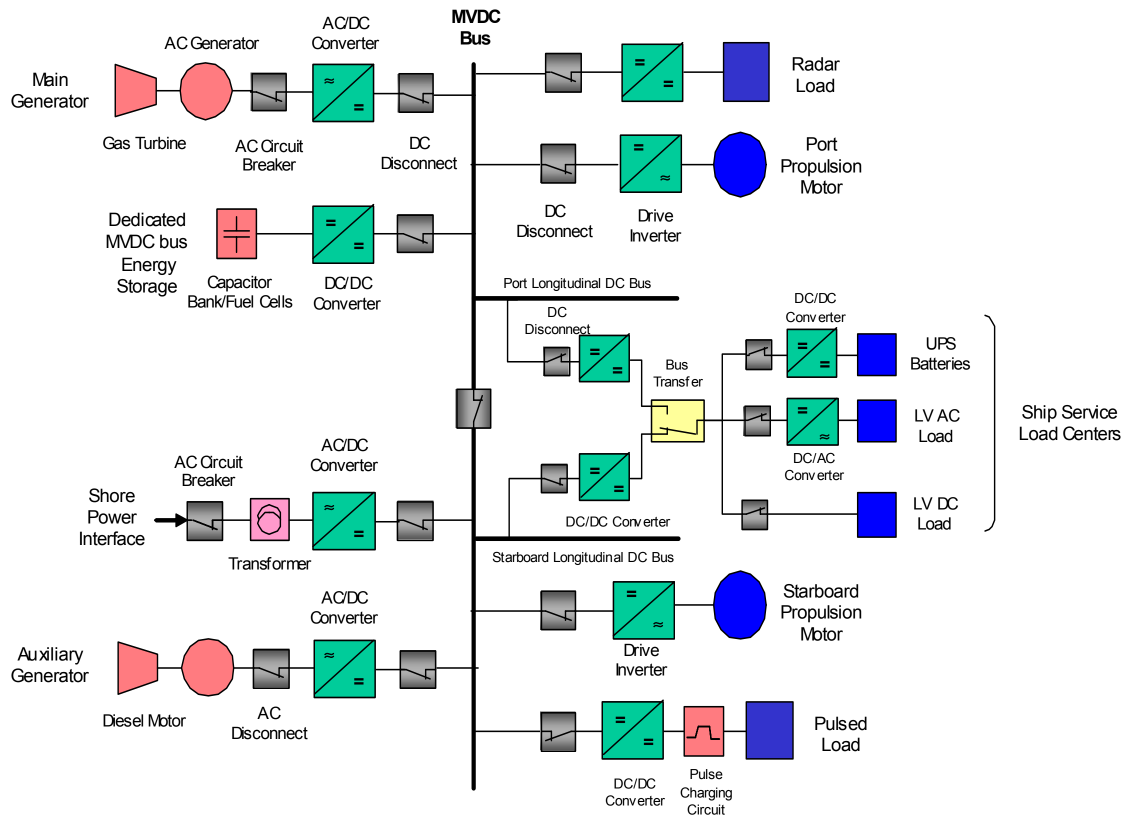

Figure 2 – Mapping of Functional Representation in Figure 1 into Specific Engineering Design

To reduce the size and weight, transformer between generators, propulsion motors and dc bus may be eliminated. With capability of power electronics to control and interrupt current, most load side circuit breakers may be replaced by load disconnect switches.

The common ratings of MVDC power system, including their operating devices and auxiliary equipment, should be selected from the following:

- Rated maximum voltage (Vd)
- Rated insulation level (Ud),
- Rated continuous current (Ir)
- Rated short-time withstand current (Ik)
- Rated duration of short circuit (tk)

Recommended Nominal voltage Vd classes are:

1.5, 3, 6, 12, 18, 24, or 36kV.

These voltage classes also may be:

±0.75, ±1.5, ±3, ±6, ±9, ±12, or ±18kV

Recommended rated insulation level Ud depends on grounding and control/protection means.

DC voltage stress tends to accumulate debris and salt on the insulators. This should be taken into consideration during design and for maintenance. If PWM converters are provided then impact of switching step voltage on the life of the insulation should be evaluated.

The proposed standard addresses impact of system grounding on corrosion which is always a factor to be considered in MVDC systems. The tendency of return currents to wander away into the ground can set up electrolysis with water pipes and similar metallic. This was well understood in the late 19th Century and was one of the reasons why London's Underground railways adopted a fully insulated DC system with a separate negative return rail as well as a positive rail - the four-rail system. Nevertheless, some embarrassing incidents in Asia with disintegrating manhole covers near a metro line in the 1980s means that the problem still exists and isn't always properly understood.

All P1709 working group documents are available on the website: ***https://bishopgroup.org/AEPS/1709***. Participation in the working group does not require IEEE SA membership. Everybody interested in joining the group should contact ***ykhersonsky@ieee.org***.

VI. IEEE P1713™

The Marine subcommittee under the Petroleum and Chemical Industry Committee of the IEEE Industry Applications Society formed a working group in September 2006 to work on development of a shore power standard. The working group's Project Authorization Request IEEE-P1713 was approved by IEEE-SA in December 2006. The scope of the project covers system components necessary for connecting large commercial ships to shore power including the shore power supply, shore connection boxes, cable connections, and control system [9].

The Recommended Practice for Electrical Shore-to-Ship Connections is expected to publish in early 2010 after balloting in 2009. Industry is anxious for standards in this area especially in California where new restrictions have been placed on the operation of auxiliary diesel engines on ocean-going vessels at-berth in California ports (Section 2299.3, title 13, chapter 5.1, California Code of Regulations).

The working group is focused on ensuring that systems are compatible at ports around the world. Coordinated development of analytical techniques, port infrastructure and shipboard electrical plants will facilitate the implementation of an "any ship, any port" concept so that retrofitted ships can pull into any port and expect to connect to shore side power. The recommended practice addresses both 6.6 kV to 11 kV connections from 7.5 MVA to 20 MVA. System components are addressed with particular attention to interface requirements between the shore and ship. Stakeholders for P1713 include port operators, terminal operators, ship builders, designers of port power systems and equipment manufacturers.

All P1713 working group documents are available on the website: ***https://bishopgroup.org/AEPS/1713***. Anyone interested in joining the group should contact **k.l.peterson@ieee.org**.

VII. IEEE WORKING GROUP i8 POWER ELECTRONICS BUILDING BLOCKS CONCEPT

Role of power electronics continues to increase in practically all applications of electricity, because electricity is an energy form that can be converted into different forms, frequency, voltage, DC, pulses etc., thus enabling new applications, increasing efficient use of energy, enabling efficient use of new forms of generation such as wind, solar, fuel cells and new forms of storage etc. Marine applications are no exception. For ships, power electronics enable variable speed propulsion drives, optimum use of power and energy sources and storage through Medium Voltage AC or DC Integrated Power System (IPS). Increasingly, and increasing number of offshore oil and gas platforms are receiving power from shore via HVDC submarine cables.

It has long been recognized that central to innovative and efficient use of electric power requires significant reduction in cost, weight, size and losses of power electronics. Because of limited space this need specially applies to ships and other marine applications, and hence reduction of size, and losses, are of greater importance for offshore applications than onshore applications.

Power electronics is akin to microelectronics, part of silicon science, and a sand-based technology. Trends in microelectronics applications, i.e. computers, servers, etc., has led to their assembly from functional building blocks with high volume production and reduction in cost and increase in performance. On the other hand, suppliers of high power electronics applications, both civilian and military, designed their application starting from devices all the way to converters and application. Following microelectronics paradigm, power electronics needed a revolution.

Recognizing this, about 20 years ago, Office of Naval Research (ONR) led an initiative called Power Electronics Building Block (PEBB) to do just that with several large and small projects to develop technology and now practiced by many suppliers. In 2000 Working Group WG i8 Power Electronics Building Block Concepts was launched under Substation Committee of Power Engineering Society PES (now Power and Energy Society PES) to spread the word and change power electronics business culture. [Figure 3 and 4]

For example, one PEBB design, which is a phase-leg of a two-level converter, with passives and intelligence built into it and with required multiple PEBBs and programmed design process, one can complete design of an application (for a few MWs) within a two to three weeks, program the PEBBS from a laptop with wireless communication for required application configuration and duties and ready to go, as against taking typically two to three years of design effort. Thousands of such PEBBs have been sold to clients of drives, wind generation etc. Another PEBB design is a phase-leg for a three-level converter, several of which can be assembled to provide tens of MWs converters for drives, utility and marine applications. In both cases noted above standard PEBBs are produced as a product line, for a wide variety of applications. Membership of this WG includes representatives from utilities, industrial and marine applications.

This Working Group Task Force 2 produced a 65 page document, defining PEBB and giving examples of what can be done. This document is applicable across the board for utilities, industrial and marine applications for power range from 1MW to hundreds of MWs. The 65 page document can be purchase from IEEE Customer Service product number 04TP170 Power Electronics Building Block (PEBB) Concepts.

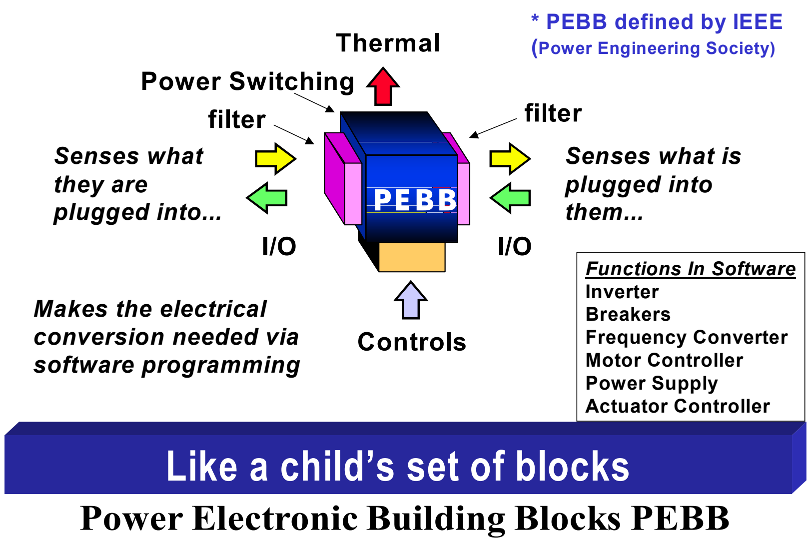

Figure 3 Power Electronics Building Block Concept

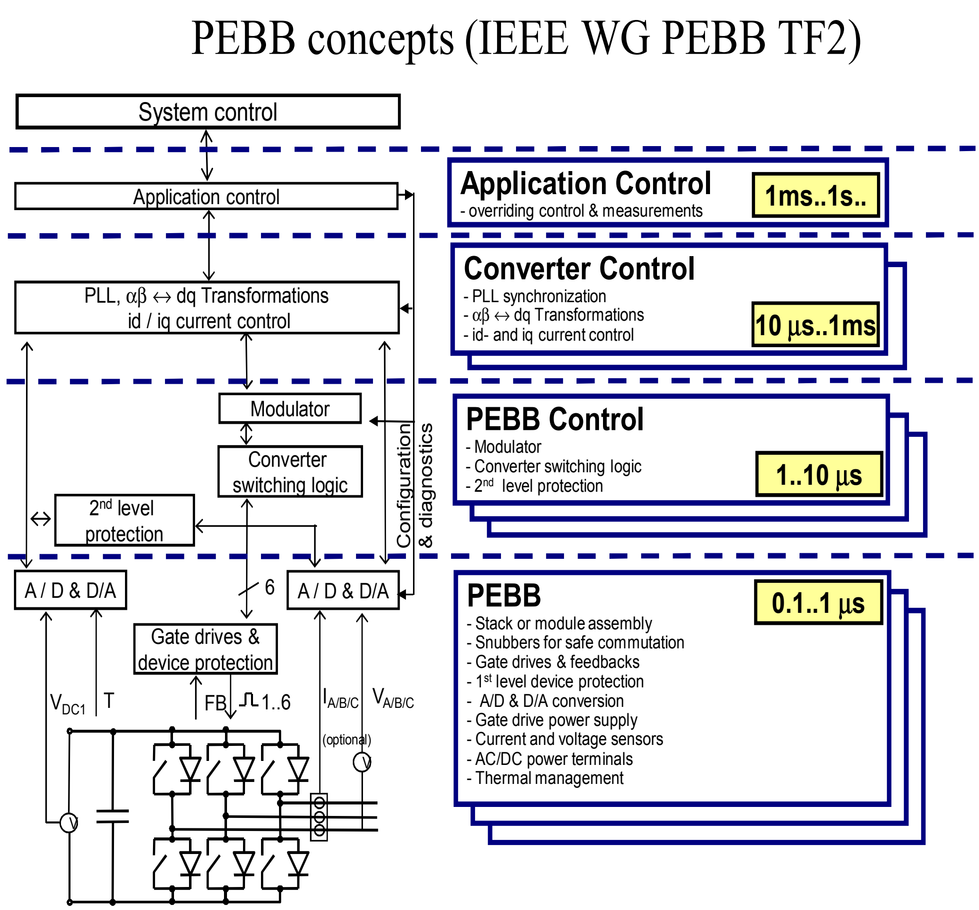

Figure 4 PEBB Multilayer Control Architecture

Task Force 2, under Chairmanship of Professor Ani Gole, is now working on: Design Tools for PEBB and PEBB Based Systems. This Task Force has produced considerable material on:

- Design Tools for PEBB Blocks
- Off-Line Tools for Evaluating PEBB Systems
- Real Time Simulation Tools
- Tools for Rapid Controller Prototyping
- Evolution of Simulation Approach
- Validation Approaches

This work has reached the stage where the WG is ready to request a Standard Project Number to write a Guide.

Task Force 1, under chairmanship of Joseph Sullivan of NSWC, has undertaken a very important and difficult task of writing a Standard P1676 “Guide for Control Architecture for High Power Electronics (1 MW and Greater) used in Electric Power Transmission and Distribution Systems”. Membership of this WG includes representatives from utilities, industrial and marine applications.
The purpose of this guide is to define hierarchical control architecture, define various /functions that need to be handled within each level, and those that need to be communicated between the levels and their required speed range. When the control functions of many different power electronic systems are investigated and evaluated, a significant degree of common functionality emerges, irrespective of the target application.

Using the concept of system levels (or layers), it is possible to define a hierarchical control architecture for high power electronics based systems.

Guide intents to provide a framework and guideline specifically for the control system in order to allow multiple vendors to design and manufacture components, subassemblies, and software, which can be used in a large variety of power electronic products or systems. This guideline will also serve as a foundation for interchangeability among different manufacturers at the layer level with defined interfaces. This Guide is due for approval by the end of 2009.

VIII. IEEE STD 45-2002 revision

Due to the large size of IEEE 45-2002, it was decided to develop the family of standards addressing specific issues in greater details.

The new standards will build upon, and are intended to be used in conjunction with, IEEE 45™, "IEEE Recommended Practice for Electrical Installations on Shipboard."

The family of standards projects will address new shipboard technologies and provide a consensus of recommended practices for design in marine electrical engineering as applied specifically to ships, shipboard systems, and equipment.

The new standards projects are:

- IEEE P45.1™, "Recommended Practice for Electrical Installations on Shipboard - Design"
- IEEE P45.2™, "Recommended Practice for Electrical Installations on Shipboard - Controls and Automation
- IEEE P45.3™, "Recommended Practice for Electrical Installations on Shipboard - Systems Integration"
- IEEE P45.4™, "Recommended Practice for Electrical Installations on Shipboard - Marine Sectors and Mission Systems"
- IEEE P45.5™, "Recommended Practice for Electrical Installations on Shipboard - Safety Considerations"
- IEEE P45.6™, "Recommended Practice for Electrical Installations on Shipboard - Electrical Testing"

The standards are being developed by the IEEE Working Group for Electrical Installations on Shipboards, and sponsored by the IEEE Industry Applications Society's Petroleum & Chemical Industry Committee. Everybody interested in joining the working group should contact moni.islam@ieee.org

IX. CONCLUSIONS

1. By mixing traditional paper presentations with invited speakers and panel discussions, IEEE Electrical Ship Technologies Symposiums have established a permanent forum for the exchange of a broad spectrum of view points for the entire scientific and technical community working in the marine industries field all around the world.
2. IEEE working group activities in writing new and revising active standards for marine industries are making possible significant risk reduction in applying new technologies by combining established industrial practices with modern analytical tools.

X. ACKNOWLEDGEMENTS

Authors gratefully acknowledged support from Mr. Terry Ericsen from Office of Naval Research and Capt Norbert Doerry from US Navy as well as contributions from the members of IEEE STD 1662-2008, P1676, P1709, P1713 and i8 working groups.

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G. VITA

Dr. Yuri Khersonsky has diverse experience in research, development, production, marketing and application of power electronics, electric drives, motion controls and ship power distribution systems. Previously, as the Vice President of Technology and Development for Power Paragon Inc. and later SPD division of L-3 Communications, he was responsible for the development and integration of AC Servo Drives, Bi-Directional Power Conversion Systems, Solid State Circuit Breakers & Buss Transfer Switches, and Power Conditioning systems for US Navy and commercial applications. Dr. Khersonsky is a Life Senior member of IEEE Industrial Applications, Power Electronics and Power Engineering societies. He is the chair of IEEE P1662 and IEEE P1709, the co-chair of IEEE Std. 519 and Liaison Representative to IEEE Standards Committee. He is a Life member of the Naval League and the Surface Navy Association, a member of the American Society of Naval Engineers, the Institute of Marine Engineering, Science and Technology and the Naval Submarine League. Dr. Yuri holds 5 patents and has published over 60 papers and 2 books. He received his MS in Electro-Mechanical Engineering and Ph.D. in Control Engineering from Odessa Polytechnic University.

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Mr. Kevin Peterson (M'87, SM'97) started his career in consulting engineering with SPARVAN Inc. in 1983 while studying for his bachelor's degree. He was promoted to Chief Electrical Engineer in 1989. In 1991 he started P2S Engineering Inc, a consulting electrical, mechanical, and telecommunication engineering firm. The Long Beach, California based firm currently has a staff of ninety personnel. Mr. Peterson serves as the firm's President / CEO. His experience in the electrical engineering field has encompassed a variety of projects involving industrial and commercial power and lighting systems. Mr. Peterson is Past President of the IEEE Industry Applications Society and has been actively involved with the society since 1988. Mr. Peterson received his B.S. degree in Electrical Engineering from California State University, Long Beach in 1986. Mr. Peterson is a Registered Professional Engineer in California, Arizona, Nevada, Washington, Oregon, and Puerto Rico.