Marelec 2009 Poster Presentation Abstracts

Number: 1 **Day:** Tuesday/ Wednesday	**<u>Electromagnetic susceptibility management – A framework for effective exploitation of electromagnetic signature management systems</u>** **Mr Alastair Ballentine, Platform Systems - UW Systems, QinetiQ, United Kingdom** The signatures and susceptibility of naval vessels change over time. Ship's staff are probably unaware of this change (and the associated tactical impact) unless some form of feedback (closed loop) system has been installed. This information can then be linked to an onboard Tactical Decision Aid (TDA) to provide the Commanding Officer with an updated situational awareness of the tactical position. For UW electromagnetic influences, the magnetic and electric signature control systems not only need to provide signature maintenance during a patrol or transit (i.e. throughout the life of the platform) they require efficient, cost effective setting to work procedures as well. Modelling and simulation tools/techniques and model-scale test-beds provide the ability to evaluate system concepts in real-time, early in the design cycle and offer the means to de-risk many aspects of the systems prior to installation on the vessel. A susceptibility management system needs to be able to accept inputs from various signature control / monitoring systems (e.g. acoustic, magnetic etc.). The timely processing of this data into threat related tactical information accessible via tactical decision aids enables the command team to holistically manage the susceptibility of the platform This paper will provide an introduction to and demonstration of a framework for a susceptibility management system. This will include demonstration of the numerical tools, the numerical work undertaken during their design and some of the closed loop (magnetic and electric) methods evaluated; real-time data from both test-beds will be used to illustrate the results and the type of tools required for the maritime warfighter to tactically exploit this information.
Number: 2 **Day:** Tuesday/ Wednesday	**<u>Extraction of ground wave for CSEM</u>** **Mr Brian Anthony Farrelly, Senior Advisor R&D, MultiField Geophysics, Norway** Marine controlled source electromagnetics has enjoyed a rapid growth over the last few years. From the beginning of that growth the air wave has been regarded as a problem. The air wave consists of electromagnetic energy which has been reflected and refracted at the air-sea interface alone on its journey from the source to the receiver. Similarly the ground wave has interacted with the sea-bed alone. These waves then reverberate within the sea as multiples and, together with the direct wave, constitute the total field. The desired ground wave may be swamped by the air wave and, not least, the multiples, especially in shallow water and at long offsets. One way to attempt to extract the ground wave is to record the cross-line magnetic field as well as the in-line electric field and then to perform up-down separation using a linear combination of the fields to distinguish the up-going fields from the down-going fields. This approach has a number of difficulties. Another approach is to use two sources at different heights and extract the ground wave, again as a linear combination of the in-line electric fields from the two sources. The coefficients for the combination are calculated by modelling and no ray approximations are involved. This approach has been tested in the field. The concept has been proved, and practical requirements for commercial use established. In particular a good signal to noise ratio is essential.
Number: 3 **Day:** Tuesday/ Wednesday	**<u>Electromagnetic Underwater Signature Management: Signature design techniques and redeployable measurement systems</u>** **DR Samantha Davidson, Research and Software Team Leader, Ultra Electronics PMES, United Kingdom** Underwater Signature Management is an integrated process that extends from initial design concept to through-life signature maintenance. In this paper we discuss electromagnetic signature design and control solutions: Electromagnetic concept evaluation DG and ICCP system design

	Through-life electromagnetic signature consultancy Magnetic treatment and multi-influence signature management solutions as follows: Multi-influence ranging and signature analysis Signature trend analysis and remedial action formulation The static electromagnetic and ELFE signature management of a vessel begins at the concept stage e.g. evaluating the signature effects of the choice of drive type and hull coating. In this paper the complete signature design process is discussed with reference to tools used from the preliminary design stage to signature acceptance. The electromagnetic design team is involved throughout the vessel design process determining the signature effect of changes proposed by the Naval Architect. Often the customer specifies only the target signatures to be achieved with the contractor taking 'complete signature responsibility'. Once in-service the signature management process continues with periodic signature measurement. Signature measurement can be undertaken utilising multi-influence sensors (magnetic, electric, ELFE, acoustic, seismic) deployed in a variety of configurations and with analysis systems optimized to meet the customer's requirements. The latest digital range system designs are highly modular allowing flexibility to match customer's operational concept. Validation sources and Signature Databases for trend analysis are available.
Number: 4 **Day:** Tuesday/ Wednesday	**Long-term variability of underwater electric noise in the port of Gothenburg** **Stefan Petrovic, Research engineer, FOI - Swedish Defence Research Agency, Sweden** Performance estimation and optimization of underwater passive surveillance systems require good knowledge of the received noise field. This is true in general and probably even more important in environments where large variability of the noise can be expected, such as in commercial harbours. Our research is focused on passive underwater detection systems for small underwater targets (i.e. divers, swimmer delivery vehicles and autonomous underwater vehicles) for harbour or port protection. Specifically we design electro-magnetic trip-wires for this purpose. As part of this effort, we measure the long-term variability of passive acoustic and electric-field background noise in a shallow water environment in the port of Gothenburg since early 2008. In this paper we present an analysis of the time-variability of low-frequency underwater electric noise. The analysed data is divided in three sub-periods, spring, autumn and winter. We study power-variations over seasons, week-days and time-of-day, for frequencies up to 7 Hz. In addition, we study how the different sources affect the stationarity and normality properties of the noise. We find that there are clear diurnal variations of the noise level. The largest contribution to the overall power which causes the diurnal variation is found to be correlated with the local trams. During times of intense tram-traffic, the influences of ocean waves or geo-magnetic variations are difficult to quantify. However, extreme weather conditions (i.e. high wind speeds causing large waves) or high geo-magnetic activity (i.e. high values of geomagnetic index), are possible to explore in the data as exceptional power levels. Our conclusion is thus that the local noise conditions in Gothenburg are dominated by anthropogenic noise sources.
Number: 5 **Day:** Tuesday/ Wednesday	**SPOMF, A successful US Navy natural laboratory providing sustained ocean observation capabilities ain the Florida Straits'** **Dr. William Venezia, Chief Engineer, Naval Surface Warfare Center, United States** The South Florida Ocean Measurement Facility (SFOMF) is a partnership model and mutually beneficial collaboration that conducts year round major at sea test and evaluation operations, sustains the operation of a complex array of sub sea sensors, and provides maintenance and shore based infrastructure to support both. Strategic partnerships, forged and maintained through stakeholder participation in academia, government and industry, provide an all encompassing in situ and remote sensing oceanographic backdrop to a comprehensive state of the art marine

	electromagnetic testing and signature measurement facility. The transformation of a long standing narrowly focused Navy test and evaluation facility is described. Formerly plagued with a decreasing customer base and increasing operational costs, creation of this fully integrated coalition has mitigated these forerunners of extinction while answering both Navy and academic needs. The successful partnership has resulted in modern facilities, a broad customer base, and steadily decreasing operational costs. Examples are provided that demonstrate the ability of the Navy's South Florida Ocean Measurement Facility to realize user cost savings and to aid in the convergence of interests and capabilities among a variety of user groups toward the solution of problems of national concern, including naval research, homeland security, and environmental stewardship.
Number: 6 **Day:** Tuesday/ Wednesday	**GEM-Shark - Electromagnetic subsurface profiler for coastal and shelf research** **Mr Hendrik Mueller, Geophysicist, University of Bremen, Germany** The MARUM centre for marine environmental research in Bremen and GEOMA research group of Vigo University have developed and successfully applied a new marine EM profiler to survey the magnetic and conductive signatures of marine sediments. The commercial electromagnetic induction (EMI) sensor GEM-3 was modified for submarine operations and mounted into a bottom¬-towed platform enabling synchronous in-situ profiling and mapping of magnetic susceptibility and electrical conductivity of unconsolidated near-surface sediments (0-50 cm). The magnetic susceptibility is used to quantify the fine-grained terrigenous clay/silt fraction as well as diagenetic magnetite depletion and anthropogenic metallic contaminants. Electric conductivity is primarily considered as measure of porosity and grain-size distribution. The sensor is used to investigate patterns of sediment transport and deposition and to detect fluid seepage, pollution and eutrophication effects. It resolves subtle and gradual variations in silt and clay content, porosity and diagenesis state at sub-meter resolution. The complementary CTD tracks micro-bathymetry and identifies bottom water characteristics. The non-magnetic and non-conductive GEM-Shark platform is a self contained ruggedized fibreglass sled of 3.6*1.2*0.6 meters size, fully encasing the GEM-3 sensor (96 cm diameter) together with an oceanographic CTD-Profiler, movement and navigation sensors and a lead-battery power supply. Its glass pressure sphere contains all sensor electronics, an embedded PC and a DSL network telemetry unit, providing online control of platform status, position and measurements via the armoured coax tow cable. The system is devised for coastal and shelf operations of 5 to 500 m water depth. Typical towing speeds are 2 knots on gravel and 3-4 knots on mud and sand, providing sub-meter resolution at a daily coverage of 50-100 km. The broadband frequency domain electromagnetic sensor GEM-3 with horizontal coplanar and concentric arrangement of transmitter, bucking and receiver coils is operated with 5 superimposed frequencies between 75 Hz to 16 kHz and a sampling rate of 25 Hz. A half-space model algorithm considering sensor elevation and CTD based seawater conductivity is used to calculate sub-surface susceptibility from the low frequency in-phase response and sub-surface conductivity from the quadrature component in the kilohertz range. The sensing concept has been verified with cored reference material. During its first deployments in 2008 at the Baltic Sea Eckernförde Bight and NW Iberian Shelf, the system has successfully covered more than 500 km profile length without major failure and damage and is now scheduled to map sediment plume tracks of the Rio de la Plata. We will present data examples depicting cold seeps, sediment waves, mud belts and nepheloid passages.
Number: 7 **Day:** Tuesday/ Wednesday	**Seafloor electrical measurements autonomous observatory in hydrothermal zones: the Elecmomar Project** **Dr Jean-Francois D'Eu, Research Engineer, Laboratoire Domaines Oceaniques, France** To understand seafloor hydrothermal activity, its distribution with depth and to follow its evolution, 4-D (space and time) imaging is essential. Only a few parameters can be measured to retrieve the geometrical constraints and the system dynamics. Electrical conductivity is one of them. Indeed, seawater's conductivity doubles or more along the path in the hydrothermal plumbing system, due to temperature and ionic exchanges. The water flows in fractured basaltic areas, where basalts are electrically resistant. The evolution of the hydrothermal activity may be followed by leaving an autonomous instrument on the seafloor for repeated measurements, for example once a day. Electrical measurements techniques such as

	electric cross-sections, commonly used on land, may be used provided some adaptation to deep ocean studies. In the past 20 years, trials of electrical and electromagnetic measurements have been performed in hydrothermal zones (by Ifremer, SIO, U. of Toronto and SOC teams). These studies showed the feasibility of such an instrument to get the information on the fluids conductivity,. They never led to a fully operational long term system to image hydrothermal systems and their evolution. The ELECMOMAR project is a multi-electrodes instrument, with 2 sets of electrodes (passive and active electrodes), to get an electrical section of about 100m long and up to 100m deep, that describes the electrical conductivity of the seafloor(see figure1). The first set of electrodes injects current in the crust while the other set measures the potential differences, in order to built an image of the electrical resistivity. The instrument will be deployed for one year to record on a regular basis the evolution of the system. It will be deployed in the MOMAR zone, on Lucky Strike. The current status of the instrument will be presented and discussed.
Number: 8 **Day:** Tuesday/ Wednesday	**<u>Novel electromagnetic seafloor receiver as compared to conventional systems</u>** **Dr Thomas Nielsen, Chie Technology Officer, Quasar Geophysical Technologies, United States** Quasar Geophysical Technologies presents an innovative marine electromagnetic field recorder based on a new class of low-noise electric field sensors and a highly optimized short induction sensor. These novel sensors are combined into a compact package that measures all six components of the seafloor electromagnetic field. The discrete profile of this instrument and the absence of long electrode arms make this recorder useful for rapid deployments and recoveries during offshore EM surveys for hydrocarbon exploration and defense monitoring purposes. The performance of our new electric field sensors is documented by extensive tests alongside instruments developed by the Scripps Institution of Oceanography. Our electric field sensors couple to the seawater capacitively, whereas the more conventional Scripps-type Ag/AgCl electrodes involve the deliberate transfer of ions between the electrodes and the surrounding seawater. Thus, while the Scripps electrode chemistry stability requires the electrodes to be constantly maintained wet in order to achieve low noise performance, our electrodes do not require any special handling and can be left dry on the deck of a ship without any adverse effects on data quality in subsequent deployments. Controlled-source EM and magnetotelluric data comparisons between our sensors and the Scripps type obtained through field-deployments off the coast of San Diego and in the Gulf of Mexico demonstrate the noise levels possible for each of these systems. The magnetic field sensor design utilizes modern electronics, with coil winding and core construction optimized for low noise performance in a short light weight package ideal for a compact marine EM receiver. The performance of our low power magnetic sensors is illustrated by comparisons of magnetotelluric data collected alongside Scripps receivers in 1 km deep water off the coast of San Diego and with simultaneously collected land magnetic data
Number: 9 **Day:** Tuesday/ Wednesday	**<u>Development of a high performance transportable multi-influence sensor for naval vessel ranging applications</u>** **Howard Jones, Principal Engineer, Ultra Electronics PMES, United Kingdom** Ultra Electronics has developed a high performance transportable multi-influence sensor for naval vessel ranging applications. In this paper we describe the development process and examine the challenges that we faced. **Challenges** Mechanical stability: High tidal flow; Marine fouling; 24 bit data acquisition of signals with good 1/f noise performance; Distortion of the electric field due to the presence of the sensor housing; Diverless Deployment High performance electrodes: Long life; Robust Low impedance; Low noise; Low offset and drift

	E-Field Amplifier: Low noise and drift Wideband Magnetometer: Incorporates low noise triaxial magnetometer proven in service on current Ultra ranges; Acoustic and Pressure; Incorporates high performance designs proven in service on current Ultra ranges Something about transmission protocols and ranges with / without junction box and fibre converter? **Objectives** Design a sensor to meet the criteria outlined above; Demonstrate sensor performance **Methods employed** 24 bit, careful layout of analogue circuits, FPGA control, software filtering; Small sensor size; FEA analysis of the structure to minimise bend and vibration; Modelling of the predicted field distortion at the sensor due to the sensor's own structure **Validation equipment** Demonstration of field distortion carried out in a specialised test tank; 24 bit converter performance demonstrated; Overall system performance demonstrated **Conclusions** We have demonstrated that high precision multi-influence (including electric and acoustic) measurements can be made using a small transportable under water sensor. The advantages of small size include low drag and high mechanical stability when subjected to tidal flow, enable the system to be deployed with a minimum of surface handling equipment.
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Number: 10 **Day:** Thursday	**<u>Time domain marine controlled-source electromagnetic survey in shallow water</u>** **Dr Yuguo Li, Project Scientist, University Of California San Diego, United States** Recently, an intense commercial interest has arisen in applying the marine controlled-source electromagnetic (CSEM) method for offshore hydrocarbon exploration. Ma-rine CSEM surveys have been carried out both in the frequency and time domain. The frequency domain CSEM method has been applied successfully in deep wa-ter areas to detect hydrocarbon reservoirs and to characterize gas hydrates. In shallow water environments, at water depths of less than 300 meters, however, the frequency domain CSEM method may face a significant challenge for detecting thin hydrocarbon reservoirs because the airwave dominates the electromagnetic response and contains no information about resistivity structures of seabed. We have revisited the transient CSEM forward problem and have written a new 1D time domain forward code and a 2.5D time domain finite element code. With the use of these codes, we study the transient electromagnetic responses of offshore hydrocarbon models. This study indicates that airwave effects are weaker in tran-sient CSEM method than in the frequency domain method and the field magnitudes are weaker also. The airwave arrives earlier in shallow water and later in deep water environments and can be easily separated from signals traveling through the deep resistor. Although in an intermediate water depth the airwave and the signal from the deep resistivity layer overlap each other and both signals are not clearly separated, one can still see a clear anomaly compared to the background model without hydrocarbon reservoirs. For shallow water, deep-towing the transmitter near the seafloor has no clear advantage and a surface towed system may be used.
Number: 11 **Day:** Thursday	**<u>Reducing signatures, corrosion, and costs with a well designed sathodic protection system</u>** **<u>with a well designed cathodic protection system</u>** **Barry Torrance, Product Manager, Aish Technologies Ltd, United Kingdom** Proper control of electric and magnetic fields around ships and submarines has long been a goal of sophisticated navies. The

	risks of mine detonation and of detection of submerged vessels from the air must be reduced. Corrosion prevention techniques, and indeed the corrosion process itself, both produce electric and magnetic fields that contribute to these fields. These have become known as corrosion-related signatures. Over the last twenty five years, advanced impressed current cathodic protection systems and auxiliary equipments have been developed to reduce these signatures. Modelling techniques, both numerical and physical, have improved and become more available. To date these have been primarily applied to submarines. In today's changing operational scenarios, however, surface ships have a higher likelihood of littoral operation, and mine sophistication is increasing. Attention is therefore turning to reducing the underwater signatures of surface vessels as well as submarines. This poster session describes the following corrosion-related signatures, and how they may be reduced while at the same time maintaining corrosion protection: • Power Frequency ELFE (Extremely Low Frequency Effect) • Shaft Related ELFE • Static Electric (also known as Underwater Electric Potential) • Corrosion-Related Magnetic The presentation also demonstrates how careful consideration of cathodic protection design early in a vessel's design cycle can significantly reduce through-life costs and increase vessel availability and operability, as well as achieve enhanced low signature performance. In addition, some future concepts are postulated in the areas of signature management and own-ship signature prediction.
Number: 12 **Day:** Thursday	**<u>Subsea wireless video link and its application to ROV docking</u>** **Mark Rhodes, Engineering Manager, WFS Ltd, United Kingdom** Wireless radio communications have become ubiquitous in the office and industrial environments. There is increasing demand for the provision of comparable high speed wireless data transmission capabilities when industrial and military activities are carried out under the ocean. In fact there is an additional motivation for wireless interaction in the marine environment as high speed data connectors and cabling are unreliable and their precise manipulation by remotely operating vehicles is challenging. This paper describes the implementation of a 100 kbps subsea data link and outlines its configuration for some typical applications including provision of a short range wireless video link as an aid to Remotely Operated Vehicle docking. Implementation of a high speed subsea radio modem presents unique technical challenges. The range benefits of minimising the carrier frequency have resulted in very high percentage bandwidth occupancy and minimised carrier cycles per data bit. In a typical configuration the modem signals through inductive coupling with launch and recovery achieved using compact 0.5 m diameter loops and achieves reliable communication over 5 m range at 156 k baud rate. The modem has been configured to provision a transparent Ethernet bridge for maximum compatibility with deployed equipment. We will discuss some of the challenges of implementing this standard over a subsea radio link. In one example application the signalling protocol has been adapted to support the H.264/MPEG-4 AVC video standard. The modem implements variable frame rate capabilities to provide high resolution still images where detailed inspection is required increasing to 10 frames per second at 100 kbps real time video for surveillance and guiding movement. One usage case for this wireless video capability is the observation of a docking process from diverse observation angles. An ROV can deploy remote video cameras to subsequently observe its movements and bi directional communications capability allows transmission of commands over the downlink. Video cameras can be remotely configured for pan; zoom; tilt; focus; frame rate or picture quality while transmitting video. This paper will describe design challenges of the subsea broadband radio link, modulation scheme and protocol requirements for compatibility with the unique channel properties. Some typical applications will be described to outline the design requirements each application presents for modem operation. This device delivers a unique capability, has undergone extensive trials and is now deployed in customer applications.

Number: 13 **Day:** Thursday	<u>**Static magnetic signature translation**</u> **Dr Eugene Lepelaars, Researcher, Radar & EW, TNO The Hague, Netherlands** For various reasons it may be desirable to know in advance the static magnetic signature of a ship, given its position and heading, based on measured signature data at another position and for another heading. An example is the comparability of magnetic signature data of one ship measured at different ranges. In this paper we will discuss a method to determine the translation of the magnetic signature for undegaussed ships, based on induced magnetization. For a given steel ship construction in the earth magnetic field, calculating the disturbed magnetic field is considered a forward problem. From experience we know that for an undegaussed ship, the induced magnetization forms the major contribution to the magnetic signature. Furthermore, the steel primarily behaves linearly. With this in mind, we perform an inverse procedure to determine the steel distribution, given static magnetic signature data and the local earth magnetic field. To describe the steel distribution, we consider a set of solid prolate spheroids on a 3D rectangular grid. For each gridpoint a single dimension parameter is determined, based on error minimization. Once this steel distribution is known, we perform a forward calculation to obtain the magnetic signature for a different position and heading in the earth magnetic field. To perform these operations, a tool is developed in Matlab including the earth magnetic field, based on the World Magnetic Model. In the presentation we will illustrate the calculation procedure with examples. In particular we will devote attention to the validation of the method.
Number: 14 **Day:** Thursday	<u>**A NEW RADIOMAGNETOTELLURIC SYSTEM AND ITS APPLICATION FOR FOOT, CAR-BORNE AND BOAT-BORNE SURVEYS**</u> **Dr Alexander Saraev, Director of the Center of EM methods, Saint Petersburg State University, Russian Federation** Digital wide-band four-channel radiomagnetotelluric (RMT) system has been developed by the Saint Petersburg State University, MicroKOR Ltd. (Russia) and the University of Cologne (Germany). The equipment provides registration of radio transmitter's electromagnetic fields in the frequency range of 10-1000 kHz. The depth of investigations is 1-50 m. The output data are time series or spectrograms of electric and magnetic components of the electromagnetic field from which the apparent resistivity and impedance phase dependencies from frequency are calculated. Four-channel equipment allows obtaining sounding curves from two orthogonal directions (along and across a strike of an anomaly object). The number of radio transmitters in Europe and European part of Russia usually is enough for getting of sounding curves (15-25 signals for each direction). The equipment has the good noise immunity what permits its applications inside settlements at the high level of industrial noises and the presence of buried pipes and cables. Measurements of electric components of the electromagnetic field can be carried out using both grounded and ungrounded electric antennae. It allows measuring both in summer time at bad grounding conditions like on asphalt, concrete, gravel, and in winter time on ice and snow. The equipment has the possibility of GPS receiver connection in order to provide the coordinate determination of measurement points. The foot, car-borne and boat-borne modifications of the RMT system have been developed and tested. The geoelectric sections from foot and car-borne soundings have good correlations. The boat-borne system has been tested at the mapping of water pollution in Finland Gulf. There is a quite big experience of application of the new RMT system for investigations of oil contaminated areas, landfills of industrial and domestic wastes and solving of engineering tasks.
Number: 15 **Day:** Thursday	<u>**EM sub sea bottom survey using underwater vehicle**</u> **Dr Hiroshi Yoshida, Researcher, JAMSTEC, Japan** Earthquake is a serious problem that affects the human beings. The prediction and better understanding of its mechanisms are pressing issues. In Japan, Tonankai and Nankai earthquake, and Tokai earthquake, are projected to in the near future. Identification of long-term changes in the deep seafloor through continuous observations of deep sea regions is viewed as a way to predict earthquake. It is also important to study of crustal growth process by a subduction of an oceanic crust. On the other hand, ocean resources, such as methane hydrate, hydrothermal deposit, and cobalt rich crust, are come to the front. Methane hydrate is, in particular, examined as a next-generation energy resource to replace oil and natural gas. It is estimated

	that methane hydrate reserves in the deep sea around Japan. In order to survey them, various indirect methods are used. Major survey method of sea bottom and sub-sea bottom is the method using acoustic wave. For a macroscopic survey such as exploring sub-sea bottom deeply and over rock layer, a louder sound source is needed. Multi-channel and single-channel seismic survey using air gun source is utilized to survey from sea surface. Sub-bottom profiler, which has exploring rang of about a few tens meters and image resolution of about tens centimeters, is one of important acoustical tool near to sea bottom. We intend to develop a new survey tool using electromagnetic (EM) waves. We have done the test of EM wave propagation in sea water and sub-sea bottom. A prototype of pulse-power source which consists of a pulse wave generator and underwater antennas has been developed. This can generate pulse wave of up to 1 MW and supply the power to a loop antenna on which will be set seafloor. Study of propagation waves and reflected waves has been done. We estimated from test results that EM waves can reach to 100 m deep from sea surface. In this conference, we, first, introduce concept of EM sub-sea bottom survey using underwater vehicles. Next, prototype system developed is described, Finally, EM wave propagation experiments and EM wave exploration test results are discussed.
Number: 16 **Day:** Thursday	**<u>TSUNAMI PHENOMENON AND WARNING SYSTEM</u>** **Dr Youry P. SIZOV, Scientific manager, Shmidt Institute of Physics of the Earth RAS, Russian Federation** The cause of a tsunami is often an earthquake event in the ocean floor. The commencement of this earthquake represents only vertically movement of the bottom block of the earth's crust a couple of meters in a few seconds. The whole water thickness (miles or more) above the bottom is forced to move vertically. The square of this lifted ocean water can be many hundreds or thousands of miles. Colossal kinetic energy is transferred to the ocean water that transforms to so called "tsunami" or "seismic sea-wave". Some part of this kinetic energy transforms to electromagnetic (EM) energy (when electric conductive ocean medium cross the Earth's magnetic field it is induced electric and magnetic fields in the ocean medium), some parts – to acoustic waves, to gravitational-atmospheric and EM waves in the Earth atmosphere and ionosphere. It is difficult to predict for sure events as earthquakes as moreover tsunamis. Besides we do not to consider all ocean earthquakes, but must separate between them only such of its when only vertically movement of the bottom blocks of the earth's crust have been occurred. In this paper it is considered tsunami model as a soliton pattern, mathematical formulated by Bussinesca and Cortovega-de-Frith equations. Some features of solitons and some results of middle tsunami power calculations are given. Tsunami wave in a conducting sea medium crossing the Earth's magnetic field induces quasiconstant (static) electric and magnetic fields, as well as propagating alternate electromagnetic fields caused by MHD instability that one can register as a signals of tsunami. Besides it generates pressure waves – another additional form of signal. The main task is to detect these signals, transmit it to the coastal station to reach a decision on preventive notification of coastal population. Configuration of the Tsunami warning system is given as an example. The warning system is based on the bottom stations (BS) installed at some distance from shore, and coastal ground stations (CGS). The basic warning system module includes three orthogonal axes magnetic and electric sensors as well piezoelectric pressure and acoustic sensors. An optimization of the local centre (LC), CGS, BS clusters (BSC), regional coastal chain (RCC) including seismic stations (SS), and RCC centre structure schemes raises tsunami detection effectiveness and reduces false signals. The chief task is to warn tsunami risk before the tsunami reaches the coast. This system can opportunely warn not only tsunami danger, but times of its strike to the coast and coastal line sites.
Number: 17 **Day:** Thursday	**<u>New computationally effective method for modelling of ferro-magnetic signature for realistically specified surface ships</u>** **Mr Pieter Schippers, scientist, TNO Defence, Security and Safety, Netherlands** The ferro-magnetic signature of surface ships in the earth magnetic field induces a disturbance such that magnetic mines in

	particular cause a serious threat in shallow water environments. For better assessment of this threat, a new computationally efficient model called FERROSHIP, was developed to predict these ferro-magnetic signatures of steel objects present in an external magnetic field. Surface ships are modelled in FERROSHIP, supposing steel walls of different thickness. The shape of the walls is described by a so-called voxel file, generated with a tool box in the model and compatible with our acoustic signature modelling software. In this file also the local wall thickness is specified for our magnetic calculations. Further the voxel modelling method is extended to add realistic degaussing coils to the object. FERROSHIP makes use of a new approximate method that allows for fast computation of the demagnetisation at any point in a shell shaped object structure. The property that solid ellipsoids show uniform magnetization is used here in combination with the known local curvature of the wall at the voxel position. This new approach was successfully validated for spherical shells where the signature is described by an exact analytical expression, known from literature. Also benchmark data for some other simple shell shaped objects like an ellipsoidal shell are used in this validation. Further the model was extended with an implemented hysteresis model taken from literature. In the latter model a non specified generic steel type is modelled. Application of FERROSHIP for realistically shaped objects is shown in some examples, where the model accounts for the magnetic history in a first approach. As a next step degaussing coils are modelled inside the ship. The effect of the coil system is computed for various current strengths.
Number: 18 **Day:** Thursday	**A new approach to construction globally convergent algorithms for frequency sounding of layered media** **Mr Alexandre Timonov, , University of South Carolina Upstate, United States** A hyperbolic problem modelling frequency sounding of layered media is considered. An inverse problem is formulated in terms of recovering the variable refraction coefficient from measurements of the surface impedance function. Unlike the existing techniques, the original inverse problem is reduced via the Laplace transform to a family of the Cauchy problems for the Riccati equation, which are, in turn, reduced to the Cauchy problem for the first order quadratic differential equations that do not contain the sought coefficient. Based on the asymptotic analysis, the uniqueness and stability results are established and some globally convergent reconstruction algorithms are constructed. In particular, utilizing an asymptotic formula, an initial approximation of the solution is obtained by fitting the surface data with a converging series and solving the system of the first order ODEs via the Runge-Kutta method of the forth order. It is then used when solving successively the elliptic boundary problems governing the propagation of the harmonic waves in an inhomogeneous layer. After each iterate, both the wave field and refraction coefficient are updated until a stopping criterion is satisfied. This procedure results in both the reconstructed interior wave field and refraction coefficient. Although the numerical study is still in progress, some preliminary results are demonstrated to exemplify the computational feasibility of the proposed approach.