Optimisation of platform electromagnetic signatures: latest developments in data modelling and analysis for treatment systems and ranges

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Abstract — This paper will summarise the latest developments in modelling of offboard electromagnetic signatures with particular reference to stealthy vessels. Both electric and magnetic signature modelling will be considered for a variety of sensor types and distributions. Applicability of the electromagnetic modelling for minecountermeasure vessels, stealthy frigates and underwater vehicles will be considered as well as the impact of facilitated verification and maintenance of the health of the overall cathodic protection provided for steel hulled vessels

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1 Introduction

Signature Management is a key element of operational capability. The primary goal of signature management technology is to reduce the likelihood of detection and thereby to increase survivability in the operational field.

There are three prime elements for electromagnetic vessel signature management:

- Vessel design for stealthy signature vessel
- Signature optimisation for stealth
- Cathodic protection system health assessment

This paper will examine the electromagnetic signature management of vessels from initial concept through to vessel ranging. The complete process from the preliminary design stage to vessel signature acceptance will be discussed with particular reference to design tools and range configuration. Several examples will be presented in detail.

2 Objectives

The objective of the paper will be to describe key current developments including signature optimisation and measurement.

2.1 Electromagnetic signature optimisation

The interaction of a vessel hull with its environment, notably the sea water gives rise to corrosion where metallic areas of the hull are exposed. The corrosion of a vessel can be minimised by the suitable application and maintenance of coatings. Since coatings cannot be applied or maintained perfectly an impressed cathodic corrosion protection system, ICCP, is used in order to impress current on to the hull such that the relative potential of hull relative to the seawater is such that corrosion is rendered energetically impossible.

To enable the control or optimisation of the electric field or Corrosion Related Magnetic (CRM), from a vessel it is necessary to have a detailed knowledge of the relative hull to seawater electrical potential or corrosion hull state. Knowledge of the vessel's corrosion hull state is necessary for the control of the signature because the systems placed on a vessel to control the signature will also impact on the hull state and thus affect its corrosion protection. Furthermore it is the hull state that ultimately determines the vessel's electric signature and also the majority of electric signature control systems employed are the same type of systems used to prevent corrosion of the vessel.

The corrosion hull state of vessel continually changes with time due to both the physical state of the hull and its interaction with the environment, the seawater. Thus in order to control the electric signature of a vessel it is necessary to routinely characterise the corrosion hull state of a vessel. We will describe how the signature of a vessel can be optimised in conjunction with the provision of an assessment of the health of cathodic protection systems.

2.2 Electromagnetic sensor spacing in range design

Multi-influence ranges which combine static electromagnetic and alternating influence (ELFE, acoustic, seismic) signature measurement and analysis have developed from the traditional degaussing ranges. The latest generation of digital multi-influence ranges provide all underwater influences (static magnetic and electric fields, alternating magnetic and electric fields, pressure, acoustic and seismic influences) and, uniquely for the sensor size, full sensor bandwidths (for example 3kHz for 3-axis ELFE and 100kHz for acoustic) with additional benefits of the compact design which include increased ease of deployment and system flexibility.

Increased deployability and recoverability is obtained via the utilisation of smaller underwater components. Sensors can be deployed in a standalone configuration or several sensors can be connected to create a range or linked arrays with an underwater hub. Smaller sensor size enables more densely spaced sensor configurations. In this paper we will discuss the effect of modelling the electromagnetic signatures of stealthy vessel and underwater vehicles using the number of sensor and sensor spacings as variables in the analysis.

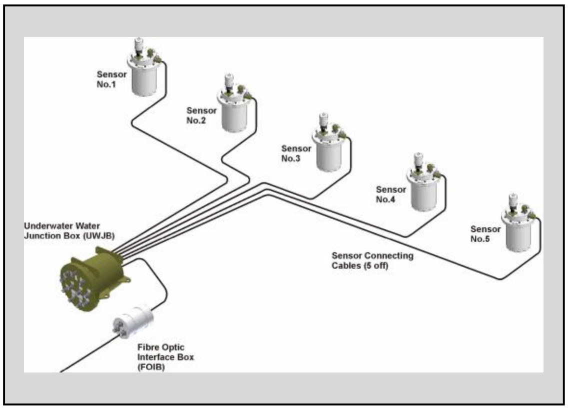

Fig. 1. A simple 5 sensor range

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Author/Speaker Biographies

Dr Samantha Davidson Dr Davidson graduated from Oxford University with a BA in Physics and a Doctorate in Magnetics. She was then appointed Ranges Research leader at Ultra and led the development of electromagnetic modelling for the Transmag product. She has 25 years experience in signature management including underwater system design and analysis and is currently Capability Manager for Underwater Measurement at Ultra Electronics CCS.