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TITLE

PROPOSAL FOR AN ELECTRO-OPTICS RANGE AT THE NAVAL ELECTRONICS SYSTEMS TEST RANGE \(NESTRA\)

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PROPOSAL FOR AN ELECTRO-OPTICS RANGE AT THE NAVAL ELECTRONICS SYSTEMS TEST RANGE (NESTRA)

by

J.L. Forand, E. Riseborough, K. Wheaton & Cdr Richardson-Prager

October/octobre 1998

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October/octobre 1998

Approved by/approuvé par

Gabriel Dion

Section Head/Chef de Section

18 Sep. 98

Date

ABSTRACT

This document presents arguments for the addition of an Electro-Optics (EO) Range to the Naval Electronics Systems Test Range (NESTRA) located at Osborne Head near the entrance to Halifax harbour. With the increasing use of offensive and defensive EO systems in the maritime environment, the Canadian Armed Forces and in particular the Navy will require a site where experiments to test new EO ideas and systems can be performed, new and current operational procedures with current EO systems can be evaluated, EO signatures of Canadian ships and aircraft can be measured, and personnel can be trained to use and understand the information provided by different EO systems.

After the Introduction, Section 2 describes the suitability of the NESTRA site for the location of an EO Range, and the basic infrastructure that would be required to fulfill the interests of the different user communities. Section 3 provides information on the specific interests of the scientific community within DND, and the Navy's operational community for the creation of an EO Range. The final sections summarize the reasons why we believe it is time for DND to establish an EO Range at Osborne Head and provide a list of recommendations and actions.

RÉSUMÉ

Ce document de discussion présente des arguments en faveur de l'addition d'un champ électro-optique (EO) au 'Naval Electronics Systems Test Range' (NESTRA), situé à Osborne Head près de l'entrée du port d'Halifax. En raison de l'usage croissant des systèmes EO offensifs et défensifs dans l'environnement maritime, les Forces Armées Canadiennes et en particulier la Marine auront besoin d'un site où des expériences pour tester de nouvelles idées et systèmes EO pourraient avoir lieu, des procédures nouvelles et courantes pourraient être évaluées au moyen des systèmes EO actuels, des signatures EO de navires et d'avions canadiens pourraient être msurées, et le personnel pourrait être formé en vue d'utiliser et de mieux comprendre l'information qui provient des différents systèmes EO.

Après l'introduction, la deuxième section décrit la pertinence du site NESTRA pour l'installation d'un champ EO, et l'infrastructure fondamentale requise pour combler les besoins de toutes les communautés qui l'emploieraient. Dans la troisième section, on fournit l'information sur les intérêts particuliers des communautés scientifiques du MDN, et les intérêts de la communauté opérationnelle de la Marine pour la création d'un champ EO. Les dernières sections exposent les raisons pour lesquelles le temps est venu pour le MDN d'établir un champ EO à Osborne Head, et fournissent une liste de recommandations et d'actions.

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EXECUTIVE SUMMARY

This document presents arguments for the addition of an Electro-Optics (EO) Range by the Department of National Defence (DND) at the Naval Electronics Systems Test Range (NESTRA). NESTRA is located at Osborne Head, at the entrance to Halifax harbour. With the increasing use of offensive and defensive EO systems in the maritime environment, our Canadian Armed Forces and in particular our Navy will require a site where experiments to test new EO ideas and systems can be performed, new and current operational procedures with current EO systems can be evaluated, EO signatures of Canadian ships and aircraft can be routinely obtained to evaluate their vulnerability to EO-based threats, and our people can be trained to use and understand the information provided by different EO systems.

Due to the increasing importance of Electro-Optical (EO) systems and sensors in military operations, and the growing importance of the coastal environment, the ability of our Navy to test new EO ideas and systems, evaluate new and current operational procedures with our EO systems, obtain EO signatures of our ships and aircraft so as to evaluate their vulnerability to EO threats, and to train our personnel to use and understand the information provided by our EO systems in Canada and under Canadian operating conditions is becoming increasingly important and recognized within the Navy.

To address these capability concerns, the Chief of Maritime Staff (CMS) supports along with Defence Research Establishment Valcartier (DREV), further renovation to the existing infrastructure at the Naval Electronics Systems Test Range (NESTRA) at Osborne Head. The site has most of the required buildings, potable water, plentiful electricity, and excellent communication services. From Osborne Head, users have an unobstructed view towards all points between the east and south cardinal points, is exposed to weather coming from all points between the north-east and south-west, and covers all the approaches to Halifax harbour. Excellent secondary sites for the installation of EO sources and other temporary or semi-permanent equipment are also available at Hartland Pt., in the direction of Shut-In Island to the east, and towards Chebucto Head and Sambro Island to the South. It is located within 20 km of downtown Halifax, Dalhousie University, the Naval Dockyard, Defence Research Establishment Atlantic (DREA), the Bedford Institute of Oceanography (BIO), and the airport at Shearwater. This allows easy access to many of the Navy's resources, research and technical facilities at DREA, and other resources that could be obtained independently or in partnership with other institutions and industries in the Halifax area. In addition, co-locating EO, radar and other sensor systems (for example millimeter wave) will also facilitate the testing and development of synergistic EO-RADAR or other systems and their operation.

Within DND, there are a number of communities which have shown an interest in the further development of an EO range alongside the present RF range at Osborne Head.

At the level of basic research and prototype development, there are the defence scientists working DREV in the EO, and at DREO in the RF. There are also researchers at other sites within DND who are tackling operational problems, and those who work to acquire intelligence information for the military. The link between these communities is Maritime Command, which has ships, submarines and aircraft with EO operations, and test and evaluation requirements under coastal and open ocean conditions. The international community, particularly through NATO and TTCP, also have an interest in using such facilities. This would be a unique site and perhaps the first permanent operational maritime EO range in the world.

The creation of an EO range at DND's site at Osborne Head is something that would be of great benefit to operations within Maritime Command and for the research community within DND. Appropriate renovations to the south wing of the site's main building will provide all users with the ability to profitably use the site throughout the year and with a minimum of technical difficulties during the installation and operation of their equipment. The Navy and the Air Force would be able to use the site to obtain routine EO signatures of their equipment and equipment belonging to other forces against sea, sky and land backgrounds, and to train personnel in the use of EO equipment and in the interpretation of their results. The operational research community will be able to use the site to perform more in-depth studies into different modes of ship or aircraft operation when they are under an EO threat. Finally, the research community within the DREs will be able to use the site to advance new areas of EO research, develop new or improved EO equipment, to understand the results, advantages and problems with each technology, and to provide avenues for innovative solutions.

1.0 INTRODUCTION

The increasing use of infrared (IR) systems, by Armed Forces around the world, for the surveillance, detection, and identification of possible threats, and counter-measures against IR threats is becoming very important in the coastal environment. As a result, the Department of National Defence (DND), through its Defence Research Establishments (DREs), has participated in many national and international (NATO, TTCP or other multilateral) trials over the last 10 years. However, in the last five years, there has been an increasing emphasis on the performance of both EO and RF systems in coastal regions, against small and fast armed naval vessels, and low-flying missiles and aircraft. As a result, even more emphasis has been put on performing trials and testing systems in different coastal regions of the world.

In particular, the ability of our Maritime Forces to test new EO ideas and systems, evaluate and update operational procedures for use with EO system, obtain EO signatures of our ships and aircraft so as to evaluate their vulnerability to EO threats, to train our personnel to use and understand the information provided by EO systems is becoming of increasing importance. While, the above list is not exhaustive, it does point to problem areas that our Maritime Forces will have to address in the near future. Consequently, we believe that it would be in DND's interest to further develop the Naval Electronics Systems Test Range (NESTRA) at Osborne Head into an Electromagnetic (EM) Range, where RF systems, EO systems operating in the ultra-violet (UV), the visible (VIS), and the infrared (IR), and other EM systems could be studied either separately or in concert .

While the Defence Research Establishments at Valcartier (DREV) and Ottawa (DREO) have both used the site at Osborne Head to carry out measurements, the creation of a permanent EO range at Osborne Head for performing basic research and operational research provides definite advantages. Its location at the entrance to Halifax harbour, only 20 km from downtown Halifax, places it in an excellent position to carry out

experiments and make routine measurements involving resources (ships, submarines, aircraft, etc.) and personnel belonging to Maritime Command under typical North Atlantic conditions throughout the year. The infrastructure at the site has most of the required buildings (although some renovation is required), potable water, plentiful electricity, and excellent communication services. From Osborne Head, users have an unobstructed view towards all points between the east and south cardinal points, is exposed to weather coming from all points between the north-east and south-west, and covers all the approaches to Halifax harbour. Excellent secondary sites for the installation of EO sources and other temporary or semi-permanent equipment are also available at Hartland Pt., in the direction of Shut-In Island to the east, and towards Chebucto Head and Sambro Island to the South.

The next section focuses on the specific features of the Osborne Head site and the surrounding area, the subsequent section describes the specific interests of certain user communities, and the final section attempts to summarize the needs and benefits of having an Electro-Optical range at Osborne Head.

This work was carried out between December 1997 and April 1998 under work unit 1AB11, Environmental Effects in the Marine Surface Layer.

2.0 THE EO RANGE

This section describes the specific features of the NESTRA site and of the surrounding area which make it of interest to the research community and other communities within DND, the facilities currently available, and some of the improvements required to make it more user friendly.

2.1 The NESTRA Site at Osborne Head

The NESTRA site at Osborne Head is located at the entrance to Halifax harbour (see Fig. 1), is easily accessible by road, and is only 20 km from the Navy's Dockyard, its ships and submarines. Air resources, helicopters and other aircraft, are available from nearby Shearwater airport, and from CFB Greenwood. It is also within 30 km of personnel and resources belonging to DND's Defence Research Establishment Atlantic (DREA), Fisheries and Ocean's Bedford Institute of Oceanography (BIO), Dalhousie University, and other public and private institutions with interests in the marine environment located within the Halifax area.

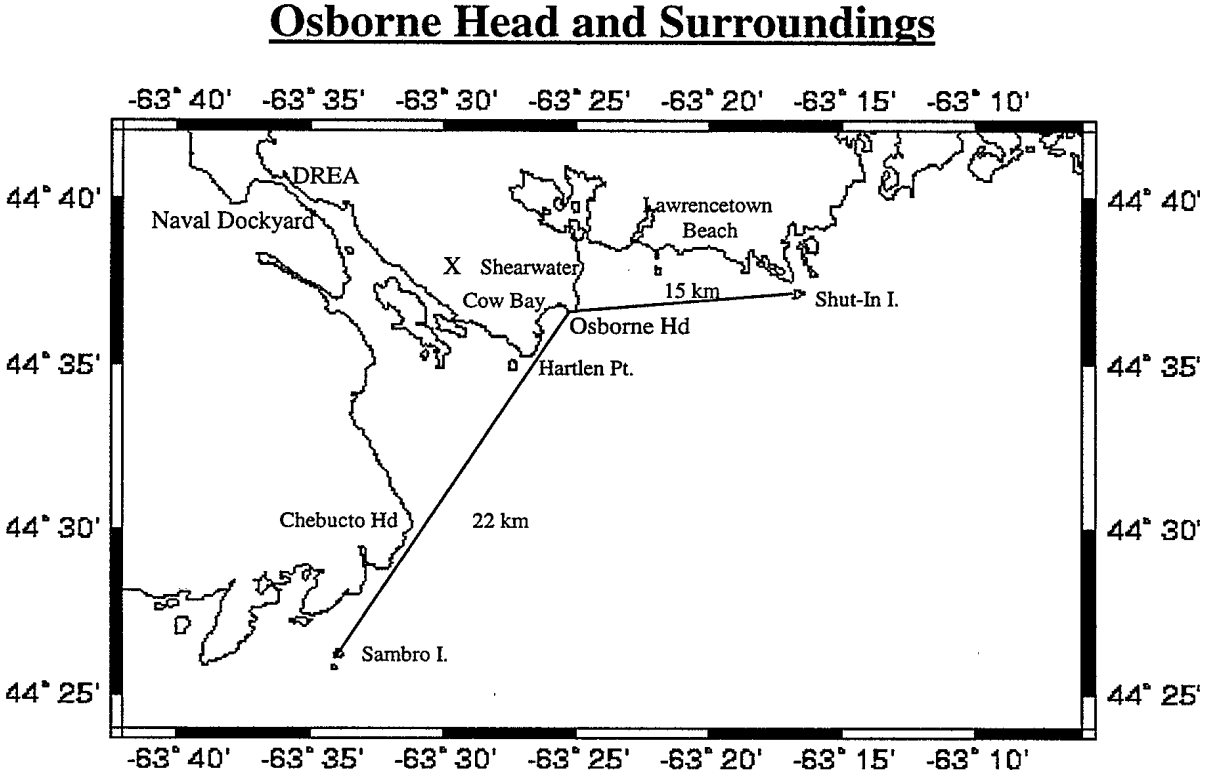

FIGURE 1 - Map of the area surrounding Osborne Head

The site is secure as it is protected by a fence on its land edge and there is a commissionaire on duty at all times. The site provides a 120 degree field of view (FOV)

between Chebucto Head and Sambro Island to the south south-west and Shut-In Island to the east such that all approaches to Halifax harbour are covered. The FOV also allows a clear ocean view of the sun from sunrise to noon; i.e. from its lowest to highest height above the horizon. One slight problem with the site is its proximity to the shipping lanes into Halifax harbour, as this can curtail certain activities in the direction of Chebucto Head. However, the traffic is not so important that it should cause any significant problems.

2.2 Facilities at Osborne Head

Figure 2 shows a more detailed map of the installations at Osborne Head as they existed before the renovations for the new radar range in 1996. These renovations were done on the centre section of building 301. The site is supplied with about 40 kV of electrical power, potable water, telephone and other communication services. It offers the possibility of installing equipment at elevations from sea level (near the mark for a flag pole) to 25 m above sea level (near the operational height on-board a naval vessel) in front of building 301.

The unused and empty wing on the left hand side of building #1 (see Fig. 2) would be an excellent location for carrying out research and development (R&D), test and evaluation (T&E), and other work in EO. Renovation to the wing would involve the creation of sufficient all-weather space, on the building's the seaward side, for the placement of EO systems so that they would have good unobstructed views of the sea from Shut-In Island to Chebucto Head. One possibility would be to construct a sheltered and encloseable balcony just outside a windowed operational laboratory (Op. Lab) space. This would allow exposure of equipment to the outside world and some of the rigours of the climate at Osborne Head, while the operating personnel would be able to monitor the equipment from a warm and dry laboratory. The Op. Lab should also be provided with appropriate communications so that it could act as (or link to) a command and control

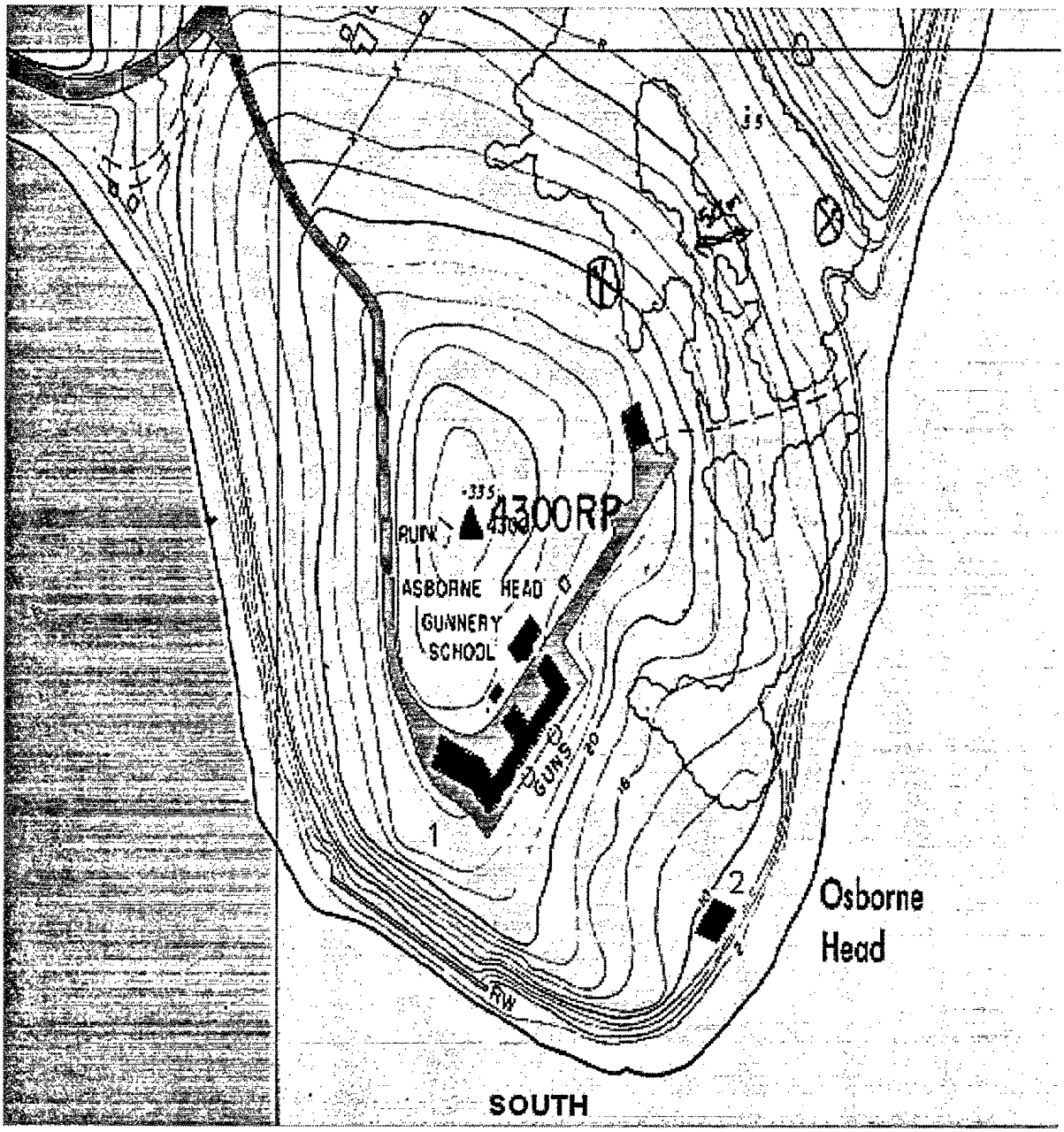

FIGURE 2 - Schematic image of the NESTRA site at Osborne Head (roadways in dark gray and buildings in black)

centre during trials. Behind the Op. Lab, other lab, office and living space would also be required. In particular, space for an electronics shop, an optics shop, a mechanical shop, a common work area, a conference or meeting room, offices, and storage space. Access to

the roof for the placement of antennas for telemetry, and the installation of meteorological equipment would also be necessary.

To study EO effects at elevations close to sea level, a structure to house equipment should be built down close to the beach in front of the main buildings (building #2 on Fig. 2). It would be used for the operation of EO equipment at the operational heights used by submarines, for the installation of additional meteorological equipment, and for a closer study of the marine boundary layer. While this building is not a current requirement, its construction is recommended for later upgrades to the site.

2.3 Other Sites

Sites for the placement of additional equipment, such as EO sources and meteorological stations, on private or crown land, are available within 11 km in the direction of Shut-In Island. Possible sites of interest include Lawrencetown Beach (~ 7 km), Fox Pt. (~ 5 km) at one end of the beach and Half Island Pt. (~ 9 km) at the furthest end. Lawrencetown beach is exposed to the sea from the south and southeast. In the other direction, there is Cow Bay Beach (~ 1 km), Hartlen Pt. (~ 2 km), Chebucto Head (~ 15 km), and Sambro Island (~ 22 km). Cow Bay Beach is exposed to the sea from the southeast, Chebucto Head from the east and northeast, and Sambro Island from all points between the northeast and southwest. A closer survey of all these sites is required in order to determine their suitability with respect to accessibility, security, availability of power, and physical characteristics.

3.0 THE USER COMMUNITY

Within DND, there are a number of communities which have shown an interest in the further development of an EO range alongside the present RF range at Osborne Head. At the level of basic research and prototype development, there are the defence scientists

working DREV in the EO, and at DREO in the RF. There are also researchers at other sites within DND who are tackling operational problems, and those who work to acquire intelligence information for the military. The link between these communities is Maritime Command, which has ships, submarines and aircraft with EO operations, and test and evaluation requirements under coastal and open ocean conditions. The international community, particularly through NATO and TTCP, also have an interest in using such facilities. This would be a unique site and perhaps the first permanent operational maritime EO range in the world.

3.1 Maritime Forces (MARLANT)

The Maritime Forces require signatures of naval vessels, aircraft and decoys in all parts of the electro-magnetic (EM) spectrum. Facilities currently exist in the radar domain (NESTRA); however, no such facilities exist in the infrared, visible, ultraviolet or millimeter wavebands. Absolute signatures at all EO & RF wavelengths are required to test the effectiveness of signature reduction techniques, including the application of new paints, the use of new materials, and the use of new construction techniques. They are also required to evaluate the effectiveness of decoys such as flares, chaff, and smokes at different wavelengths. Furthermore, realistic measurements of platforms and decoys are required to make both real-time and computer model test and evaluations of the vulnerability of vessels and aircraft from threats that use different parts of the EM spectrum, and to develop and refine tactical operations for countering such threats. The further development of the NESTRA site at Osborne Head to other wavelength bands is required to test and evaluate the ways in which Canada's investment in its Maritime Forces are protected against any EM threat.

3.2 Operational Research

The principal responsibility of Operational Research is the development of operational tactics. This work requires the measurement of both absolute and relative signatures in both the infrared (IR) and radiofrequency (RF) parts of the EM spectrum for all platforms and decoys used by Maritime Forces. The impact of atmospheric effects under varying meteorological conditions on the propagation of EM radiation, the detectability of platforms, and the efficiency of various decoys is also required. In combination, the vulnerability of platforms to various threats can be simulated and evaluated for differing conditions under which they might operate around the world.

3.3 Defence Research Establishments (DREs)

The DREs at Valcartier (DREV) and Ottawa (DREO) are the research centres which have the most interest in further development of the Osborne Head site due to their development work in EO and RF, respectively. At the same time DREA in Dartmouth would probably be able to provide them with certain technical, logistical, communications, and other support services such as wave and meteorological buoys.

3.3.1 Defence Research Establishment Valcartier (DREV)

All of DND's in-house research in EO is performed at DREV. Within its buildings, three of its eight sections are involved in EO research. The three sections are Passive Systems and Passive Target Acquisition (PSPTA), Active Systems and Active Target Acquisition (ASSTA), and Electro-optical Warfare (EOW). The objectives of the PSPTA and ASSTA sections are very similar. They have an interest in developing passive (EO receivers) or active (EO emitters and receivers) systems for many uses, but in particular for target detection and acquisition. An infrared search and track (IRST) is an example of a passive system while a laser range-gated imager, like ALBEDOS (Airborn

Laser-Based Enhanced Detection and Observation System), is an example of an active system. The EOW sections interests are in EO countermeasures, for example, the reduction of a military vehicle, aircraft or ship's IR signature, and strategies for countering an attack by EO-guided weapons.

DREV personnel from all three sections have used the Osborne Head site during the last five years and there is a continuing interest to carry out further research at the site. Work at the site has consisted of both research and development, and of more specific tasks requested by Maritime Command. Trials in support of the Navy were carried out during the Gulf War in 1990-91, joint EO radar trials with personnel from DREV and DREO were held in 1995, and most recently, NATO carried out the SWG/4 trials in 1997. The recent deployment of the HMCS Toronto to the Gulf has also initiated more requests for support from DREV, including the possibility of certain trials at Osborne Head. However, carrying out trials at Osborne Head in February instead of during the summer or early fall is not a simple task. During the same period, several groups within the ASSTA section, have carried out international trials off the North Sea in Germany and The Netherlands, at the FORACS site on the island of Crete, and in Monterey and San Diego, California that could and should also be carried out at Osborne Head.

Various groups at DREV have plans to carry out future EO experiment at Osborne Head; particularly, if it is renovated appropriately. The plans include trials in support of the SIRIUS project (a joint IRST program between Canada and The Netherlands), trials to test both ground or ship based active and passive remote sensing systems, and systems such as ALBEDOS for surveillance, and search and rescue.

3.3.2 Defence Research Establishment Atlantic (DREO)

DREO is where most of DND's in-house research in radar systems is performed. Three sections are directly involved in radar research, and one section is involved in

measuring radar cross-sections (RCSs). The four sections are Surface Radar (SR), Aerospace Radar and Navigation (ARN), Space Systems (SS), and Electronic Counter-Measures (ECM). The NESTRA site at Osborne Head has been used by the all but the Space Systems section as they are principally involved in developing space-based radar systems. The Maritime Radar Group (MRG) of the SR section has used the site on three occasions in the last eight years. They have used the site to collect radar-jamming data in both the main beam and the side-lobe, low elevation tracking data, and rain and sea clutter data using an Experimental Array Radar System (EARS) developed at DREO. The EARS experiments made use of a special concrete block poured to support the radar, a sea king helicopter as a target, and the CFAV Riverton to house a jammer. Most of this work is to support studies involving the Active Phased Array Radar (APAR). The AN Section has performed sea clutter measurements at Osborne head, and the ECM Section has developed a radar for measuring the radar cross-sections (RCS) of ships. In fact, the Fleet Maintenance Facility (FMF) in Halifax has a copy of the RCS radar permanently stationed at Osborne Head. Both systems were recently used during the SWG-4 trials in June of 1997. FMF's system was used to measure ship RCSs, and the DREO system was used to measure chaff RCSs by slaving it to a Sky-Guard radar. High range-resolution (HRR) radar is to be implemented in both the EARS and RCS radars with the Maritime Radar group using it to compile a RCS library of air targets and the ECM section using it to isolate large reflectors on ships. Initially, the MRG's HRR studies would more likely be performed at airports; however, the NESTRA site would be useful for testing identification algorithms in a maritime environment.

3.3.3 Defence Research Establishment Atlantic (DREA)

As DREA does not have any direct research interests in the propagation of electromagnetic radiation above the water, they would not likely be directly involved in any measurement at the range. Nevertheless, due to its location in Dartmouth, and its ability to provide certain maritime support and other logistical support to DND and the

other DRE's, its implication in the project is a definite advantage. For example, their Technical Services Section has a mechanical drafting shop, a machine shop, a wave and meteorological buoy, and provides services for DND's research vessels. While none of these services can be used continuously, they could be used for up to a month during a DND sponsored trial.

3.4 The International Community

Due to Canada's active participation in joint international trials similar to those which the DREs would plan to conduct at Osborne Head, other countries, particularly like-minded countries within NATO and TTCP, would probably have an interest in using the site and provide Canada with easier access to their sites. This could occur under the auspices of NATO, TTCP, current memoranda of understanding (MOUs), or even through contracting out. Certainly, the site, if properly developed, could be capable of providing facilities and capabilities that do not currently exist anywhere else within NATO or TTCP countries. In particular, it could provide a site at which EO equipment could be operated under a variety of North Atlantic meteorological conditions.

4.0 SUMMARY

The creation of an EO range at DND's site at Osborne Head is something that would be of great benefit to operations within Maritime Command and for the research community within DND. Appropriate renovations to the south wing of the site's main building will provide all users with the ability to profitably use the site throughout the year and with a minimum of technical difficulties during the installation and operation of their equipment. The Navy and the Air Force would be able to use the site to obtain routine EO signatures of their equipment and equipment belonging to other forces against sea, sky and land backgrounds, and to train personnel in the use of EO equipment and in the interpretation of their results. The operational research community will be able to use

the site to perform more in-depth studies into different modes of ship or aircraft operation when they are under an EO threat. Finally, the research community within the DREs will be able to use the site to advance new areas of EO research, develop new or improved EO equipment, to understand the results, advantages and problems with each technology, and to provide avenues for innovative solutions.

5.0 RECOMMENDATIONS/ACTIONS

The creation of an EO range at NESTRA before the end of 1999 will require the work of people from a number of organizations within DND in order to assure that the most appropriate changes are made to the site. With this in mind, we suggest the following course of action:

1. formation of a steering group for the proposed changes to the NESTRA facility at Osborne Head (Fall 1998). The steering group should be composed of people from all interested organizations.
2. creation of a floor plan for changes to the south wing of the main building at the NESTRA site by the steering group (Fall 1998).
3. submission of the plan to an architect for the production of drawings and an estimate of the cost (Winter 1999).
4. final revisions to the architects plans by the steering group (Winter 1998).
5. open the bidding process for the desired renovations (Spring 1999).
6. begin renovations in the Spring of 1999 for completion by the fall of 1999.

6.0 ACKNOWLEDGEMENTS

Dr. Forand wishes to acknowledge the input of his colleagues in the three EO sections at DREV in the development of this proposal. Without their willingness to give their time, energy and ideas, it may not have seen the light of day.

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This discussion paper presents arguments for the addition of an Electro-Optics (EO) Range to the Naval Electronics Systems Test Range (NESTRA) located at Osborne Head near the entrance to Halifax harbour. With the increasing use of offensive and defensive EO systems in the maritime environment, the Canadian Armed Forces and in particular the Navy will require a site where experiments to test new EO ideas and systems can be performed, new and current operational procedures with current EO systems can be evaluated, EO signatures of Canadian ships and aircraft can be measured, and personnel can be trained to use and understand the information provided by different EO systems.

After the introduction, Section 2 describes the suitability of the NESTRA site for the location of an EO Range, and the basic infrastructure that would be required to fulfill the interests of the different user communities. Section 3 provides information on the specific interests of the scientific community within DND, and the Navy's operational community for the creation of an EO Range. The final sections summarize the reasons why we it is time for DND to establish an EO Range at Osborne Head and provide a list of recommendations and actions.

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