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DEFENCE R&D DÉFENSE

SISWS Environment Modelling

Q-289A Cruise Plan

J.L. Forand
DRDC Valcartier

Defence R&D Canada – Valcartier

Technical Note

DRDC Valcartier TN 2006-690

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Author

J.L. Forand (Chief Scientist Q-289A)

Approved by

J-M. Garneau

Head Optronic Sensing

Work unit 11AQ01, Shipboard Integration of Sensor and Weapon Systems (SISWS)

Abstract

This document presents the cruise plan that was written for the Trial Demonstration component of the Shipboard Integration of Sensor and Weapons Systems (SISWS) Technical Demonstration Program (TDP) to support the Environmental Modeling component of the TDP. The objective of the trial was to test an integrated system that gathers and processes environmental information, from diverse sources, for the prediction of own ship sensor capability and own ship visibility, for all relevant wavelengths (i.e., IR and RF), and to demonstrate this system during a field trial onboard the CFAV Quest. The system that was developed is the Shipborne Integrated Environment System for Tactics and Awareness (SIESTA). System developments started in October 2001 and it was completed in 2005, and it was ready for trial in September of 2005 onboard the CFAV Quest off Halifax.

Résumé

Ce document présente le plan de croisière qui a été écrit pour le composant d'essai de démonstration de programme de démonstration technologique (PDT) SISWS (intégration des systèmes de capteurs et d’armes embarqués) pour soutenir le composant Modélisation de l’Environnement du PDT. L'objectif de l'épreuve était de tester un système intégré qui recueille et traite des conditions de l’environnement, provenant des sources diverses, pour la prévision de la capacité des capteurs sur notre navire et des capteurs externes de détecter notre navire pour toutes longueurs d'ondes appropriées (IR et RF), et de démontrer ce système pendant un essai réel à bord de NAFC Quest. Le système qui a été développé est SIESTA (système d'environnement intégré sur navire pour tactique et évaluation de la situation). Les développements de système ont commencé en octobre 2001 et ont été terminé en 2005, et il était prêt pour l'épreuve en septembre 2005 à bord de NAFC Quest au large de Halifax.

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Executive summary

The Shipboard Integration of Sensor and Weapons Systems (SISWS) Technical Demonstration Program (TDP) began in October 2001 to develop, validate and demonstrate new technologies aimed at improving the survivability of a ship through the use of novel Above Water Warfare (AWW) sensor and weapon management techniques. As part of this work, the objectives of the Environmental Modeling task of this TDP was to develop an integrated system that gathers and processes environmental information from diverse sources for the prediction of own ship sensor capability and own ship visibility, for all relevant infrared (IR) and radio-frequency (RF) wavelengths, and to demonstrate this system during a field trial onboard the CFAV Quest. The system that was developed by DRDC Valcartier and DRDC Ottawa is the Shipborne Integrated Environment System for Tactics and Awareness (SIESTA). Developments of the system began in 2001, it was completed in 2005, and it was ready for trials in September of 2005 onboard the CFAV Quest off Halifax. This document presents the cruise plan that was developed for this trial.

Forand, J.L., 2007, SISWS Environment Modelling: Q-289A Cruise Plan, DRDC Valcartier TN 2006-001, Defence Research and Development Canada.

Sommaire

Le programme de démonstration technologique (PDT) SISWS (intégration des systèmes de capteurs et d'armes embarqués) a commencé en octobre 2001 pour développer, valider et démontrer des nouvelles technologies visant améliorer la surviabilité d'un bateau par l'utilisation des nouvelles techniques de gestion des capteurs de système d'armes pour la guerre de surface (AWW). Comme partie de ce travail, le composant Modélisation de l'Environnement de ce PDT avait comme objectif de développer un système intégré qui recueille et traite des conditions de l'environnement, provenant des sources diverses, pour la prévision de la capacité des capteurs sur notre navire et des capteurs externes de détecter notre navire pour toutes longueurs d'ondes appropriées (IR et RF), et de démontrer ce système pendant un essai réel à bord de NAFC Quest. Le système qui a été développé par RDDC Valcartier et RDDC Ottawa est SIESTA (système d'environnement intégré sur navire pour tactique et évaluation de la situation). Le développement du système a commencé en 2001, a été terminé en 2005, et était prêt pour l'essaie à bord de NAFC Quest au large de Halifax en septembre 2005. Ce document présente le plan de croisière qui a été conçu pour cet essaie.

Forand, J.L., 2007, SISWS Environment Modelling: Q-289A Cruise Plan, DRDC Valcartier TN 2006-001, Defence Research and Development Canada.

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1. INTRODUCTION

This document presents the Q-289A Cruise Plan for use of the CFAV Quest from September 6 to 19, 2006 as part of the Environmental Modeling (EM) component of the Shipboard Integration of Sensor and Weapons Systems (SISWS) Technical Demonstration Program (TDP). The guiding objective of the TDP was to develop, validate and demonstrate new technologies aimed at improving the survivability of a ship through the use of novel Above Water Warfare (AWW) sensor and weapon management techniques (Ref. 1).

The objectives of the EM component were to develop an integrated system that gathers and processes environmental information, from diverse sources, for the prediction of own ship sensor capability and own ship visibility, at all relevant IR and RF wavelengths, and to demonstrate this system during a field trial onboard the CFAV Quest. The system that was developed is the Shipborne Integrated Environment System for Tactics and Awareness (SIESTA). It was developed jointly by DRDC Valcartier and DRDC Ottawa under the direction of DRDC Valcartier. System development started in October 2001 and was ready to be trialed for September of 2005.

In the following sections of this document, we provide an overview of the Cruise Plan, its objective, the assets required, the operating area, the schedule, the trial procedure, the Standard Operating Procedure (SOP) for the LIDAR system, and the Environmental Assessment Form.

2. OVERVIEW

During the period 6 – 19 September 2005, DRDC Valcartier, DRDC Atlantic and DRDC Ottawa scientists, engineers, technologists, and contractors will undertake experiments and engineering tests on an Environmental Modelling (EM) system to produce near real-time estimations of the performance of ship-based infrared (IR) and radio-frequency (RF) sensors, and the visibility of a ship by external (off-ship) IR and RF sensors using the real-time acquisition of environmental data (meteorological, geographical and ship environment). The ship to be used will be the CFAV Quest and the test area will nominally cover the sector 40 km east and south of Osborne Head.

The EM system will consist of an Environment Computer that will control the acquisition of the environmental data from both ship-based and external data streams, launch the required model calculations that are performed on other processing systems, capture the results of these calculations, and display the various estimations to the users.

The ship-based data will be obtained from Quest's NADAS and IMCS systems and from additional environmental sensors that will be added by the participants. External data will be obtained from the CF's Weather Office (CFWOS) via the Quest's Internet connection.

To test and validate the model estimations, it is planned to simultaneous measure the IR and RF signature of the ship from the NESTRA facility at Osborne Head, and to measure IR and RF targets in the Osborne Head area from IR and RF sensors mounted onboard the Quest.

In addition, the Quest's zodiac and RHIB will be used to measure the ability of the IR and RF sensors at Osborne Head and onboard the Quest to detect small fast surface targets.

Other supplementary measurements may be added as the program advances, momentum is gained, and the chance to make use of this unique opportunity is realized.

CFAV QUEST will return to Halifax on completion of the program on or before 19 Sept. 2005.

3. OBJECTIVE

The objective of Cruise Q-289A is to conduct tests, trials and experiments in support of the SISWS TDP; in particular, the Environmental Modelling (EM) part of this program that is being developed by DRDC Valcartier and DRDC Ottawa. DRDC scientists, engineers and technologists from DRDC Valcartier, DRDC Ottawa, and DRDC Atlantic will undertake experiments to test and validate the Environmental Modelling (EM) system that is being developed to make near real-time estimations of the performance of ship-based infrared (IR) and radio-frequency (RF) sensors, and the visibility of a ship by external (off-ship) IR and RF sensors using the real-time acquisition of environmental data (meteorological, geographical and ship environment).

To fulfill this objective the following sections describe ten types of tests and measurements that are planned and Table 1 provides a brief summary of each test or measurement along with the principle scientist in charge.

3.1 EM System – Ship-Based Data Integration

Objective: To integrate the EM system being developed at DRDC Valcartier and Ottawa into the Quest's intranet so that it can acquire data available from the Quest's NADAS and IMCS systems, and other systems added to the Quest by the participants.

In particular, this will include two of DRDC Valcartier's MFOV LIDARs installed on the Quest's quarterdeck, DRDC Atlantic's deployed wave and meteorological buoys, and a special meteorological package from DRDC Valcartier installed above the bridge. The meteorological package will include measurements of visibility at 0.5, 3.8 and 10.6 microns, rain rate and others. Additional information from other sensors, such as radiosondes, will also be investigated.

Each system component will be individually tested to ensure the intended design and interface criteria have been met before beginning the sea trials.

3.2 EM System – External-Based Data Integration

Objective: To integrate the EM system being developed at DRDC Valcartier and Ottawa into the Quest's Internet link so that it can acquire data available from the CFWOS.

This data should include BUFR data (vertical profiles of temperature, pressure, humidity, etc.) from 3 geographic locations near Osborne Head, reflectivity data from the Gore radar near the Halifax International airport, and HPAC data (contains multiple BUFR data sets) covering a region extending at least 100 km in all directions from Osborne Head (~30,000 km^2) with a grid spacing of 10 km.

Each data component will be individually tested to ensure the intended design and interface criteria have been met before beginning the sea trials.

3.3 EM System Operation

Objective: To test the operation of the completely integrated EM system in real-time as it acquires real-time data from the sensors on the ship and from the external-based data sources.

Each component will be individually tested to ensure the intended design and operation criteria have been met before beginning the sea trials.

3.4 IR and RF Atmospheric Propagation

Objective: To compare the predictions of the propagation properties of the atmosphere in the IR and RF bands from data obtained using the meteorological systems installed on the Quest (local measurements) to results obtained from data obtained from the CFWOS (external measurements).

This exercise will include the comparison of specific meteorological parameters, such as water temperature, rain rate, etc. between different sensors, and surface layer parameters such as the Monin-Obukhov length, that are related to its stability. The importance of this work is to develop the ability to obtain data from diverse sources (local and external) such that a consistent coherent high quality set of data can always be provided to the EM system and its models.

3.5 Ship IR Visibility Measurements

Objective: To measure the visibility of the Quest in the 3-5 (MW) and 8-12 (LW) micron IR bands from Osborne Head at ranges varying from 1 to at most 40 kilometers under varying environmental conditions and ship aspect angles.

DRDC Atlantic will be providing the IR cameras, through contract with Davis Engineering, for these measurements.

The results of these measurements will be compared with the predictions produced by the EM system and used to validate SHIPIR and the Quest's IR model. Note: NTCS/SHIPIR and IRBLEM are part of the EM system.

3.6 Ship RF Visibility Measurements

Objective: To measure the visibility of the Quest using a Navigation radar and an X-band radar from Osborne Head at ranges varying from 1 to at least 40 kilometers under varying environmental conditions and ship aspect angles.

DRDC Ottawa will be providing the RF systems for these measurements.

The results of these measurements will be compared with the predictions produced by the EM system and used to validate the Quest's RCS model.

3.7 IR Sensor Performance Measurements (Low Flying Targets)

Objective: To measure the performance of IR sensors onboard the Quest in the LW and MW IR bands against low flying targets.

Targets will be simulated using blackbodies (probably at temperatures close to 100 and 300 ^{o}C) placed near Osborne Head and will be observed against its land background under varying environmental conditions. These cameras will be provided by NETE.

The results of these measurements will be compared with the predictions produced by the EM system.

3.8 RF Sensor Performance Measurements (Low Flying Targets)

To measure the performance of the RF sensor (Nav. Radar) onboard the Quest against low flying targets.

Targets will be simulated using known RCS reflectors (probably between 0.01 and 1 m^2) placed near Osborne Head and will be observed against its land background under varying environmental conditions. DRDC Ottawa is providing an interface to log the output (I,Q) from the Quest's navigational radar. The possibility of having aircraft as targets is also being investigated.

The results of these measurements will be compared with the predictions produced by the EM system.

3.9 IR Sensor Performance Measurements (Small Fast Surface Targets)

Objective: To measure the performance of IR sensors in the MW and LW IR bands against small fast surface targets.

The Quest's zodiac and RHIB will provide the targets to be measured at varying ranges under varying environmental conditions. The IR systems at both Osborne Head and onboard the Quest will be used. The zodiac and the RHIB will be instrumented with a portable GPS to log their positions and with I-buttons to record the temperatures of various surfaces. DRDC Valcartier will be providing these systems.

These results will be used to improve IR models of such small targets and to test the IR sensor performance component of the EM system for such targets.

3.10 RF Sensor Performance Measurements (Small Fast Surface Targets)

Objective: To measure the performance of RF sensors against small fast surface targets.

The Quest's zodiac and RHIB will provide the targets to be measured at varying ranges under varying environmental conditions. The RF systems at both Osborne Head and onboard the Quest will be used. The zodiac and the RHIB will be instrumented with a portable GPS to log their positions provided by DRDC Valcartier.

These results will be used to improve RF models of such small targets and to test the RF sensor performance component of the EM system for such targets.

Table 1 : Q-289A Tests & Measurements

Serial	Test or Measurement	Principal Investigator(s)	Assets	Description
Q289A-01	EM System Ship Based Integration	Forand	EM System NADAS IMCS MFOV LIDARs Met Package Buoys Others?	Integrate the EM system with data available from the Quest's NADAS and IMCS systems, and other systems added to the Quest. This will include two MFOV LIDARs, wave and met buoys, a special met package and other sensors.
Q289A-02	EM System External Based Integration	Forand	EM System Globalstar CFWOS	Integrate the EM system with Quest's Internet link so that it can acquire data available from the CFWOS. This data should include BUFR data (vertical profiles of temperature, pressure, humidity, etc.), radar reflectivity data, and HPAC data.
Q289A-03	EM System Operation	Forand Thomson	All above systems	Test the operation of the EM system in real-time as it acquires real-time data from all sources.
Q289A-04	IR & RF Atmospheric Propagation	Forand Thomson Bissonnette	All above systems	Compare predictions of the propagation properties of the atmosphere in the IR and RF bands using meteorological systems installed on the Quest and data from CFWOS.
Q289A-05	Ship IR Visibility	Hutt	MW Camera LW Camera Calibration Sources Quest	Measure the visibility of the Quest in the MW & LW IR bands from Osborne Head.
Q289A-06	Ship RF Visibility	Riseborough Kashyap	X-band Radar Navigation Radar Calibration targets Quest	Measure the visibility of the Quest using a Navigation radar and an X-band radar from Osborne Head.
Q289A-07	IR Sensor Performance (low flying targets)	Forand	MW Camera LW Camera Calibration sources Target sources	Measure the performance of IR sensors onboard the Quest in the LW and MW IR bands against low flying targets.
Q289A-08	RF Sensor Performance (low flying targets)	Riseborough	X-band Radar Navigation Radar Calibration targets	Measure the performance of the RF sensor (Nav. Radar) onboard the Quest against low flying targets.
Q289A-09	IR Sensor Performance (small fast surface	Forand Hutt	MW Cameras LW Cameras	Measure the performance of IR sensors in the MW and LW IR

	targets)		Calibration sources RHIB Zodiac GPS & Logger I-Buttons	bands against small fast surface targets.
Q289A-10	RF Sensor Performance (small fast surface targets)	Riseborough Kashyap	X-band Radars Navigation Radars Calibration targets RHIB Zodiac GPS & Logger	Measure the performance of RF sensors against small fast surface targets.

4. ASSETS

CFAV Quest – Sept. 6 – 19
Quest RHIB(s)
Quest Zodiac(s)
DRDC Atlantic Wave Buoy
DRDC Atlantic Met Buoy
DRDC Valcartier MFOV LIDAR Trailer
DRDC Ottawa MXCR Truck
NESTRA Site (Osborne Head)
NETE Stabilized LW & MW Camera System
Davis Eng. LW & MW Camera System
RCS Measurement Facility

5. PARTICIPATING FORCES

DRDC Valcartier
DRDC Ottawa
DRDC Atlantic
CFAV QUEST
NESTRA
NETE
D Met Oc
MetOc (Halifax)
Environment Canada

6. EXPERIMENTAL EQUIPMENT

1 – Environmental Modelling System
    1 – Environment Computer
    6 – Processing Computers
    2 – Bridge Monitors
    Miscellaneous
1 – Meteorological Package

1 – HSS Visibility Meter
1 – Gerber IR Extinction Meter
1 – Optical Rain Gauge
1 – Solar Radiance
1 – Sonic Anemometer
1 – Data Acquisition Computer
Miscellaneous

1 – MW/LW Stabilized Camera System (NETE)
1 – MW Camera
1 – LW Camera
1 – Stabilized Platform
1 – Digital Recording Station
1 – Blackbody Calibration Sources
Miscellaneous

1 – Meteorological station (installed at Osborne Head)
1 – Navigation radar data recording system
1 – MFOV LIDAR trailer
1 – LIDAR 1 System (1.57 micron radiation)
1 – LIDAR 2 System (0.532 & 1.06 micron radiation)
4 – Blackbody targets for installation at Osborne Head
1 – Met & Wave Buoy
1 – TriAxys Wave Buoy
2 – RCS Targets on shore
2 – RCS Targets on Buoys

6.1 Operating Areas and Clearances

CFAV QUEST will transit to the NESTRA range at Osborne Head and operate in the area described in Section 5.2 and shown in Figure 1.

A Notice to Airmen (NOTAM) will be promulgated either for each time period during which the LIDAR 2 system will be in operation or for the entire operational period.

6.2 Q-289A Op Area

The trial will be carried out off Osborne Head within CF Op Area A, such that its apex is at Osborne Head and it sweeps out an area from due East to almost due South out to 50 kilometers. Occasional transits out to 100 km may also occur to test the radar systems.

In general operations will be limited to an area described by the sector (O,E50,S50) defined in Table 2.

Table 2: Q-289A Op Area

Point	Name	Latitude (N)	Longitude (W)
B1	Met buoy	44^o 36.500´	63^o 19.960´
B2	Wave buoy	44^o 32.500´	63^o 25.000´
B3	EC Buoy	44^o 30.000´	63^o 24.000´
O	Osborne Head	44^o 36.720´	63^o 25.317´

EC0	1 km South	44^o 36.180´	63^o 25.317´
E50	50 km East	44^o 34.500´	62^o 47.530´
SC0	1 km East	44^o 36.720´	63^o 24.558´
S50	50 km South	44^o 11.075´	63^o 13.500´
E05	5 km East	44^o 36.180´	63^o 21.601´
E10	10 km East	44^o 36.180´	63^o 17.770´
E15	15 km East	44^o 36.000´	63^o 13.984´
E20	20 km East	44^o 35.760´	63^o 10.200´
E25	25 km East	44^o 35.540´	63^o 06.430´
E30	30 km East	44^o 35.300´	63^o 02.654´
E35	35 km East	44^o 35.060´	62^o 58.880´
S02	2 km South	44^o 35.816´	63^o 24.558´
S3.7	3.7 km South	44^o 34.900´	63^o 24.558´
S05	5 km South	44^o 34.075´	63^o 24.558´
S06	6 km South	44^o 33.630´	63^o 24.558´
S10	10 km South	44^o 31.344´	63^o 24.558´
S15	15 km South	44^o 28.772´	63^o 23.120´
S20	20 km South	44^o 26.215´	63^o 21.800´
S25	25 km South	44^o 23.680´	63^o 20.420´
S30	30 km South	44^o 21.158´	63^o 19.000´
S35	35 km South	44^o 17.764´	63^o 17.255´

6.3 Marlant Op Areas

Operating area requests will be submitted for the areas, dates and times as follows:

MARLANT OP Area A - DRDC Valcartier has requested this area and requires Quest to deploy two bottom tethered buoys within 15 kilometers of Osborne. The expected coordinates are given in Table 3.

Required Period: 0800Z 12 Sept. 2005 to 1600Z 19 Sept. 2005

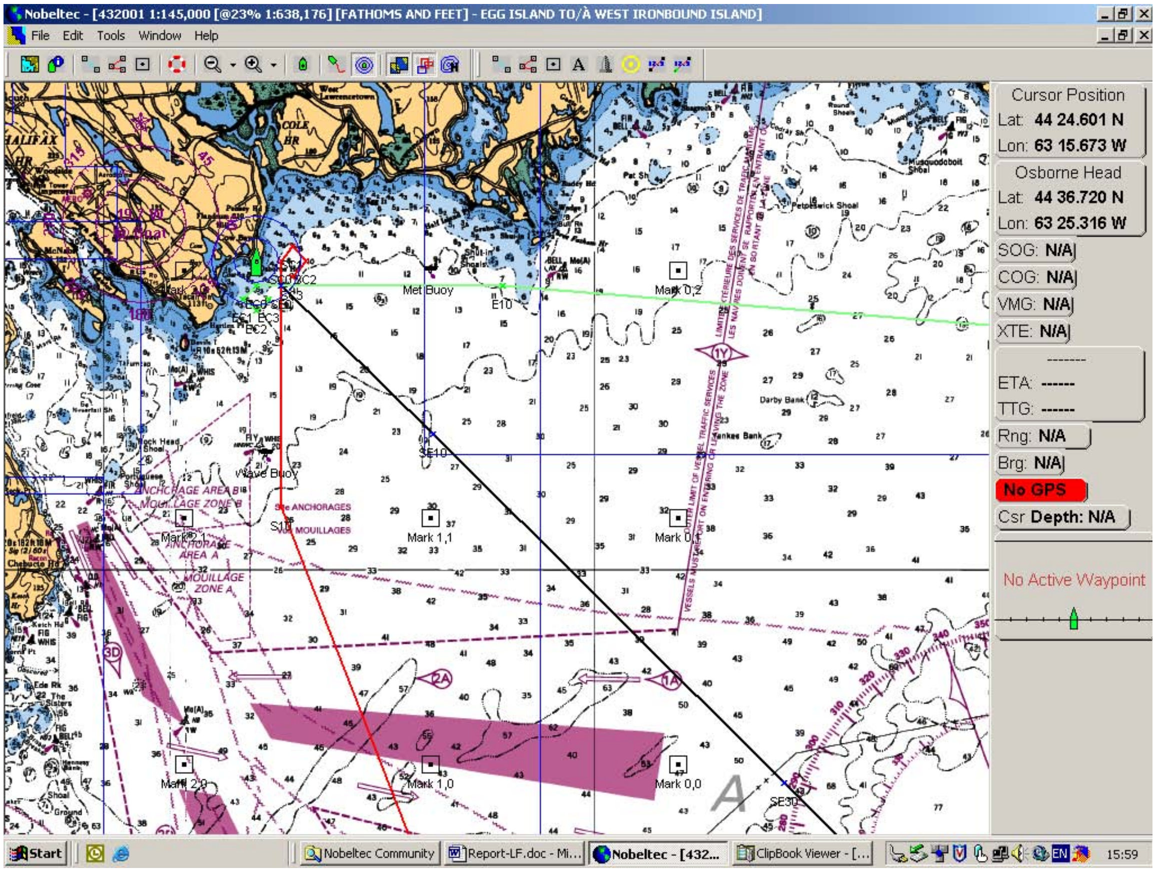

Figure 1: Part of the Q289A Operational Area defined in the table above. The green, red and black lines show possible tracks to be run during the trial. The positions of the buoys and some of the coordinates requested for the HPAC data (□) are also shown.

6.4 Schedule

The Q289A schedule is comprised of tests of the EM System, measurements of the Quest from Osborne Head, and measurements of targets from the Quest. The full trial will be from Sept. 6 to 19 inclusive as summarized in Table 3 below.

6.5 Calendar

Table 3: Q-289A Calendar September 2005

Sunday	4	11 – Day off if possible	18 – Sea trial tests & measurements
Monday	5 – Labour Day - Participants start arriving	12 – Trial Plans Meeting (all participants) - Leave dockyard 0900 - Deploy buoys - Sea trial tests & measurements	19 – Pickup VIPS - Sea trial demonstration - Return to port - Pack & unload the Quest - Pack up at Osborne Head - Quest starts Q289B
Tuesday	6 – Quest meeting - Begin installation onboard Quest - LIDAR trailer on Quest - Install Met package - Install EM System	13 – Sea trial tests & measurements	20 – Final meeting (all participants) - Finish all packing - Participants free to leave
Wednesday	7 – Continue Quest installation & begin tests - pre-cruise briefing @ 1000 hrs onboard Quest (only specified participants will be required)	14 – Sea trial tests & measurements	21
Thursday	8 – Kickoff meeting (all participants present) - Install Camera system on Quest - Install equipment at Osborne Head	15 – Sea trial tests & measurements	22
Friday	9 – Continue installations and testing	16 – Sea trial tests & measurements	23
Saturday	10 – Continue installations and testing	17 – Sea trial tests & measurements	24

7. PROCEDURES FOR OPERATING AREAS

The RHIB and/or the Zodiac may be deployed for the conduct of planned experiments. The Chief Scientist will promulgate specific requirements as far in advance as possible.

7.1 Procedure

Tests of the systems installed onboard the Quest will be integrated and tested between Sept. 6th and 11th. The Quest will sail on the 12th and begin by deploying DRDC's meteorological buoy and wave buoy. During this time, systems deployed at Osborne Head and onboard the Quest will be able to test their IR and RF sensors. All systems should be ready for the first trial run to start after lunch. Note: deployment of the buoys will require that certain sea conditions be met; thus, if advisable, deployment of the two buoys could be performed on the 9th, or later than the 12th.

Trial runs like that described in Table 4 will be carried out beginning on the afternoon of the 12th and terminating on the evening of the 17th or the morning of the 18th. Each run should take about 5.5 hours from start to finish, including 90 minutes to get back to the next starting point. In general this would allow us to perform runs before breakfast, before lunch, and after supper. Nominally, two runs will be performed each day. Note, that all the steps in Table 7.1 are subject to change before or during the trial. The 18th is to be used for preparations of the visit by the VIPs on the 19th. The VIP visit will require that they be picked up for 0900 and that part of one trial run be performed. At the end of this run, the deployed buoys will be retrieved and the Quest will return to dockyard and unloading of all equipment will commence. Priority must be given to offloading the LIDAR trailer. Deployment and recovery of the Quest's RHIB and zodiac will also be required as requested by the Chief Scientist.

The Quest will stop all measurements and seek shelter under the advice of the Captain and whenever conditions at sea exceed Force 7 (Winds ~ 30 knots & Wave heights ~ 5 m). This final condition could be changed, as it is dependent upon the maximum sea state under which equipment installed on Quest can be safely and reliably operated.

Finally, during the various trial runs, only personnel authorized by the Chief Scientist will be allowed on the Helo deck. The reason for this is so that the operation of the stabilized IR camera system from NETE is free from any type of interference. Furthermore, a Notice to Airmen (NOTAM) will be promulgated for each time period during which the LIDAR 2 system (see Annex A) will be in operation or for the entire operational period.

Table 4: Q-289A Trial Run Description

Step #	Activity	Purpose	Time (min.)
1	Sail in at 10 knots from S10 to SC0, E10 to EC0, or SE10 to either SC0 or EC0.	To allow the ship to reach thermal equilibrium.	30
2	Record the IR & RF signatures of the ship when it reaches SC0 or EC0.	To obtain IR & RF signatures of the ship under thermal equilibrium.	1
3	Continue recording IR & RF signatures as the ship performs a tight 270-degree turn.	To obtain IR & RF signatures of the ship at other aspect angles	5
4	Sail out at 10 knots towards S5, E5 or SE5.		15
5a	When at 5 km from O, present the starboard or port side to O and hold position.	Initiate the EM system and acquire IR & RF data of the ship and of the IR & RF targets onshore.	15
5b	Offload the zodiac or the RHIB on the side not facing O.	To obtain IR & RF signatures of these small targets	0
6	Perform a 270-degree turn before continuing to sail towards S10, E10 or SE10.	To obtain IR & RF signatures of the ship at other aspect angles.	5
7a	Sail towards S10, E10 or SE10.		15
7b	Zodiac or RHIB motors towards O at 15 knots. The manoeuvres are TBD.	To obtain IR & RF signatures of the zodiac or RHIB from the Quest and Osborne Head.	0
8a	When at 10 km from O, present the starboard or port side to O and hold position. Zodiac or RHIB should be at O.	Initiate the EM system and acquire IR & RF data of the ship and of the IR & RF targets onshore.	30

8b	When demanded, the Zodiac or RHIB will motor towards the Quest at 15 knots. The manoeuvres are TBD.	To obtain IR & RF signatures of the zodiac or RHIB from the Quest and Osborne Head.	0
8c	After arriving at the Quest, onload the zodiac or the RHIB on the side not facing O.		0
9	Perform a 270-degree turn before continuing to sail towards S15, E15 or SE15.	To obtain IR & RF signatures of the ship at other aspect angles.	5
10	Sail towards S15, E15 or SE15.		15
11	When at 15 km from O, present the starboard or port side to O and hold position.	Initiate the EM system and acquire IR & RF data of the ship and of the IR & RF targets onshore.	15
12	Perform a 270-degree turn before continuing to sail towards S25, E25 or SE25.	To obtain IR & RF signatures of the ship at other aspect angles.	5
13	Sail towards S25, E25 or SE25.		30
14	When at 25 km from O, present the starboard or port side to O and hold position.	Initiate the EM system and acquire IR & RF data of the ship and of the IR & RF targets onshore.	0
15	Perform a 270-degree turn before continuing to sail towards S35, E35 or SE35.	To obtain IR & RF signatures of the ship at other aspect angles.	0
16	Sail towards S35, E35 or SE35.		30
17	When at 35 km from O, present the starboard or port side to O and hold position.	Initiate the EM system and acquire IR & RF data of the ship and of the IR & RF targets onshore.	15
18	Perform a 270-degree turn before continuing sailing back towards S10, E10 or SE10.	To obtain IR & RF signatures of the ship at other aspect angles.	5
19	Sail towards S10, E10 or SE10.	Time to eat and prepare for the next run	90
		Total Time	326
Note: **1)** 0 times are either neglected or part of other steps. **2)** positions where the ship stops and other activities could change prior to or during the trial			

8. PLOTS AND LOGS

<u>NOTE</u>: All logs shall be recorded in ZULU time. Local times may also be noted in parenthesis.

8.1 Cruise (Bridge) Log

It is requested that during all trial runs, the bridge staff enter the following information in the ship’s log or a Cruise Log at least once every watch:

• time
• ship's position and heading
• sea state and swell estimates
• air and sea temperature
• wind speed and direction

Bridge Personnel shall maintain a watch for marine mammals as specified in the DND Environmental Assessment form (Annex B).

Bridge Personnel shall maintain a watch for birds and aircraft that could fly directly over the Quest. They shall immediately inform the Chief Scientist (or designate) and the Scientist in charge of the LIDAR of this possibility so that they can take proper actions to satisfy the requirements described in Annex A and Annex B.

Bridge personnel shall maintain a watch for all surface craft that may come within 400 meters of the ships stern or sides during periods when the LIDAR is under operation. They shall immediately inform the Chief Scientist (or designate) and the Scientist in charge of the LIDAR of this possibility so that they can take proper actions to satisfy the requirements described in Annex A and Annex B.

Upon changes in the ship's course or speed, it is requested that the change be noted in the Cruise log.

A copy of the Cruise log will be delivered to the Chief Scientist at the conclusion of the trial by the Lab Supervisor.

8.2 Dry Lab Logs

Personnel designated by the Chief Scientist shall maintain the following logs that shall be submitted to the Chief Scientist at the completion of the trial.

1. NADAS data – it will be the primary tool for collection of data on position, course, ship's speed, wind speed and direction. Its acquisition will be the responsibility of the Laboratory Supervisor.
2. ECPINS data – it will be used to facilitate track reconstruction. Its acquisition will be the responsibility of the Laboratory Supervisor
3. EM System Log – will document the activities of the EM system and will be maintained by its team.
4. LIDAR Log – will document the activities of the LIDAR systems installed on the quarterdeck and will be maintained by its team.
5. IR Sensor Log – will document the activities of the stabilized IR sensor system installed on the helo deck and will be maintained by its team.
6. RF Sensor Log – will document the activities of the RF sensor system (Nav radar and data logger) and will be maintained by its team.
7. Met Log – will document the activities of the additional meteorological sensors installed above the bridge. Remarks about the weather and sea state should also be kept within this log and will be the responsibility of its technician or his designate.
8. Q289A Main Log – will log all events of interest to the Chief Scientist that occur during the trial and will be the sole responsibility of the Chief Scientist or his designate.

8.3 Osborne Head (NESTRA) Logs

Personnel designated by the Chief Scientist shall maintain the following logs that shall be submitted to the Chief Scientist at the completion of the trial.

1. IR Sensor Log – will document the activities of the IR sensor system installed at NESTRA

and will be maintained by its team.
2. X-band Sensor Log – will document the activities of the X-band RF sensor system at NESTRA and will be maintained by its team.
3. Nav Sensor Log – will document the activities of the Navigational radar at NESTRA and will be maintained by its team.
4. Q289A NESTRA Log – will log all events of interest to the Scientist in charge at the NESTRA site during the trial and will be the sole responsibility of this scientist or his designate.

9. LASER RADIATION

The conduct of Q289A requires the use of two LIDAR systems onboard the CFAV Quest. LIDAR 2 operating at 0.532, 1.06 microns and LIDAR 1 at 1.57 microns.

<u>Usage</u>: Only authorized personnel will be allowed access to areas susceptible to being exposed to radiation from the LIDAR systems when it is in operation. All personnel will be notified of these areas before the trial, and notified to clear these areas before it begins operation. This information will be provided to the CFAV Quest's responsible officer by the Chief Scientist or his designate.

Standard Operating Procedures (SOP) and other details related to the operation of the LIDAR are given in Annex A.

10. COMMUNICATIONS

a) VHF PRI Channel 16

b) Call Signs:	CFAV QUEST Quest RHIB Quest Zodiac NESTRA NESTRA IR NESTRA RF
c) Quest Lab	MSAT Voice 1-600-700-6980 MSAT Fax 1-600-700-9336 Globalstar 1-613-988-2688
d) HF SSB (RT)	PRI 25100 kHz SEC 2237 kHz
e) UHF	PRI 279.400 MHz SEC 259.400 MHz

11. SAFETY

The Captain of CFAV QUEST is responsible for the safety of the ship and all personnel onboard. Personnel must be alert for hazards inherent in the conduct of the trial. Security concerns related to the operation of the LIDAR system are given in Annex A.

12. PERSONNEL

Chief Scientist Q-289A
J. Luc Forand
DRDC Valcartier
Phone: (418) 844-4500 ext 4503
E-mail: luc.forand@drdc-rddc.gc.ca

Table 5: Q-289A Personnel Requirements

#	NAME	POSITION	Work Sites	Establishment
1	J.L. Forand	Chief Scientist	Quest	DRDC Valcartier
2	J. Gilbert	EM Program Manager	Quest	Prominov
3	S. Yuen	System Programmer	Quest	Nurun
4	L. Gauthier	Lab Technician	Quest	DRDC Valcartier
5	G. Potvin	Scientist	Quest/Nestra	DRDC Valcartier
6	L. Bissonnette	Scientist	Quest	DRDC Valcartier
7	G. Roy	Scientist	Quest	DRDC Valcartier
8	N. Roy	Scientist	Quest	Contractor
9	S. Cantin	Lab Technician	Quest	DRDC Valcartier
10	G. Tremblay	Technician	Quest	Contractor
11	J. Tessier	Videographer	Quest/Nestra	DRDC Valcartier
12	L. Conway	SISWS Prog. Manager	Quest/Nestra	Contractor
13	A. Thomson	Scientist	Quest	DRDC Ottawa
14	B. Szeker	System Programmer	Quest	Contractor
15	E. Riseborough	Engineer	Quest/Nestra	DRDC Ottawa
16	Denis Lamothe	Lab Technician	Nestra	DRDC Ottawa
17	Grant Duff	Lab Technician	Nestra	DRDC Ottawa
18	Bob Moore	Contractor	Nestra	DRDC Ottawa
19	Stephane Legault	Scientist	Nestra	DRDC Ottawa
20	Daniel Boivin	Lab Technician	Nestra	DRDC Ottawa
21	David Vaitekunas	DRS Contractor	Nestra	Davis Engineering
22	Christopher Liu	DRS Contractor	Quest	Davis Engineering
23	Eric Fortier	Chief Technician	Quest	NETE
24	Yves Bedard	Technician	Quest	NETE
25	Trevor Ponee	Quest Technician	Quest	DRDC Atlantic
26	Dave Wright	Quest Technician	Quest	DRDC Atlantic
27	Bob MacDonald	Quest Lab Supervisor	Quest	DRDC Atlantic
28	Marcel Lefrancois	Scientist	Quest	DRDC Atlantic
Note: This list is not finalized but does give a good indication of the number of personnel to be present from each organization and their principal and secondary work site. As such 16 persons are expected to be onboard for the entire trial and 5 others for shorter times.				

12.1 Personnel Transfers

At times certain personnel will be required to transfer to and from shore. The transfers are to be conducted at dockyard, at NESTRA, or another site considered appropriate by the ship's Captain (e.g. the Shearwater Yacht Club). Additional transfers may be expected for day visits only.

VIPs will be picked up on the morning of Sept. 19th from dockyard, and dropped off later that same day when the CFAV Quest returns to the dockyard at the end of trial Q289A.

13. References

1. Ford, B., Conway, L., Toulgoat, M., Forand, L., Thomson, A., Martelli, R., Ferland, G., Parry, T., Charland, S., Duprat, G., Jones, G., Cooper, R., Guven, E., and McCarthy, T., "Shipboard Integration of Sensor and Weapon Systems (SISWS): Overview, Benefits, Progress", DRDC Ottawa TR 2005-256, December 2005, UNCLASSIFIED

Annex A – LIDAR System Operation

This annex describes the procedures and precautions that will be employed for the safe operation of DRDC Valcartier's LIDAR systems. The trailer containing the LIDAR system will be deployed on the Quest's quarterdeck such that the top of the trailer is near the level of the helo deck. The LIDAR system consists of two systems. One system can operate at 0.532 and 1.06 microns and the other only at 1.57 microns.

The 1.57-micron system (LIDAR 1) operates at an eye-safe wavelength and presents minimal danger to personnel onboard the Quest. During operations off Osborne Head, it will be operated such that it scans half the sky aft of the ship's stern. In other words, considering the stern of the ship to be at zero degrees azimuth, it will cover from 0 to 90 degrees zenith and –90 to 90 degrees in azimuth. During testing at dockyard, it will be operated such that it only covers ±20 degrees about the zenith. Exposure times up to 10 seconds are also highly unlikely with this system as it operates as a scanner and never looks at a point in space for more than 1 millisecond. In this case, the eye-safe range for a single laser pulse is applicable.

The 0.532 and 1.06-micron system (LIDAR 2) is not eye-safe out to ranges of 5.7 and 3.6 km, respectively, for exposure times of 10 seconds. Thus it does present a potential danger to personnel onboard the Quest and others operating in the area at both wavelengths. However, due to physical constraints, it will only be able to operate in the vertical direction (w.r.t. the trailer's surface) and will only be potentially visible from the air. For a divergence of 0.35 mrad, the diameter of the beam at an altitude of 10 km is 3.5 m and at 20 km it is 7.0 m; thus, exposure times by personnel in aircraft are highly unlikely to occur for periods up to 10 seconds. In this case, the eye-safe range for a single laser pulse is applicable.

Summary information for both LIDAR systems are given in Table 6 and their SOP's are given below.

LIDAR 1 System (1.57 μm) - Standard Operating Procedure (SOP)

1. The scientist in charge of the system is responsible for seeing that this SOP is followed;

2. The LIDAR 1 system operating at 1.57 microns is a Class 3A laser that is eye-safe at 49 m from its exit aperture when not scanning and at 0 m when scanning. Thus, personnel will not require any optical protection under this SOP.

3. The system will be operated from the roof of a trailer installed on the quarterdeck of the CFAV Quest and controlled by operators inside the container.

4. Authorized operators or personnel are those recognized by the Chief Scientist upon the advice of the scientist in charge of the system.

5. The following control measures will minimize the chance of hazardous exposure when operating the system:

    a. authorized operators shall periodically read and always follow this safety SOP;
    b. authorized operators will have received proper training;

c. only authorized personnel will be allowed in the trailer;
d. only authorized personnel will be allowed on the trailer's roof;
e. no one on the ship is to look directly into the laser beam;
f. the laser beam shall never be pointed anywhere on the ship;
g. appropriate laser warning signs to be located around the quarterdeck;
h. before enabling the beam (beam emitted into the atmosphere) all individuals present should be warned, all required safety measures should be satisfied, and no personnel should be in the path of the beam;
i. when enabled, the laser shall not be left unattended unless it is part of an approved and/or controlled environment, and designated for such operation. In all other cases, it should be shutdown.;
j. the system should be secured against unauthorized use. This safety system should never be bypassed or over-ridden;
k. operate the system only as approved by the experimental plan;
a. a visual watch for any boat activity coming within the ENOHD of the laser (330 m) must be maintained. If the system is not scanning, the laser beam is to be disabled. If the system is scanning, operations may continue. The watch will be maintained by CFAV Quest personnel on the bridge and by personnel operating the system;
l. the laser beam will be disabled (beam not emitted into the atmosphere) when it is not to be operated shortly;
m. report any suspected injury or defective equipment to the proper authority immediately, so that appropriate action may be taken.

LIDAR 2 System (0.532 & 1.064 μm) - Standard Operating Procedure (SOP)

1. The scientist in charge of the system is responsible for seeing that this SOP is followed;

2. The LIDAR 2 system consists of two Class IV lasers operating at 0.532 and 1.064 μm. These lasers can cause eye injury if used improperly. Exposure of the eye to either the direct beam, or a beam reflected from a flat mirror-like surface, could cause an injury even at great distance.

3. The system will be operated from inside a trailer installed on the quarterdeck of the CFAV Quest and controlled by operators inside the trailer. The laser beams exiting from the trailer will only be able to exit vertical to the trailer's flat roof. In other words, when the CFAV Quest is at an even keel, it will exit in the zenith direction.

4. A Notice to Airmen (NOTAM) will be provided before each operational period. This will include the start and end times and the region of operation.

5. Authorized operators or personnel are those recognized by the Chief Scientist upon the advice of the scientist in charge of the system.

6. The following control measures will minimize the chance of hazardous exposure when operating the this system:

   a. authorized operators shall periodically read and always follow this safety SOP;
   b. authorized operators will have received proper training;
   c. only authorized personnel will be allowed in the trailer;
   d. only authorized personnel will be allowed on the trailer's roof, a laser hazard zone;

e. no one on the ship is to look directly into the laser beam;
f. the beam shall never be pointed anywhere on the ship. This will not be possible due to imposed physical constraints;
g. appropriate laser warning signs to be located around the quarterdeck;
h. before enabling the beam (beam emitted into the atmosphere) all individuals present should be warned, all required safety measures should be satisfied, and no personnel should be in the path of the beam;
i. the system should be secured against unauthorized use. This safety system should never be bypassed or over-ridden;
j. operate the system only as approved by the experimental plan;
k. a visual watch for any aircraft or flock of birds that could fly directly over the system within the single pulse NOHD of the laser (~5 km) must be maintained. The beam will be disabled under these conditions. The watch will be maintained by CFAV Quest personnel on the bridge and by personnel operating the system;
l. the beam will be disabled (beam not emitted into the atmosphere) when it is not to be operated shortly
m. the system will be shutdown when it is to be left unattended;
n. protective eyewear must be inspected periodically by the users for pitting and cracking of the attenuating material, for mechanical integrity, and light leaks in the frame;
o. protective equipment is no substitute for common sense and the use of good safety practice;
p. any personnel susceptible to be exposed to the direct beam or its specular reflections within the NOHD or ENOHD when the laser is operated, always require eye protection. Special attention shall be given to potential reflections off wet vertical surfaces;
q. do not expose unprotected personnel. Individuals shall never wander in the laser hazard zone (within NOHD) without appropriate laser eye protection. Laser protection should provide at least a protection of OD 5 covering the 0.532 and 1.064 μm wavelengths. Such eye protection should have curved lenses to prevent hazardous back-reflections; and
r. report any suspected injury or defective equipment to the appropriate authority, so that appropriate action may be taken.

Table 6: LIDAR System Parameters

Laser System	LIDAR 1	LIDAR 2	
Wavelength (μm)	1.57	1.064	0.532
Output Energy (mJ)	30	11	9
Pulse Width (ns)	12	12	12
Pulse Rate Freq. (Hz)	10	100	100
Divergence (mrad)	0.35	0.35	0.35
Laser Class	3A	4	4
NOHD[1] (m)	49	3590	5710
Cmbd NOHD[2]	-	10800	
ENOHD[3] (m)	330	21400	24500
Single Pulse NOHD[4] (m)	0	1510	3970
Cmbd Single Pulse NOHD[2]	-	4576	
Single Pulse ENOHD[5] (m)	15	9040	18800
ENOHD Basis	Magnifying optics – 7x50 mm binoculars.		
Optical Density (OD)[6]	0.7	4.2	4.7
Personnel Protective Equipment (PPE)	None required	Goggles of OD = 5 Minimum at 1.06 μm	Goggles of OD = 5 Minimum at 0.532 μm

1 – NOHD – Nominal Optical Hazard Distance using exposure times of 0.25 seconds for visible radiation and 10 seconds for invisible radiation
2 – Cmbd NOHD – Combined NOHD when both the 0.532 and 1.064 micron lasers are used simultaneously and coaxially
3 – ENOHD – Extended Nominal Optical Hazard Distance using exposure times of 0.25 seconds for visible radiation and 10 seconds for invisible radiation
4 – Single Pulse NOHD – using exposure times corresponding to a single pulse
5 – Single Pulse ENOHD – using exposure times corresponding to a single pulse
6 – OD – Optical Density (multiple pulses)

Annex B – DND Environmental Assessment Form

DND EA Form

PART I PROJECT IDENTIFICATION

Note: This part must be submitted to the Base/Wing Environmental Officer for registration on the Canadian Environmental Assessment Registry within 14 days of the commencement of the environmental assessment.

1.0 Project Title: SISWS Environmental Modeling/ SISWS Modélisation Environnementale
1.1 Description of the project: The objective of this project is to conduct a trial onboard the CFAV Quest and from NESTRA in support of the SISWS (Shipboard Integration of Sensors & Weapons) TDP (Technical Demonstration Program); in particular, the Environmental Modelling (EM) part of this program. This program is being supported by DRDC Valcartier, DRDC Ottawa, DRDC Atlantic, D Met Oc and MetOc. Scientists, engineers and technologists from these establishments will be undertaking experiments to test and validate the Environmental Modelling (EM) system that is being developed to make near real-time estimations of the performance of ship-based infrared (IR) and radio-frequency (RF) sensors, and the visibility of a ship by external (off-ship) IR and RF sensors using the real-time acquisition of environmental data (meteorological, geographical and ship environment). To support this work, two DRDC Atlantic buoys will be moored off Osborne Head (NESTRA), two LIDAR (Light Detection & Ranging) systems operating lasers at 0.532, 1.57 and 1.06 microns will be installed on the CFAV Quest, IR cameras will be installed on the CFAV Quest, and a radar system and IR cameras will be installed at NESTRA. Radiosondes will also be launched from both NESTRA and CFAV Quest.
1.2 Project schedule: 12-19 September, 2005
1.3 Project Location: Dartmouth, Nova Scotia. The sea test will be carried out in a sector extending about 50 km east and south of Osborne Head, NS (nominal location 44° 36’N, 63° 25’W) and at Osborne Head (NESTRA).
1.4 Originating Directorate, Base, or Unit: DRDC Valcartier
1.5 EA Start Date: 13 May, 2005
1.6 Type of Project: Other (non-CEAA EA) **1.6.1 EA “Trigger”:** Non-applicable (non-CEAA EA)
1.7 OPI’s EA/project File reference #: 1267-1431-05/06-03 **1.7.1 CEA Registry # :**
1.8 Other Responsible Federal authorities: Not applicable

1.9 Federal Environmental Assessment Coordinator:

1.10 Contacts:

1.10.1 FEAC Point of Contact:

a) Mr. Gary Fisher, SO Env.
b) DRDC Atlantic, Dartmouth, NS
c) 902-427-3432.
d) 902-427-3435
e) gary.fisher@drdc-rddc.gc.ca

1.10.2 Project OPI/principle point of contact:

a) Dr. J. Luc Forand, DS-5
b) DRDC Valcartier, Val-Belair, QC
c) 418-844-4000 (4503)
d) 418-844-4511
e) luc.forand@drdc-rddc.gc.ca

1.11 Public Notification: Not required

PART II ASSESSMENT OF EFFECTS AND CONCLUSIONS

Note: This part must be submitted to the Base/Wing Environmental Officer for registration on the Canadian Environmental Assessment Registry. See Steps 3A, B&C: EA Manual

2.0 Assessment of environmental effects

The detailed assessment of environmental effects and supporting documentation is at Annex A (with additional annexes or enclosures as necessary)

2.1 Executive Summary

The major environmental concerns for this project are disruptions to the aquatic environment due to its sea activities in an area off Osborne Head, and the effects of the 0.532 and 1.06 micron LIDAR systems on persons or birds flying directly over the CFAV Quest. However, no residual impact on the environment is expected from the activities of this project due to the mitigation measures to be followed.

Disruptions to the aquatic environment are mitigated by the duration of our time in the area, and effects of the 0.532 and 1.06 micron LIDAR systems are mitigated by their operation only in the zenith (vertical) direction.

2.2 EA Determination

On the basis of this EA Report, it has been determined that the impact of this project on the environment is as follows (indicate with an X):

- EA terminated with no determination. Project cannot proceed: [ ]
- Project is not likely to cause significant adverse environmental effects. The project can proceed with application of the mitigation measures specified in this report: [X]
- The project is likely to cause significant adverse environmental effects. The project cannot proceed: [ ]
- Refer the project, through the chain of command and only on the recommendation of ECS environmental advisor and DGE, to the Minister of Environment for referral to a mediator or panel review: [ ]

2.3 Follow-up

Is a follow up or monitoring program required? Yes [ ] No [X]

Describe the follow-up program and how and by whom it will be implemented.

PART III RECOMMENDATIONS AND SIGN-OFF

3.0 EA Report prepared by: J. Luc Forand   ____ Signature block, signature, and date
3.1 EA Report reviewed by (with recommendation by NDHQ, Formation or Base/Wing Environmental Specialist Staff if applicable): Mr. Gary Fisher   ____ Signature block, signature, and date
3.2 EA Report accepted and approved by: Jean Marc Garneau (H/OpS) The undersigned accepts the determination and recommendations of this environmental screening report. The undersigned also accepts the responsibility to incorporate the recommendations of the report into the project design and implementation. ____ Signature block, signature, and date of the DND/CF decision-making authority for the project

Part IV ASSESSMENT OF ENVIRONMENTAL EFFECTS

4.0 Project Description and Scope: See Step 2A: EA Manual

a. General Description of the project:
Measurement and predictions of the performance of IR & RF sensors will be obtained from sensors installed on the CFAV Quest, and measurements and predictions of the CFAV Quest's visibility will be obtained from IR & RF sensors installed at Osborne Head (NESTRA) as the ship's position is changed.

<u>EM System – Ship-Based Data Integration</u>
Objective: To integrate the EM (Environmental Modeling) system being developed at DRDC Valcartier and Ottawa into the Quest's intranet so that it can acquire data available from the Quest's NADAS (Non-Acoustic Data Acquisition System) and IMCS (Integrated Machinery Control System) systems, and other systems added to the Quest by the participants. This will be performed at dockyard.

In particular, this will include DRDC Valcartier's MFOV (Multiple Field of View) LIDAR installed on the Quest's quarterdeck, DRDC Atlantic's deployed wave and meteorological buoys, and a special meteorological package from DRDC Valcartier installed above the bridge. The meteorological package will include measurements of visibility at 0.5, 3.8 and 10.6 microns, rain rate and others. Additional information from other sensors, such as radiosondes will also be obtained.

<u>EM System – External-Based Data Integration</u>
Objective: To integrate the EM system being developed at DRDC Valcartier and Ottawa into the Quest's Internet link so that it can acquire data available from the CFWOS (Canadian Forces Weather Office Service). This will be done at dockyard.

This data should include BUFR data (vertical profiles of temperature, pressure, humidity, etc. obtained from a meteorological model) from 3 geographic locations near Osborne Head, reflectivity data from the Gore radar near the Halifax International airport, and HPAC data (contains multiple BUFR data sets) covering a region extending at least 100 km in all directions from Osborne Head (~30,000 km^2) with a grid spacing of 10 km.

<u>EM System Operation</u>
Objective: To the operation of the completely integrated EM system in real-time as it acquires real-time data from the sensors on the ship and from the external-based data sources. This will be done at dockyard.

Each component will be individually tested to ensure the intended design and operation criteria have been met before beginning the sea trials.

<u>IR and RF Atmospheric Propagation</u>
Objective: To compare the predictions of the propagation properties of the atmosphere in the IR and RF bands from data obtained using the meteorological systems (including LIDAR systems) installed on the Quest (local measurements) to results obtained from data obtained from the CFWOS (external measurements). This will be done at sea.

This exercise will include the comparison of specific meteorological parameters, such as water temperature, rain rate, etc. between different sensors, and surface layer parameters such as the Monin-Obukhov length, that are related to its stability. The importance of this work is to develop the ability to obtain data from diverse sources (local and external) such that a consistent coherent high quality set of data can always be provided to the EM system and its models.

<u>Ship IR Visibility Measurements</u>
Objective: To measure the visibility of the Quest in the 3-5 (MW; mid-wave) and 8-12 (LW – long-wave) micron IR bands from Osborne Head at ranges varying from 1 to at most 40 kilometers under

varying environmental conditions and ship aspect angles. This will be done at sea.

Ship RF Visibility Measurements

Objective: To measure the visibility of the Quest using a Navigation radar and an X-band radar (~9 GHz) and K_u-band radar (~16 GHz) from Osborne Head at ranges varying from 1 to at least 40 kilometers under varying environmental conditions and ship aspect angles. This will be done at sea.

IR Sensor Performance Measurements (Low Flying Targets)

Objective: To measure the performance of IR sensors onboard the Quest in the LW and MW IR bands against simulated low flying targets. This will be done at sea.

Targets will be simulated using blackbodies (probably at temperatures close to 100 and 300 ^{o}C) placed near Osborne Head and will be observed against its land background under varying environmental conditions.

RF Sensor Performance Measurements (Low Flying Targets)

Objective: To measure the performance of the RF sensor (Nav. Radar @ ~9 GHz) onboard the Quest against simulated low flying targets. This will be done at sea.

Targets will be simulated using known RCS reflectors (probably between 0.01 and 1 m^2) placed near Osborne Head and will be observed against its land background under varying environmental conditions.

IR Sensor Performance Measurements (Small Fast Surface Targets)

Objective: To measure the performance of IR sensors in the MW and LW IR bands against small fast surface targets. This will be done at sea.

The Quest's zodiac and RHIB (Rigid Hull Inflatable Boat) will provide the targets to be measured at varying ranges under varying environmental conditions. The IR systems at both Osborne Head and onboard the Quest will be used. The zodiac and the RHIB will be instrumented with a portable GPS (Geographic Positioning System) to log their positions and with I-buttons to record the temperatures of various surfaces.

RF Sensor Performance Measurements (Small Fast Surface Targets)

Objective: To measure the performance of RF sensors against small fast surface targets. The Quest's zodiac and RHIB will provide the targets to be measured at varying ranges under varying environmental conditions. This will be done at sea.

The RF systems at both Osborne Head and onboard the Quest will be used. The zodiac and the RHIB will be instrumented with a portable GPS to log their positions.

b. Project components, scope, and timeframe:

Boats

CFAV Quest – will be used to change the position of the ship and the sensors onboard with respect to Osborne Head

Zodiac/RHIB – will be used as targets for the sensors onboard the Quest and located at Osborne Head

Radiative Sources

LIDARs @ 1.57, 1.06 & 0.532 microns – will scan the sky at these three wavelengths from its position on the CFAV Quest. The 1.57 micron laser is eyesafe at 49 m, and the 1.06 and 0.532 micron lasers are eyesafe at about 1.5 & 4.0 km, respectively.

Blackbody sources – these sources will be used for IR sensor calibration and as targets. They will have blackbody temperatures of between 100 and 200 degrees Celsius. They will be located on the Quest and at Osborne Head

X-Band & K_u band radar – will be operated from Osborne Head

Navigation radar – will be operated from the Quest and Osborne Head

Sondes

Meteorological Buoy – will be tethered to the sea bottom about 8 km east of Osborne Head

Wave Buoy – will be tethered to the sea bottom within 8 km south of Osborne Head

Radiosondes – will be launched up to twice a day from Osborne Head or CFAV Quest

4.1 Description of the existing environment: See Step 2B: EA Manual

a. Sources of information, including site visits
Site visits and information from colleagues at DRDC Atlantic.

b. Boundaries
Trial dates are from 6 – 19 September 2005. The Quest will be at dockyard from 6-11 September and at sea off Osborne Head from 12-19 September.

Field Site Boundary: will mostly be carried out inside the sector defined by the apex O at Osborne Head and the points E50 and S50:

O - 44^o 36.72' N, 63^o 25.32'W
E50 – 44^o 34.50' N, 62^o 47.53'W
S50 – 44^o 11.08' N, 63^o 13.50'W

c. General description
In this area, the sea bottom sediment is chiefly Sable Island sand and gravel. Gravel and bedrock outcroppings generally occur outside of 2 km, but are occasionally very close (within 0.5 km) to the coast.

d. Valued Ecosystem Components
Marine habitat, marine animals, terrestrial animals, birds, people/health

4.2 Consultation: See Step 1C&D, Annex A&B: EA Manual

a. Consultation within DND
1) Dr. Luc Bissonnette, DS, Sensor Performance Group, DRDC Valcartier – LIDAR specialist
2) Dr. Gilles Roy, DS, Advanced Surveillance Sensors, DRDC Valcartier – LIDAR specialist
3) Dr. Marc Chateauneuf, DS, Threat Detection, DRDC Valcartier – Laser officer
4) Dr. Dan Hutt, DS, DRDC Atlantic – Knowledgeable about the area for our trial
5) Larry MacInnis, DRDC Atlantic – Quest Supervisor

b. Consultation with the Public - None

c. Consultation with other Dept's, agencies or jurisdictions - None

4.3 References List and state the relevance of any applicable laws, regulations, SOPs, reports, etc. used to complete this EA report.

a. Regulations and Policies
1) Canadian Environmental Assessment Act Fisheries Act
2) MARLANT Environmental Policy
3) DRDC Environmental Assessment Policy
4) DAOD 4003-2

b. Other References

4.4 Environmental Effects: See Step 2C: EA Manual

4.4.1 ENVIRONMENTAL EFFECTS MATRIX

Project Component Enter each component e.g. phases of construction, aspects of operation	**VALUED ECOSYSTEM COMPONENTS** (Add to/delete from matrix below as necessary) Show potential effects with an "X"																	
	Physical						Biological						Social					
	Atmosphere	Ocean Water	Ground Water	Soils	Terrain	Ambient Noise	Terrestrial Animals	Terrestrial Habitat	Aquatic Animals	Aquatic Habitat	Flying Animals	Vegetation	Heritage/Historical	Recreation/Aesthetic	People/Health	Economy	Services	Land Use
Boat Navigation		X							X									
Radiative Sources							X				X				X			
Sondes									X		X							

4.5 Discussion of Effects and Mitigation: See Steps 2D, 2E and 2F: EA Manual

4.5.1 Boat Navigation

a) Platforms used for most activities
b) Aquatic animals & habitat
c) Disruption of their habits
d) Keep a watch for aquatic animals and take reasonable actions to avoid them. Operations will only occur for 8 days.
e) Residual Effects – no adverse impacts are expected after mitigation
f) No follow-up or monitoring required

4.5.2 Boat Navigation

a) Platform used for most activities
b) Ocean water
c) Water pollution
d) Normal measures taken by CFAV Quest
e) Residual Effects – no adverse impacts after mitigation
f) No follow-up or monitoring required

4.5.3 Buoy Operation

a) Installation & Operation
b) Aquatic animals
c) Disruption of their habits
d) Buoys will be deployed in the area for less than two weeks
e) Residual Effects – no adverse impacts after mitigation
f) No follow-up or monitoring required

4.5.4 Radiosonde Operation

a) Operation
b) Flying animals
c) Disruption of their habits
d) Keep a watch for flocks of birds to and take reasonable operations to avoid them. Operations will only occur for 8 days and be limited to 4 per day.
e) Residual Effects – no adverse impacts after mitigation
f) No follow-up or monitoring required

4.5.5 1.57 micron LIDAR Operation

a) Operation at dockyard or at sea
b) People/health
c) Injury to the eye
d) The effect of laser radiation at 1.57 microns on humans is quite well known. Standard calculations, that assume an integration time of 10s, predict an NOHD (Nominal Optical Hazard Distance) of 49m and an ENOHD (Extended NOHD) of 330m. However, this is mitigated by the fact that the system is always used in a scanning mode such that it never remains pointed in the same direction for more than 1ms. Thus, a more realistic NOHD can be determined assuming just a single pulse. Then, the laser is eye-safe with an ENOHD of 15 meters. To further mitigate any dangers, when at sea, the laser will only be pointed within ±90 degrees of the ships stern and between the horizon and the zenith, and when at dockyard, the laser will only point within ±20 degrees of the zenith. Furthermore, it will not be pointed towards land unless it is more than 330m away.
e) Residual Effects – no adverse impacts after mitigation
f) No follow-up or monitoring required

4.5.6 1.57 micron LIDAR Operation

a) Operation at dockyard or at sea

b) Terrestrial animals
c) Injury to the eye
d) The effect of laser radiation at 1.57 microns on animals is similar to that for humans. Standard calculations, that assume an integration time of 10s, predict an NOHD of 49m and an ENOHD of 330m. However, this is mitigated by the fact that the system is always used in a scanning mode such that it never remains pointed in the same direction for more than 1ms. Thus, a more realistic NOHD can be determined assuming just a single pulse. Then, the laser is eye-safe with an ENOHD of 15 meters. To further mitigate any dangers, the laser will never be pointed towards land that is less than 330m away, and when at dockyard, the laser will only point within ±20 degrees of the zenith.
e) Residual Effects – no adverse impacts after mitigation
f) No follow-up or monitoring required

4.5.7 1.57 micron LIDAR Operation

a) Operation at dockyard or at sea
b) Flying animals
c) Injury to the eye
d) The effect of laser radiation at 1.57 microns on animals is similar to that for humans. Standard calculations, that assume an integration time of 10s, predict an NOHD of 49m and an ENOHD of 330m. However, this is mitigated by the fact that the system is always used in a scanning mode such that it never remains pointed in the same direction for more than 1ms. Thus, a more realistic NOHD can be determined assuming just a single pulse. Then, the laser is eye-safe with an ENOHD of 15 meters. To further mitigate any dangers, a watch could be kept for flocks of birds that come within 50 meters of the ship such that appropriate action could be taken.
e) Residual Effects – no adverse impacts after mitigation
f) No follow-up or monitoring required

4.5.8 1.06 micron LIDAR Operation

a) Operation at dockyard or at sea
b) People/health
c) Injury to the eye
d) The effect of laser radiation at 1.06 microns on humans is quite well known. Standard calculations, that assume an integration time of 10s, predict an NOHD of 3590m and an ENOHD of 21400m. However, this is mitigated by the fact that the system will always point at the zenith (vertically). Thus, as only persons flying over the site could potentially be affected, a more realistic NOHD can be determined assuming just a single pulse. For example, at a height of 1km the beam as a diameter of 0.35m, thus a person flying at 120 km/hr would only be within the beam for at most 10ms, the time for a single pulse. In this case the NOHD is 1510m and the ENOHD is 9040m. To further mitigate any dangers, a watch will be kept for any airplanes flying directly over the CFAV Quest such that appropriate actions can be taken.
e) Residual Effects – no adverse impacts after mitigation
f) No follow-up or monitoring required

4.5.9 1.06 micron LIDAR Operation

a) Operation at dockyard or at sea
b) Terrestrial animals
c) Injury to the eye
d) The effect of laser radiation at 1.06 microns on animals is similar to that for humans. Standard calculations, that assume an integration time of 10s, predict an NOHD of 3590m and an ENOHD of 21400m. However, this is mitigated by the fact that the system will always point at the zenith (vertically). Thus, no terrestrial animals could be affected.
e) Residual Effects – no adverse impacts after mitigation
f) No follow-up or monitoring required

4.5.10 1.06 micron LIDAR Operation

a) Operation at dockyard or at sea
b) Flying animals
c) Injury to the eye
d) The effect of laser radiation at 1.06 microns on animals is similar to that for humans. Standard calculations, that assume an integration time of 10s, predict an NOHD of 3590m and an ENOHD of 21400m. However, this is mitigated by the fact that the system will always point at the zenith (vertically). Thus, as only birds flying directly over the site could potentially be affected, a more realistic NOHD can be determined assuming just a single pulse. For example, at a height of 100m the beam as a diameter of 3.5cm, thus a bird flying at 12 km/hr would only be within the beam for at most 10ms, the time for a single pulse. In this case the NOHD is 1510m and the ENOHD is 9040m. To further mitigate any dangers, a watch will be kept for any flocks of birds that come close the CFAV Quest, such that appropriate actions can be taken.
e) Residual Effects – no adverse impacts after mitigation
f) No follow-up or monitoring required

4.5.11 0.532 micron LIDAR Operation

a) Operation at dockyard or at sea
b) People/health
c) Injury to the eye
d) The effect of laser radiation at 0.532 microns on humans is quite well known. Standard calculations, that assume an integration time of 250ms, predict an NOHD of 5710m and an ENOHD of 24500m. However, this is mitigated by the fact that the system will always point at the zenith (vertically). Thus, as only persons flying over the site could potentially be affected, a more realistic NOHD can be determined assuming just a single pulse. For example, at a height of 1km the beam as a diameter of 0.35m, thus a person flying at 120 km/hr would only be within the beam for at most 10ms, the time for a single pulse. In this case the NOHD is 3970m and the ENOHD is 18800m. To further mitigate any dangers, a watch will be kept for any airplanes flying directly over the CFAV Quest such that appropriate actions can be taken.
e) Residual Effects – no adverse impacts after mitigation
f) No follow-up or monitoring required

4.5.12 0.532 micron LIDAR Operation

a) Operation at dockyard or at sea
b) Terrestrial animals
c) Injury to the eye
d) The effect of laser radiation at 0.532 microns on animals is similar to that for humans. Standard calculations, that assume an integration time of 250ms, predict an NOHD of 5710m and an ENOHD of 24500m. However, this is mitigated by the fact that the system will always point at the zenith (vertically). Thus, no terrestrial animals could be affected.
e) Residual Effects – no adverse impacts after mitigation
f) No follow-up or monitoring required

4.5.13 0.532 micron LIDAR Operation

a) Operation at dockyard or at sea
b) Flying animals
c) Injury to the eye
d) The effect of laser radiation at 0.532 microns on animals is similar to that for humans. Standard calculations, that assume an integration time of 250ms, predict an NOHD of 5170m and an ENOHD of 24500m. However, this is mitigated by the fact that the system will always point at the zenith (vertically). Thus, as only birds flying directly over the site could potentially be affected, a more realistic NOHD can be determined assuming just a single pulse. For example, at a height of 100m the beam as a diameter of 3.5cm, thus a bird flying at 12 km/hr would only be within the beam for at

most 10ms, the time for a single pulse. In this case the NOHD is 3970m and the ENOHD is 18800m. To further mitigate any dangers, a watch will be kept for any flocks of birds that come close the CFAV Quest, such that appropriate actions can be taken.

e) Residual Effects – no adverse impacts after mitigation

f) No follow-up or monitoring required

4.6 Cumulative Effects: See Step 2G: EA Manual

a) Most previous trials using the CFAV Quest have had similar VECs as this project. The differences are our use of LIDAR systems and no sonar systems.

b) Potential cumulative effects would be noticed if the 1.06 and 0.532 micron LIDARs are used at the same time. Then the single pulse NOHD is 4576m, which is slightly more than that given for the 0.532 micron system used alone (NOHD of 3970m).

c) Mitigation measures for using the two systems simultaneously would be the same as for using the 0.532 micron system by itself as described above in section 4.6.

d) No adverse residual affects are expected if the mitigation measures are followed.

4.7 Accidents and malfunctions:

1) An accident could cause fuel to leak from the ships. This could cause local effects to the marine animals and coastline. The ship and its small craft are regularly inspected and licenced to operate in Canadian waters so this is not seen as a serious risk.

4.8 Effects of the environment on the project

1) Rough seas could damage our buoys, small craft and the CFAV Quest. The Captain of the Quest is responsible for the safety of his ship.

2) Rough seas could incommode personnel on the CFAV Quest. The Captain of the Quest is responsible for the safety of the ship's complement.

4.9 Follow-up program: See Step 2H: EA Manual

Follow-up program required for the project Yes [ ] No [X]

If yes, provide details of the program.

4.10 Summary Table (optional)

4.11 Conclusions

In conclusion, the major concerns are disruptions to the aquatic environment due to our activities in an area off Osborne Head, and the effects of the 0.532 and 1.06 micron LIDAR systems on persons or birds flying directly over the CFAV Quest. However, no residual impact on the environment is expected from the activities of this project due to the mitigation measures that are to be followed.

Finally, no significant public concerns need to be addressed for this project.

List of symbols/abbreviations/acronyms/initialisms

SISWS	Shipboard Integration of Sensor and Weapon Systems
DRDC	Defence Research & Development Canada
TDP	Technical Demonstration Project
IR	Infrared
RF	Radio Frequency
LIDAR	Light Detection and Ranging
CFAV	Canadian Forces Auxiliary Vehicle
SIESTA	Shipborne Integrated Environment System for Tactics and Awareness
AWW	Above Water Warfare
RHI	Range-Height Indicator
CAPPI	Constant-Altitude-Plan-Position Indicator
GEM	Global Environment Multiscale
EM	Environment Modelling
SOP	Standard Operating Procedure
CFWOS	Canadian Forces Weather Office Site
NADAS	Non-Acoustic Data Acquisition System
IMCS	Integrated Machinery Control Service
NESTRA	Naval Electronics Systems Test Range Atlantic
RHIB	Rigid Hull Inflatable Boat
MFOV	Multiple Field of View

BUFR	Binary Universal Form Representation
HPAC	Hazard Prediction & Assessment Capability
MW	Mid-Wave
LW	Long-Wave
IRBLEM	Infrared Boundary Layer Effects Model
SHIPIR	Ship Infrared
NTCS	Naval Threat Countermeasure Simulator
NETE	Naval Evaluation and Test Establishment
MXCR	Mobile X-Band Coherent Radar
RCS	Radar Cross-Section
D Met Oc	Directorate of Meteorology and Oceanography
MetOc	Meteorology and Oceanography
MARLANT	Maritime Forces Atlantic
VIP	Very Important Person
NOTAM	Notice to Airmen
OP	Operation
ECPINS	Electronic Chart Precise Integrated Navigation Systems
VHF	Very High Freguency
MSAT	Mobile Satellite
HF	High Frequency
UHF	Ultra High Frequency
SSB	Single Side Band
PRI	Primary
SEC	Secondary

OD	Optical Density
NOHD	Nominal Optical Hazard Distance
ENOHD	Extended Nominal Optical Hazard Distance
PPE	Personal Protective Equipment
EA	Environmental Assessment
CEA	Canadian Environmental Assessment
CEAA	Canadian Environmental Assessment Act
OPI	Office of Primary Interest
FEAC	Federal Environmental Assessment Coordinator
NDHQ	National Defence Head Quarters
OpS	Optronics & Surveillance
DND	Department of National Defence
CF	Canadian Forces
DAOD	Defence Administrative Orders & Directives

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1 - E. Chalk – ASMD Simulation

1 - MARLANT/Trinity/MetOc Halifax

1 - MARPAC/Athena/OSCP/MetOc Esquimalt

Naval Engineering and Test Establishment – NETE
9401 Wanklyn St.
Montreal, QC H8R 1Z2
1 - Eric Fortier

Environment Canada
Canadian Meteorological Centre
MSC, Environment Canada
2121 Trans Canada Service Road
Dorval, Quebec H9P 1J3
1 - Tom Robinson; PPMER

W.R. Davis Engineering Limited
1260 Old Innes Road
Ottawa, Ontario K1B 3V3
1 - David Vaitekunas

Prominov
1122 Calypso
Val-Belair, Quebec G3K 2A7
1 - Jean Gilbert

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This document presents the cruise plan that was written for the Trial Demonstration component of the Shipboard Integration of Sensor and Weapons Systems (SISWS) Technical Demonstration Program (TDP) to support the Environmental Modeling component of the TDP. The objective of the trial was to test an integrated system that gathers and processes environmental information, from diverse sources, for the prediction of own ship sensor capability and own ship visibility, for all relevant wavelengths (i.e., IR and RF), and to demonstrate this system during a field trial onboard the CFAV Quest. The system that was developed is the Shipborne Integrated Environment System for Tactics and Awareness (SIESTA). System developments started in October 2001 and it was completed in 2005, and it was ready for trial in September of 2005 onboard the CFAV Quest off Halifax. results comparing the predictions of SIESTA using the measured environmental parameters with the simultaneous sensor measurements are encouraging and indicate that the system performed to expectations. While more analysis needs to be performed and further work is required to improve SIESTA's performance, a working system has been produced that can predict the performance of own-ship IR and RF sensors and the visibility of own-ship to external IR and RF sensors.

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SISWS, Cruise Plan, SIESTA

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