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(U) U.S. Naval Research Laboratory Final Analysis Report to NATO Above Water Warfare Capabilities Group 2016 Naval Electromagnetic Operations Trials

Anthony J. Allegrezza

Advanced Techniques Branch
Tactical Electronic Warfare Division

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14. ABSTRACT

(U) During the week of 06 June 2016, the Tactical Electronic Warfare Division (TEWD) of the US Naval Research Laboratory (NRL) participated in the NATO Naval Electro Magnetic Operation (NEMO) 2016 Trials. Assets consisted of two flyable and one shore-based optical seeker simulators and one shore based RF stimulator. This report addresses NRL Code 5752's fielded Electro-Optical (EO) and Imaging Infrared (IIR) Seeker Simulation Systems and the NRL Code 5763 Radio Frequency (RF) Stimulator. It includes and covers system descriptions, setup, data collection, and test goals that were accomplished.

15. SUBJECT TERMS

Tactical Electronic Warfare Division (TEWD)
Naval Electro Magnetic Operation (NEMO)
Electro-optical (EO)
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Radio frequency (RF)
Stimulator
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EXECUTIVE SUMMARY

NATO Above Water Warfare Capabilities Group (AWWCG) has set out a program of annual Trials, approved by the NATO Naval Armaments Group (NNAG), to evaluate the effectiveness of techniques and tactics needed to establish interoperability, and to examine and reduce the potential for blue on blue engagements between member nations.

The annual program called Naval Electro Magnetic Operation (NEMO), were held from 06-10 June 2016 off Andenes/Andøya, Norway. Host for the Trials was Norway, with the United States as the co-host.

The Trials provide the opportunity to:

- Improve interoperability
- Collect scientific data for member nations and NATO STO groups
- Test procedures, tactics and equipment
- Utilize data from other countries' test equipment and ASCM Simulators/Stimulators
- Conduct Joint Electronic Warfare training
- Develop improved, and cooperative, platform protection based on Trials results

The Trials were designed from the NEMO Objectives List (NOL) as published by the System Concept and Integration Group (SCI-293) of the AWWCG. The NOL provides both broad and detailed objectives for evaluation of all aspects of Electronic Warfare related testing. Test specific objectives were derived from national requests and from available participating assets.

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1. Introduction

The Naval Research Laboratory (NRL), Tactical Electronic Warfare Division (TEWD) participated in the NATO Above Water Warfare Capabilities Group (AWWCG), 2016 Naval Electromagnetic Operations (NEMO) Trials. The Trials were hosted by Norway, with the United States as the co-host.

The Trials were conducted in the area of Andøya, Norway (reference Figure 1). The Norwegian Air Force, 133 Air Wing based at Andøya Air Station, was the host location for the Trials. Facilities and test support were provided by Andøya Air Station, the Andøya Space Launch Center, the Norwegian Navy Operational Logistics Unit (MARCSS), and associated Surface and Air Operations Areas.

Andøya Air Station is located in Andenes, on the northern end of the island of Andøya, in Northern Norway approximately 200 miles north of the Arctic Circle (reference Figure 2). This area provided a protected fjord (Andfjorden) on the east and open ocean on the north and west. The Air Station provided ground sites to support numerous test and measurement stations, airfield, and aircraft support.

NRL provided a Lear jet with captive-carry imaging infrared (IIR) and Electro-Optical (EO) Simulators, and at ground sites located on the Air Station, an IIR Simulator and Radio Frequency (RF) Stimulator.

Figure 1 Map of Norway

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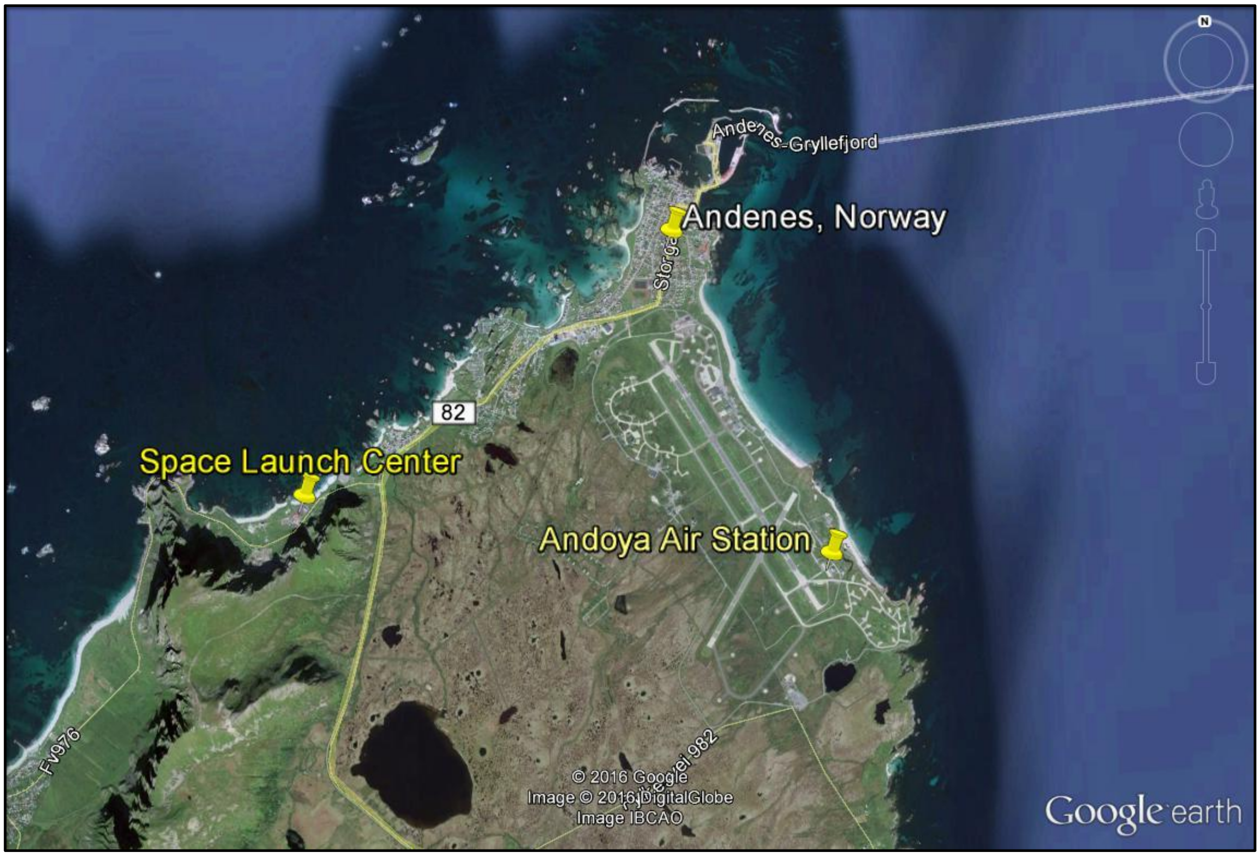

Figure 2 Andenes and Andøya Air Station

The following ships participated in the 2016 NEMO Trials:

- HDMS Niels Juel (F-363) – Denmark
- BNS Leopold I (F-930) – Belgium
- HNLMS De Ruyter (F-804) – Netherlands
- SPS Blas de Lezo (F-103) – Spain
- FS Aquitaine (D-650) – France
- TCG Barbaros (F-224) – Turkey
- HNoMS Roald Amundsen (F-311) – Norway
- HNoMS Storm (P-961) – Norway
- HNoMS Steil (P-963) – Norway
- HNoMS Mjølner (HS-5) – Norway (used only for ROSY testing)

The following countries provided shore assets:

Germany	Norway	USA
France	Turkey	NATO (JEWCS)
Denmark	Great Britain	Netherlands

The following countries provided air assets:

- USA – Lear jet
- Norway – DA-20 jet, PICO-SAR Helo, P3-C, UAV
- Germany – TERRASAR Satellite

2. US NEMO Objectives

2.1. EO/IIR Objectives

- Collect EO/IIR imagery of various platforms
- Evaluate the effectiveness of decoys and deployment tactics against imaging infrared (IIR) seekers
- Evaluate ship detection based on signature measurements.

2.2. RF Objectives

Create a multi-threat environment using the CAWS Radar Stimulator in conjunction with German ASCM Simulator.

3. Test Sites, Assets & Setup

3.1. Shore Sites

EO/IIR and RF test and measurement sites were set up on the eastern shore side of the Air Station. FOXTROT Portable and CAWS were housed in host provided CONEX type shelters. Figure 3 shows the locations of the FOXTROT Portable and CAWS systems shore sites.

- FOXTROT Portable 69° 17.178’ N, 016° 10.299’ E
  - Shore Site Equipment Configuration shown in Figure 4
- CAWS was located at 69° 17.037’ N, 016° 10.590’ E
  - Shore Site Equipment Configuration shown in Figure 5

Figure 3 Shore Test Site Locations

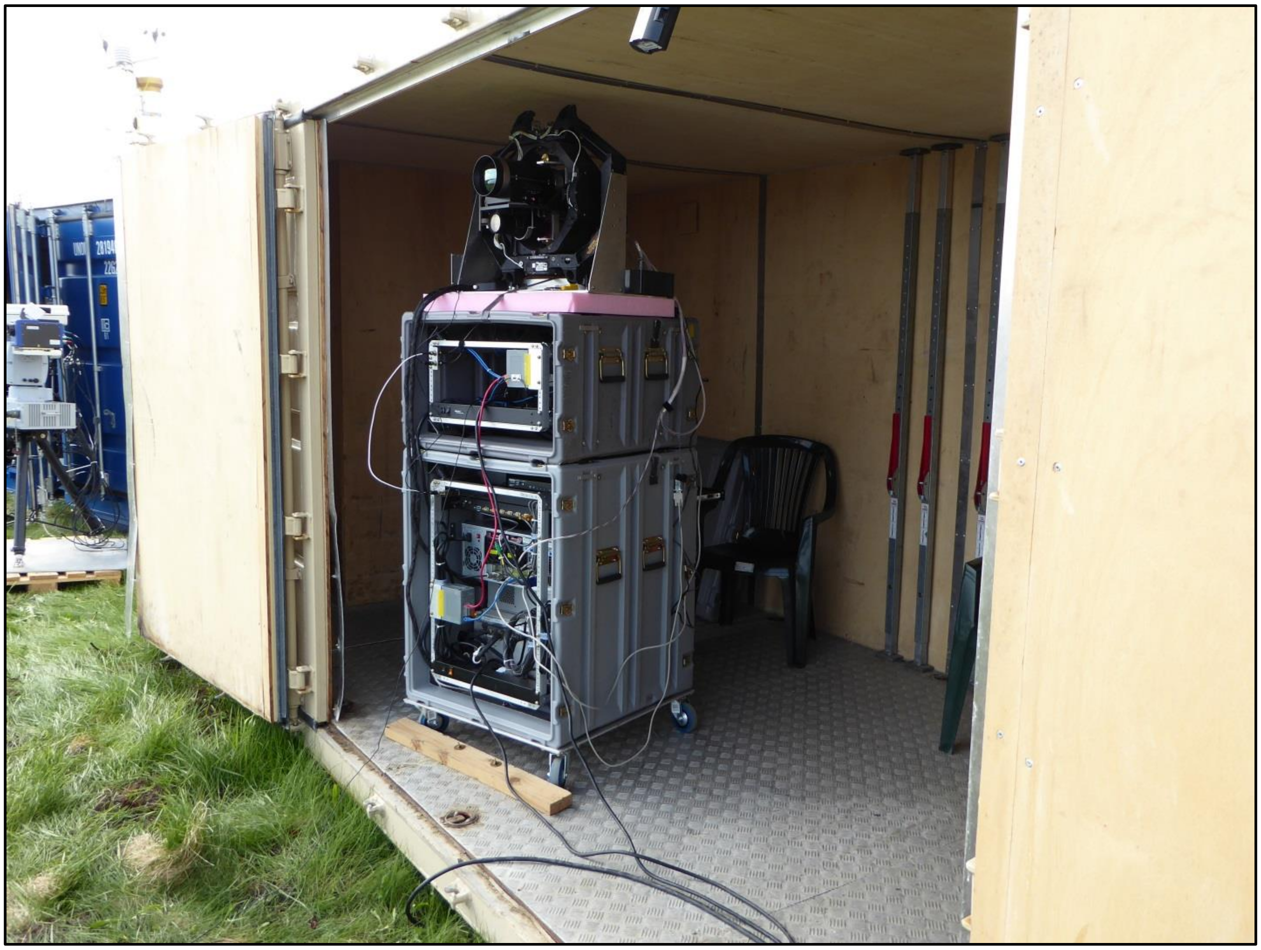

Figure 4 FOXTROT Portable Shore Configuration

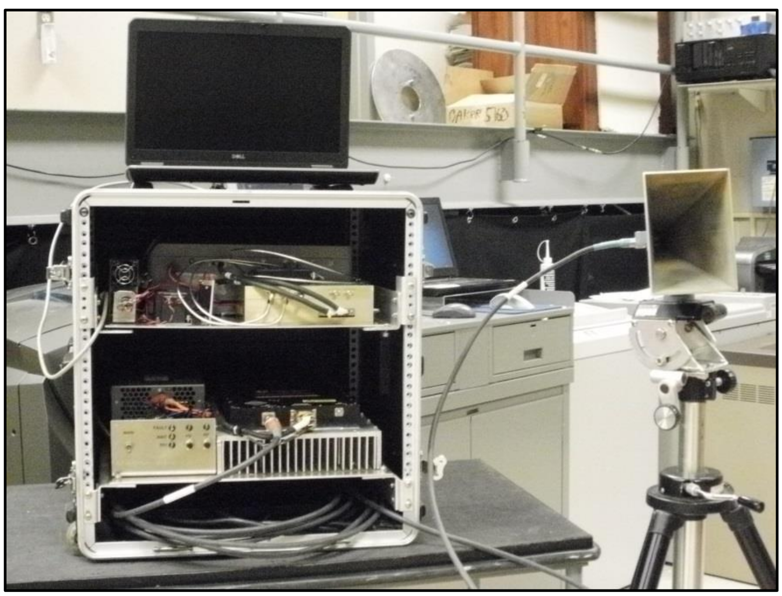

Figure 5 CAWS Shore Site Configuration

3.2. Lear jet Systems

Lear jet (Figure 6) was configured with flight-ready versions built in Standard Instrumentation Pod (SIP), and deployed as a captive-carry simulator under the wing. FOXTROT flyable simulator (Figure 8) is a programmable, man-in-the-loop, real-time image tracking systems designed to simulate imaging infrared (IIR) and Electro-Optical (EO) Television (TV) missile threats. The systems are research tools intended to represent both modern and future classes of threats with imaging front-ends, and sophisticated image processing capabilities. Two configurations of flyable payloads were deployed: IOTA-MIKE (Figure 7) an EO TV visible band seeker, and FOXTROT, a mid-wave IIR band seeker simulator. The air crew consisted of a pilot, copilot, the FOXTROT operator, the IOTA-MIKE operator.

Figure 6 Lear jet

Figure 8 FOXTROT Pod

Figure 7 IOTA MIKE Pod

4. Test Asset Descriptions

4.1. Description of FOXTROT Anti-ship Missile (ASM) Simulator

FOXTROT is a simulator for an IIR ASM, composed of off-the-shelf, commercially available components. Configuration and general specifications as shown in Table 1, detailed specifications as shown in Appendix 1. This simulator is maintained under the US Navy's Effectiveness of Naval Electronic Warfare Systems (ENEWS) program. Control and integration software was developed by NRL's Tactical Electronic Warfare Division. Two versions of the simulator were fielded:

- Flyable – housed in a Standard Instrument Pod (SIP) for captive-carry under the wing of the Lear jet.
- Portable – packaged in lightweight containers and located in a shelter at the ground operations IR Test Site.

The FOXTROT simulator is a programmable, man-in-the-loop, real-time image tracking system designed to simulate imaging infrared (IIR) missile threats. The system was developed as a research tool with the ability to represent both modern and future classes of threats, with an imaging front end and sophisticated image processing capabilities. Video data from an imager can be processed in real time or saved as raw video data that can be post-processed for target track evaluation and algorithm development.

The FOXTROT simulators consists of several major sub-system components: commercially available infrared imager, wide field-of-view reference TV camera (visible band), video image processing and analysis computer, gyro-stabilized gimbal with an electronic control loop, data recording devices, and standard PC for I/O control. The infrared imager and the reference camera are installed on the same gimbal.

Both FOXTROT simulators (flyable and portable) were based on a "NightConqueror II - 256" IIR camera from Cincinnati Electronics as the primary tracker. The NightConqueror is a ruggedized, staring focal plane array based, mid-wave infrared camera.

FOXTROT simulators also utilize a visual reference camera. The flyable system contains a Cohu Closed Circuit Television (CCD), wide field-of-view visible TV camera. The FOXTROT portable system uses a Photon Focus, 14-bit monochrome visible camera.

FOXTROT relies on manual acquisition, by an experienced operator to select the target of interest, after which the target is auto-tracked. The tracking algorithm is based on a binary threshold, centroid track. The digital image is passed into the video processing PC which determines a target pixel value threshold based on imagery inside several gates. Outer clutter gates adjust the threshold based upon the amount of clutter in the scene/image. A background gate and track gate then determines the final threshold based upon the image within their gates and clutter data from the clutter gates. The result is a binary color image of the target. This image is centroided and new track gate dimensions are calculated for the next image. The resulting data is then passed back to the gimbal to maintain pointing accuracy.

4.2. Description of IOTA-MIKE Unmanned Aircraft System (UAS) Simulator

IOTA-MIKE Standard Instrument Pod (SIP) Anti-ship Missile Simulator – The IOTA-MIKE system is a programmable simulator of a visible band optical UAS payload comprised all off-the-shelf, commercially available components. Configuration and general specifications as shown in Table 1, detailed specifications as shown in Appendix 1. The software is written and maintained by NRL's Tactical Electronic Warfare Division and the software load used for the NEMO 2016 Trials is unclassified. This system is housed in a SIP that was slightly modified to accommodate its gimbal and mounted to the wing of the Lear jet for flight.

The IOTA-MIKE simulator consists of several major sub-system components: commercially available CCD NTSC camera (visible band) imager, laptop computer for system control, gyro-stabilized gimbal with an electronic control loop, data recording devices, and an on board PC/104 embedded computer for I/O control.

IOTA-MIKE relies on an experienced operator to determine the target of interest. The tracking algorithm is based on a binary threshold, centroid track. The digital image is passed into the video processing PC which determines a target pixel value threshold based on imagery inside several gates. Outer clutter gates adjust the threshold based upon the amount of clutter in the scene/image. A background gate and track gate then determines the final threshold based upon the image within their gates and clutter data from the clutter gates. The result is a binary color image of the target. This image is centroided and new track gate dimensions are calculated for the next image. The resulting data is then passed back to the gimbal to maintain pointing accuracy.

<table>
<tr><th colspan="6">UNCLASSIFIED</th></tr>
<tr><th>System Name</th><th>Spectral Band (µm)</th><th>Detector Type</th><th>FOV (Wide/Narrow)</th><th>Gimbal Limits</th><th>Tracker</th></tr>
<tr><td colspan="6">FOXTROT Portable SIM</td></tr>
<tr><td>- CE Night Conqueror</td><td>Mid-Wave IIR</td><td>InSb (256 x 256)</td><td rowspan="2">7°x7°/-3°x3°</td><td rowspan="2">Az ±20° El +2.5° to -10°</td><td rowspan="2">Man-In-Loop</td></tr>
<tr><td>- Photon Focus Visible Camera</td><td>Monochrome 14-bit Visible</td><td>CMOS (1312 x 1082)</td></tr>
<tr><td colspan="6">FOXTROT Flyable SIM</td></tr>
<tr><td>- CE Night Conqueror</td><td>Mid-Wave IIR</td><td>InSb (256 x 256)</td><td rowspan="2">7°x7°/-3°x3°</td><td rowspan="2">Az ±20° El +2.5° to -10°</td><td rowspan="2">Man-In-Loop</td></tr>
<tr><td>- Cohu TV</td><td>Color Visible</td><td>CCD NTSC</td></tr>
<tr><td colspan="6">IOTA-MIKE Flyable SIM</td></tr>
<tr><td>- Cohu CCD Camera</td><td>Color Visible</td><td>CCD NTSC</td><td>6°x6°</td><td>Az ±20° El +2.5° to -10°</td><td>Man-In-Loop</td></tr>
<tr><td colspan="6" align="right">UNCLASSIFIED</td></tr>
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Table 1 EO/IIR Simulator Sensors

4.3. Description of CAWS

The Complex Arbitrary Waveform Synthesizer (CAWS) is a programmable radar stimulator (transmit only) that was developed and built by the Naval Research Laboratory. CAWS is capable of reproducing simple to complex waveforms in the I and J bands from a single device. Table 2 provides the overall system capabilities for the CAWS Stimulator. Each waveform parameter can be individually programmed to provide accurate signals for laboratory and operational testing. CAWS can be packaged in both portable (configuration used for NEMO

2016), and captive carry flyable configurations. CAWS requires connection to an external RF amplifier and antenna. Amplifiers can vary in size to match the individual test requirements. The operational concept of CAWS is similar to JEWCS ALQ-167 Stimulation Pods.

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Complex Arbitrary Waveform Synthesizer (CAWS) Specifications	
Frequency	8 – 18 GHz (I & J Band)
PRF	Programmable
Pulse Modulation	Programmable
Pulse Width	Programmable
Antenna	Fixed Horn
Polarization	Vertical
Scan	Programmable Attenuator Simulation
ERP	40 dBw
Data Products	Electronic On/Off Log Files Operator Notes
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Table 2 Complex Arbitrary Waveform Synthesizer (CAWS) Specifications

4.4. Norwegian DA-20

The Royal Norwegian Air Force operates a small fleet of Falcon DA20ECM aircraft in the electronic warfare role. Built in France as the Dassault Falcon 200 and originally designed as a business jet. The aircraft was modified to undertake maritime surveillance, electronic warfare and other roles.

5. Test Planning

5.1. Test Serial Descriptions

SCI-293 is a Task Group under the NATO Science and Technology Organization (STO), Systems, Concepts and Integration (SCI) Panel that is responsible for providing scientific support for the NEMO Trials, maintaining continuity in those trial activities from year to year.

To support this continuity, SCI-293 has developed the NEMO Objectives List (NOL) that describes the objectives that are applicable to the Electronic Warfare Community. These objectives encompass signature measurements, decoy/electronic warfare evaluation and tactics, ASCM seeker simulators and stimulators, GPS and communications jamming, radar/infrared/electro-optical threats and evaluation, and experimental concepts/equipment from participating nations and industry.

The goals and conduct of the Trials are dependent on the participation of National assets, and industry. These assets include ships, aircraft, and shore-based equipment. Test Serial Descriptions are developed from known participating assets and the individual objectives that apply form the NOL.

Table 3 outlines the NOL objectives that the US proposed to accomplish with the provided US assets.

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Objective	Description	Lear		Shore		DA-20
		FOXTROT	**IOTA-MIKE**	**FOXTROT**	**CAWS**	**EW**
D2	Flare Performance	X	X	X		
R1	RESM against simple waveforms				X	
R3	ESM performance in cluttered, congested, special environments, and situations				X	X
R6	Missile and projectile approach warning sensors				X	X
S1	Signatures - IR	X	X	X		
S1.1	Steady state IR signature	X		X		
S1.2	IR signature at different distances and at long distance	X		X		
S1.3	Dynamic IR signature	X		X		
S1.5	IR signature of exhaust gas	X		X		
S3.2	Monitoring and influencing passive signatures	X		X		
U1	Radar/ Comms Jamming					X
U4	IR (including IIR) seeker tactics (decoys, IR jamming, and/or combinations)	X	X			
U4.1	IR decoying on IR seeker	X		X		
U4.3	IR (including IIR) seeker tactics (decoys, IR jamming and or combinations)	X		X		
U4.4	Command Line-Of-Sight (CLOS; including Active/Laser) seeker tactics (decoys, jamming and or combinations)	X		X		X
U6	EO (TV/IR) seeker tactics (decoys, jamming and/or combinations)	X	X			
U7	Hybrid/multi-mode RF/IR/IIR/ARM seeker tactics (decoys, RF/IR/IIR jamming and/or combinations)			X		X
X	Experimental (industry/demonstration)	X		X		
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Table 3 US Trials Objectives from the NOL

The Andøya Test Range was subdivided into smaller OpAreas that provided regions for specific testing requirements. Figure 9 depicts the layout of the Test Range Op Areas; areas used by US are described in Table 4.

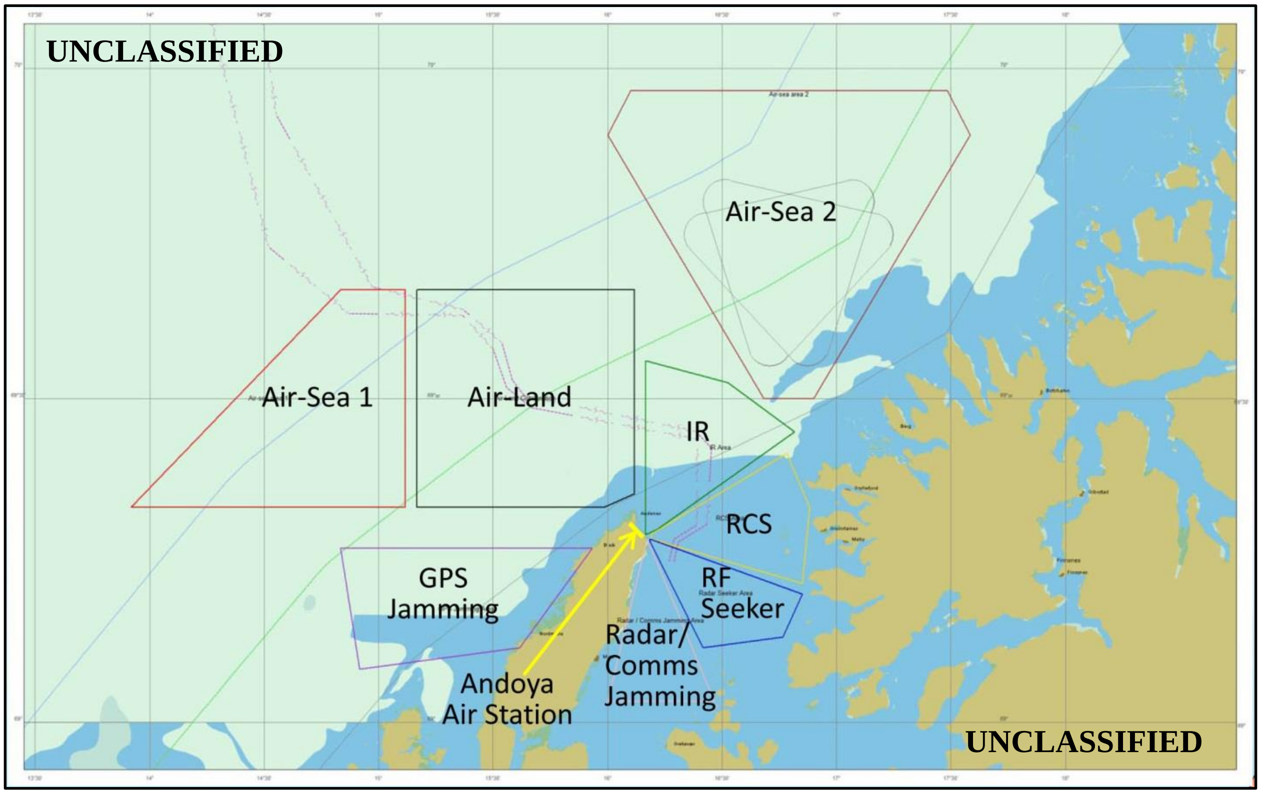

Figure 9 NEMO Trials Op Areas

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OpArea	**Designated Use**
AIR-SEA 2 (Sienna)	Northern Open Water testing with Surface and Air assets. Flight area for Lear
LAND-AIR (Black)	Open Water testing with Surface and Air assets, directly west of Fjord entrance. Flight area for Lear
IIR Measurement (Green)	Test and measurement of Surface assets by IIR equipment from shore sites (FOXTROT Portable)
RF Seeker (Blue)	Test area for RF Seekers from shore sites (CAWS location)
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Table 4 Test Range Op Areas

5.2. Flight Test Planning

Lear jet testing was scheduled for 18 flight hours during the Trials. Due to poor weather conditions the Monday afternoon sortie was terminated early and flights for Tuesday (AM and PM sorties) and Wednesday morning were cancelled. Back-up sortie time was utilized to obtain a total of 13 flight hours of testing. Planned flights for Trials are as shown in Table 5, Actual Schedule is shown in Table 6. Note – All times are Local (BRAVO) Time, UTC +2:00.

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Planned Lear Sortie Schedule

Mon 06 Jun	Tue 07 Jun	Wed 08 Jun	Thu 09 Jun	Fri 10 Jun
No Fly	0800-1030	0800-1030	0800-1030	Back-Up
1330-1600	1330-1600	1330-1600	Back-Up	-----

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Table 5 Planned Lear Sortie Schedule

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Actual Lear Sortie Schedule

Mon 06 Jun	Tue 07 Jun	Wed 08 Jun	Thu 09 Jun	Fri 10 Jun
No Fly	No Flight Ops Due To Weather	No Flight Ops Due To Weather	0843-1142	0808-1054
1745-1842 Return Early Due To Weather		1605-1730	1522-1720	1245-1422

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Table 6 Actual Lear Sortie Schedule

Test Serials were developed for Lear operations that would employ the captive carry aircraft simulator systems against the units available in the assigned Op Areas. Sixteen individual Serial Descriptions were developed. The Serials were identified as “ASMD” (Anti-Ship Missile Defense) and are summarized in Table 7.

Serials ASMD 01 through 07 supported flight operations in the AIR-SEA (Sienna) Op Area, ASMD 08 through 14 are the same, with the exception of specifying the LAND-SEA (Black) Op Area. ASMD 15 and 16 encompassed the decoy test firing for ROSY. ROSY is a demonstration decoy from Rhienmettal. Open water firings of ROSY were conducted in the LAND-AIR (Black) Op Area under Serial ASMD-15. ASMD 16 governed the runs firings ROSY inside the Fjord, in the IR Measurement (Green) Area.

All EO/IIR engagements against ships were conducted in the Air-Sea 2 (Sienna) and Land Air (Black) Op Areas. The Lear flew patterns around the Op Areas to engage single or multiple units as required. Serials were written from the NEMO Objectives List (NOL) and requirements from individual Nations. Due to limitations for Norwegian airspace, the Lear was limited to a minimum altitude of 300 feet. These Serials and the associated objectives from the NOL are described in Table 7.

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Serial ID	**Serial Description**	**NEMO OpArea**	**Objectives**
ASMD 01	Calibration Run – 300 FT LEAR EO/IR CALIBRATION RUN	Air-Sea 2 Sienna	U4, U6
ASMD 02	No Decoy Firing Run – 300 FT NO DECOY RUN, SINGLE UNIT	Air-Sea 2 Sienna	U4, U6
ASMD 03	Decoy Firing Run – 300 FT DECOY FIRING RUN, SINGLE UNIT	Air-Sea 2 Sienna	U4, U6, D2
ASMD 04	UAS Lookdown Run – 3000, 6000 & 9000 FT UAS LOOKDOWN, SINGLE UNIT	Air-Sea 2 Sienna	U4, U6
ASMD 05	Stack Lookdown Run – 3000, 6000 & 9000 FT STACK LOOKDOWN, SINGLE UNIT	Air-Sea 2 Sienna	U4, U6
ASMD 06	Force ASMD – No Decoy Firing – 300 FT NO DECOY RUN, FORCE	Air-Sea 2 Sienna	U4, U6
ASMD 07	Force ASMD – Decoy Firing – 300 FT DECOY FIRING RUN, FORCE	Air-Sea 2 Sienna	U4, U6, D2
ASMD 08	Calibration Run – 300 FT LEAR EO/IR CALIBRATION RUN	Air-Land Black	U4, U6
ASMD 09	No Decoy Firing Run – 300 FT NO DECOY RUN, SINGLE UNIT	Air-Land Black	U4, U6
ASMD 10	Decoy Firing Run – 300 FT DECOY FIRING RUN, SINGLE UNIT	Air-Land Black	U4, U6, D2
ASMD 11	UAS Lookdown Run – 3000, 6000 & 9000 FT UAS LOOKDOWN, SINGLE UNIT	Air-Land Black	U4, U6
ASMD 12	Stack Lookdown Run – 3000, 6000 & 9000 FT STACK LOOKDOWN, SINGLE UNIT	Air-Land Black	U4, U6
ASMD 13	Force ASMD – No Decoy Firing – 300 FT NO DECOY RUN, FORCE	Air-Land Black	U4, U6
ASMD 14	Force ASMD – Decoy Firing – 300 FT DECOY FIRING RUN, FORCE	Air-Land Black	U4, U6, D2
ASMD 15	ROSY Firing – 300 FT ROSY DECOY RUN, AIR-LAND	Air-Land Black	D2, S1, X
ASMD 16	ROSY Firing – 300 FT ROSY DECOY RUN, IR AREA	Shore IR Green	D2, S1, X
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Table 7 ASMD Serial Descriptions

5.3. Shore Test Planning

The overall NEMO Trials Serial Plan placed ships in designated Op Areas (IIR and RF Seeker) during specific time periods. Conduct of US shore asset participation was limited to units as they were assigned to those areas. The CAWS system operated in conjunction with the RF Simulator from Germany, to provide a multi-threat environment.

6. Data Collected & Test Results

6.1. Lear Flight Test Results

FOXTROT Flyable collected data for a total of 82 inbound runs on ships during 6 sorties on the Lear jet. A total of 31 decoy runs were recorded. The first sortie on 06 June was aborted early due to weather. The flights for 07 June and morning of 08 June were rescheduled due to poor weather conditions. FOXTROT SIP collected mid-wave IIR, visible band images and System Control Overlay Video of all of the listed runs. A summary of Lear runs conducted are found in Appendix 2.

FOXTROT Flyable experienced early problems with internal network communications preventing control. This problem was resolved and the system worked for the duration of the test.

IOTA-MIKE experienced a progressive processor failure. The processor failure caused gimbal control and camera focusing issues. This failure prevented it from operating for more than half of the later flight runs.

FOXTROT Flyable was operated in one of two modes, a man-in-the-loop mode, and a data collection mode for post processing analysis during the trial. The man in the loop run entails the operator operating the gimbal to scan the horizon for the targets of opportunity and initiating a track manually. The tracker did not simulate any specific threat missile, but rather operated in a generic centroid, binary threshold algorithm. The Data Acquisition Mode capture entailed the operator centering the image on the ship and collecting data as the system flew in. The data is full digital dynamic range which allows for high fidelity post processing of varying track algorithms and model validation.

6.2. FOXTROT Portable (Shore) Test Results

FOXTROT Portable collected data for a total of 66 runs on ships, 19 of which were decoy runs, during four days of testing. IIR and visible band imagery was recorded of eight ships at close ranges and all ship heading aspects. Target acquisition attained through man-in-the-loop mode to search and select a target of interest. After the target was selected, FOXTROT Portable used a generic centroid, binary threshold algorithm to track. Mid-wave IIR, 14 bit visible images and System Control Overlay Video collected for all of the listed runs. A summary of FOXTROT Portable (Shore) runs conducted are found in Appendix 4.

6.3. ROSY Decoy Demonstration

The evaluation of the decoy effectiveness against the imaging infrared (IIR) seekers was planned using the FOXTROT Flyable seeker simulator flying captive-carry on the Lear jet and the FOXTROT portable system set up on the shore site.

The NEMO 16 Trials offered a perfect opportunity to create and collect a data set of IIR imagery for future Science and Technology Organization (STO) Task group exploitations. This data set can be used in modeling runs for several member nations' digital ASCM models. The critical component was to use an unclassified decoy, unclassified target boat and unclassified imager(s).

Rhienmettal generously provided the organizers two ROSY tank defense decoy launchers and 120 rounds of red phosphorus decoys. The test organizers found a tug boat as the launch platform. The two launchers were mounted fore and aft at 15 degrees off axis, as shown in Figure 10. Figure 11 shows the ROSY installation on HNoMS Mjølner. STO also approved supplemental funding for expendables under their established policies. This allowed the Lear to fly against the tug and collect data. Netherlands provided a calibrated black body for FOXTROT Flyable and Portable systems to collect black body data before and after the sortie – a needed step for data to be used in modeling work.

The test was designed in two phases. The first set of runs was conducted against the tug placed within the operational area of the IIR shore site. This allowed for the assets at this site to image the event. The Lear flew a very tight approach against this configuration. This portion occurred at the beginning of the sortie. The FOXTROT ground system collected IIR and high resolution EO imagery.

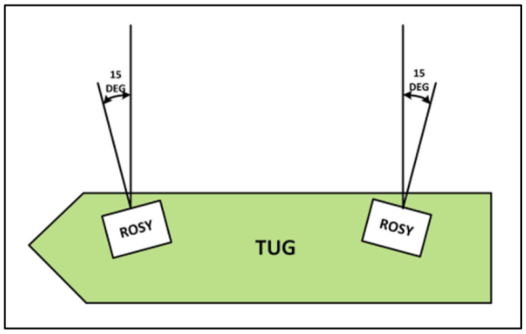

Figure 10 ROSY Installation Locations

Figure 11 ROSY Installation on HNoMS Mjølner

The second phase was done towards the end of this sortie and conducted in the Land-Sea sector, which is located to the west of the Fjord entrance. This location only permitted Lear flights and was out of view for the Portable system. This allowed for more variations in the approach angle. Data collection included flying into the sun. Also collections approaching bow were done to allow for decoy signature/capture for future work.

Each run was to use ten rounds per event. One concern was the short duration of the rounds (3 seconds) but this proved to be more than enough. The tug was 25m long and the coverage offered was more than sufficient to allow for investigations into multi-munition decoy systems.

There were 16 runs (7 successful decoys, 1 failure, 8 not post-processed) collected from the aircraft, and 7 from the shore side FOXTROT unit (3 successful decoys, and 4 failures). Run information and associated Run numbers are as shown in Table 8.

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System	OpArea	Run Numbers
FOXTROT Portable	IR Measurement (Green)	12a – 18
FOXTROT (Lear)	IR Measurement (Green)	12 – 19
FOXTROT (Lear)	Land-Air (Black)	38 – 45

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Table 8 ROSY Run Information - 09 Jun 2016

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		ROSY Decoy Demonstration Results
	S/F/U/NO	S= Successful; F=Failed; U=Unknown; NO=No Decoy
		Results of Foxtrot Flyable Simulator
Run	Result	Comments
12-15	U	Runs unable to be post-processed
16	F	Separation between decoy and tug was clear enough, so Track Gate (TG) stayed on tug.
17	S	Decoy covered tug completely. Elongated decoy cloud pulled TG away from tug and to the center of a cloud.
18	S	Similar to Run 17.
19	S	Similar to Run 17. Size and intensity of decoy moved TG away from tug.
38	NO	Calibration Run. Not post-processed
39	S	Decoy covered tug completely. After TG moved to the center of decoy cloud, tug moved away from cloud swiftly.
40	S	Similar to Run39; Cloudy sky; Background was gray. Tug was hot on cooler water.
41	S	Similar to Run39; Cloudy sky; Tug was hot on cooler water.
42	S	Similar to Run39; Gray background but still clear horizon.
43	NO	Tug was overlapped with other ship. Not post-processed
44	U	Tug was in negative contrast; Unable to perform man-in-the-loop decoy test; sky was cooler (black) and water had lots of glints. Not post-processed
45	NO	Tug was in negative contrast. Not post-processed
		Results of Foxtrot Portable Simulator on Shore Site
Run	Result	Comments
12a	F	Separation between tug and decoy was clear from seeker; Starboard Rear Quarter.
13	S	Decoy fully covered tug; TG lost on water; Starboard Side.
14	F	Separation between tug and decoy was clear from seeker; Bow Port Quarter.
15	F	Separation between tug and decoy was clear from seeker; Bow Port Quarter.
16	F	Decoy covered tug and TG expanded, seduced initially, but TG returned to the center and recaptured tug; Starboard. 10 Rounds.
17	S	Decoy fully covered tug; tug escaped from decoy swiftly. TG lost on water; Starboard. 10 Rounds.
18	S	Similar to Run 17; TG lost in sky; Starboard. 10 Rounds.

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Table 9 Post-processing results of ROSY Decoys

Table 9 shows the results of the ROSY decoy demonstration runs from both the Flyable and Portable FOXTROT simulators. A run was considered successful if the track gate initially on the ship was merged with the decoy and separated from the ship and then lost to some other parts of the background. If the decoy was launched such that it did not seduce the track gate away from the ship or later the track gate jumped back on the ship, then the run was considered a failure. For the Flyable simulator, seven of the eight runs against the model track gate stayed away from the ship. Three of the seven runs against the portable simulator were successful, and four runs failed. The four runs failed due to poor geometry and the decoy did not seduce the track gate away from the ship.

6.4. IOTA-MIKE

IOTA-MIKE flyable was operated in the man-in-the-loop mode during the Trial. This entails the operator scanning the horizon for the targets of opportunity and initiating a track manually. The tracker did not simulate any specific threat missile, but rather operated in a generic centroid, binary threshold algorithm. IOTA-MIKE being a visible band TV seeker simulator was not involved in decoy testing; however, was able to record the visible band imagery and tracking during ship runs as listed in Appendix 2. Specific results discussed between U.S. Subject Matter Expert and nation representatives during subsequent meeting.

Seven Ship Runs were recorded with IOTA-MIKE. Progressive hardware failures of the processor prevented further recording.

6.5. Decoy Runs

A total of 32 ship decoy runs were recorded by the two FOXTROT systems. Results of the individual decoy runs will not be included in this report, but will be turned over to the host nation for direct dissemination to their respective countries.

The ROSY run data (23 runs, 18 decoys) will be supplied to the host nation, and forwarded to the NATO Science & Technology Organization (STO), EO and IR Countermeasures against Anti-Ship Missiles Task Group (SCI-224).

6.6. CAWS Ground

The CAWS system was operated in conjunction with the German RF Simulator to provide a multi-threat environment. CAWS was only operated on Day 2 (07 June), participating in 22 runs.

Three signal groups were developed and provided for use in the NEMO Trials. The CAWS signals are detailed in Table 10. These signals were representative of threat type signals, but did not represent a specific threat. Mode 1 and 2 signals had frequency interference problems with other equipment, and only Mode 3a Waveform was transmitted.

CAWS transmits through a fixed horn, and produces an ERP of 40 dBw. Scanning simulation is achieved through the use of a program controlled attenuator which modulates signal power level to simulate a scanning system. For NEMO a Sector Scan was reproduced with a Scan Period of 4 seconds.

CAWS Run information is listed in Appendix 5.

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Mode Name	**Frequency (MHz)**	**Freq Agile**	**Freq Agile Range (MHz)**	**PRI (µs)**	**PRI Agile**	**PRI Agile Range (µs)**	**PW (µs)**	**PW Agile**
1a	8500.00	No	---	150.000	No	---	1.000	No
1b		Yes	±150.0		No	---		
1c		Yes	±250.0		Yes	±50.0		
2a	12500.000	No	---	150.000	No	---	1.000	No
2b		Yes	±150.0		No	---		
2c		Yes	±250.0		Yes	±50.0		
3a	15500.00	No	---	150.000	No	---	1.000	No
3b		Yes	±150.0		No	---		
3c		Yes	±250.0		Yes	±50.0		
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Table 10 CAWS Waveforms

CAWS signal summary:

1.a, 2.a, 3.a – **Simple Signal** - Fixed Frequency, Fixed PRI, Fixed PW

1.b, 2.b, 3.b – **Frequency Modulated** - Fixed PRI, Fixed PW, Frequency Sine Modulated ±150 MHz at 100 Hz rate

1.c, 2.c, 3.c – **Frequency and PRI Modulated** - Fixed PW, 10 position discrete frequencies (500 MHz bandwidth) and 10 discrete PRI values (100 µsec variation, 10 µsec steps)

7. NRL Summary

The primary objective of this trial was to take EO/IIR imagery of various platforms and to evaluate the effectiveness of IIR decoys and deployment tactics against imaging infrared (IIR) seekers. The secondary mission was to support ESM operations by transmitting a radar signal with the CAWS system. All proposed U.S. test objectives were met.

In operations with multiple ships it is critical to be able to locate and identify of each unit. The use of TACAN and AIS during testing ensures that aircraft are inbound to correct ship under test. This is extremely important when unit is firing decoys, to avoid the loss of data.

The Foxtrot flyable system collected over 776 files consisting of 314M bytes of data. The system collected both visible and mid wave IR imagery and GPS tracking data for 86 ship runs.

The Foxtrot portable system collected over 467 files consisting of 1.6T bytes of data. The system collected both visible and mid wave IR imagery for 66 ship runs.

The IOTA-MIKE system collected over 239 files consisting of 205M bytes of data. The system collected visible band imagery and GPS tracking data for 6 ship runs.

The CAWS Stimulator operated for 22 runs, providing a multiple threat environment in conjunction with the German RF Simulator.

Appendix 1 EO/IIR Simulator Configuration

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	FOXTROT Flyable SIP	**IOTA-MIKE Flyable SIP**	**FOXTROT Portable**
System Type	Man-in-the-Loop, imaging IIR	Man-in-the-Loop, imaging Visible	Same as FOXTROT SIP
Gimbal Limits	AZ = +/- 20°, EL = +8° / -17°	AZ = +/- 20°, EL = +8° / -17°	AZ = +/- 20°, EL = +2.5° / -10°
Camera Type	IIR Cincinnati Electronics NightConqueror II-256	COHU Model 3810	Same as FOXTROT SIP
Sensor Type	InSb Photovoltaic FPA	CCD color camera	Same as FOXTROT SIP
Readout	CMOS switched FET, read while integrate		Same as FOXTROT SIP
FPA Format	256(h) x 256(v) pixels	NTSC	Same as FOXTROT SIP
FPA Pixel Pitch	30 µm		Same as FOXTROT SIP
FPA Dimension	7.68 mm (h) x 7.68 mm (v)		Same as FOXTROT SIP
Optical Band	3.6 - 5.0 µm Nominal	Visible	Same as FOXTROT SIP
Optics Assembly	Dual FOV motorized lens, f/4, 50/250 mm EFL	22X 3.9mm to 85.8mm	Dual FOV manual lens, f/4, 50/250 mm EFL
Wide FOV	7° x 7°	2.51°	Same as FOXTROT SIP
Narrow FOV	3° x 3°	48.94°	Same as FOXTROT SIP
Analog Output	RS-170 Video	NTSC	Same as FOXTROT SIP
Digital Output	14-bit HOTlink at 22.1 MByte/sec		Same as FOXTROT SIP
Cooler	Ricor K508 rotary Stirling cooler	N/A	Same as FOXTROT SIP
Reference Camera	Model 3810	None	Monochrome 14 Bit Visible
Manufacturer	COHU	N/A	Photon Focus
Camera Type	CCD color camera	N/A	CMOS
Image Area	3.6 x 2.7 mm (1/4 inch format)	N/A	
Cell Size	NTSC: 4.75 (h) x 5.55 µm (v) PAL: 4.85 (h) x 4.65 µm (v)	N/A	
Number of pixels	768(h) x 494(v) = 379392 pixels	N/A	1312 x 1082 pixels
Video Resolution	NTSC: 460 lines (h) x 250 (v) PAL: 450 lines (h) x 415 (v)	N/A	NTSC: 470 lines (h) PAL: 460 lines (h)
Lens (Wide/Tele)	3.9 / 85.8 mm	N/A	2.4 / 60 mm
Optical/Digital Zoom	22x / 8x	N/A	25x / 12x
Angle of view (h)	48.94° (Wide) / 2.51° (Tele)	N/A	45° (Wide) / 2.0° (Tele)
Max. Lens Aperture	Wide: f/1.6; Tele: f/3.7	N/A	Wide: f/1.6; Tele: f/2.7
S/N ratio	56 dB	N/A	49 dB
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Appendix 2 Summary of Lear FOXTROT Runs

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Date	Run	Start/Stop Time(Z)	Ship	Series	Decoy
8-Jun-16	3*	1424/1426	Blas de Lezo	ASMD 01	No
8-Jun-16	4*	1435/1436	Blas de Lezo	ASMD 03	No
8-Jun-16	5*	1444/1436	Blas de Lezo	ASMD 02	Yes
8-Jun-16	6*	1453/1456	Blas de Lezo	ASMD 03	No
8-Jun-16	7*	1503/1506	Blas de Lezo	ASMD 04	No
8-Jun-16	8*	1511/1514	Blas de Lezo	ASMD 04	No
9-Jun-16	12*	0656/0657	Mjølner	ASMD 16	No
9-Jun-16	13*	0658/0700	Mjølner	ASMD 16	No
9-Jun-16	14*	0702/0703	Mjølner	ASMD 16	Yes
9-Jun-16	15*	0705/0707	Mjølner	ASMD 16	Yes
9-Jun-16	16*	0709/0711	Mjølner	ASMD 16	Yes
9-Jun-16	17*	0713/0714	Mjølner	ASMD 16	Yes
9-Jun-16	18*	0718/0720	Mjølner	ASMD 16	Yes
9-Jun-16	19*	0724/0725	Mjølner	ASMD 16	Yes
9-Jun-16	19a*	0743/0745	Barbaros	ASMD 09	Yes
9-Jun-16	20*	0746/0748	Aquitaine	ASMD 08	No
9-Jun-16	21*	0749/0751	Blas de Lezo	ASMD 08	No
9-Jun-16	22*	0752/0754	Barbaros	ASMD 09	Yes
9-Jun-16	23*	0755/0757	Aquitaine	ASMD 10	No
9-Jun-16	24*	0757/0759	Niels Juel	ASMD 08	No
9-Jun-16	25*	0800/0802	Roald Amundsen	ASMD 08	No
9-Jun-16	26*	0803/0805	Barbaros	ASMD 09	Yes
9-Jun-16	27*	0806/0808	Aquitaine	ASMD 09	No
9-Jun-16	28*	0809/0810	Blas de Lezo	ASMD 10	No
9-Jun-16	29*	0812/0814	Roald Amundsen	ASMD 10	No
9-Jun-16	30*	0815/0817	Barbaros	ASMD 09	Yes
9-Jun-16	31*	0819/0821	Aquitaine	ASMD 10	No
9-Jun-16	32*	0822/0824	Niels Juel	ASMD 10	No
9-Jun-16	33*	0825/0827	Roald Amundsen	ASMD 10	No
9-Jun-16	34*	0828/0830	Barbaros	ASMD 09	Yes
9-Jun-16	35*	0832/0833	Aquitaine	ASMD 09	Yes
9-Jun-16	36*	0838/0840	Aquitaine	ASMD 10	No
9-Jun-16	37*	0845/0847	Aquitaine	ASMD 10	No
9-Jun-16	38*	0855/0857	Mjølner	ASMD 15	No
9-Jun-16	39	0901/0903	Mjølner	ASMD 15	Yes

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Date	**Run**	**Start/Stop Time(Z)**	**Ship**	**Series**	**Decoy**
9-Jun-16	40	0905/0907	Mjølner	ASMD 15	Yes
9-Jun-16	41	0910/0911	Mjølner	ASMD 15	Yes
9-Jun-16	42	0917/0918	Mjølner	ASMD 15	Yes
9-Jun-16	43	0923/0924	Mjølner	ASMD 15	No
9-Jun-16	44	0928/0929	Mjølner	ASMD 15	Yes
9-Jun-16	45	0933/0934	Mjølner	ASMD 15	No
9-Jun-16	46	1330/1332	Leopold I	ASMD 08	No
9-Jun-16	47	1332/1334	Barbaros	ASMD 08	No
9-Jun-16	48	1340/1342	Leopold I	ASMD 08	No
9-Jun-16	49	1346/1350	Barbaros	ASMD 09	Yes
9-Jun-16	50	1354/1358	Leopold I	ASMD 09	Yes
9-Jun-16	51*	1403/1407	Barbaros	ASMD 09	Yes
9-Jun-16	52*	1410/1413	Leopold I	ASMD 09	Yes
9-Jun-16	53*	1418/1420	Barbaros	ASMD 08	No
9-Jun-16	54*	1425/1429	Leopold I	ASMD 09	Yes
9-Jun-16	55*	1432/1436	Barbaros	ASMD 09	Yes
9-Jun-16	56*	1440/1442	Leopold I	ASMD 09	Yes
9-Jun-16	57*	1454/1456	Barbaros	ASMD 10	No
9-Jun-16	58*	1459/1501	Leopold I	ASMD 10	No
9-Jun-16	59*	1506/1508	Barbaros	ASMD 11	No
10-Jun-16	60*	0628/0630	De Ruyter	ASMD 08	No
10-Jun-16	61*	0634/0636	Blas de Lezo	ASMD 09	Yes
10-Jun-16	62*	0641/0643	Leopold I	ASMD 08	No
10-Jun-16	63*	0648/0651	Aquitaine	ASMD 08	No
10-Jun-16	64*	0655/0658	De Ruyter	ASMD 10	No
10-Jun-16	65*	0702/0704	Blas de Lezo	ASMD 10	No
10-Jun-16	66*	0709/0712	Leopold I	ASMD 10	No
10-Jun-16	67*	0719/0721	Aquitaine	ASMD 09	Yes
10-Jun-16	68*	0726/0727	De Ruyter	ASMD 10	No
10-Jun-16	69*	0731/0734	De Ruyter	ASMD 10	No
10-Jun-16	70*	0738/0740	Blas de Lezo	ASMD 10	No
10-Jun-16	71*	0745/0748	Aquitaine	ASMD 09	Yes
10-Jun-16	72*	0754/0757	De Ruyter	ASMD 09	Yes
10-Jun-16	73	0800/0805	Blas de Lezo	ASMD 10	No
10-Jun-16	74	0808/0811	Aquitaine	ASMD 10	No
10-Jun-16	75	0816/0819	De Ruyter	ASMD 09	Yes
10-Jun-16	76	0824/0826	Blas de Lezo	ASMD 10	No
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Date	**Run**	**Start/Stop Time(Z)**	**Ship**	**Series**	**Decoy**
10-Jun-16	77*	0831/0833	Aquitaine	ASMD 10	No
10-Jun-16	78*	0839/0843	De Ruyter	ASMD 09	Yes
10-Jun-16	79*	1059/1102	De Ruyter	ASMD 08	No
10-Jun-16	80*	1105/1108	De Ruyter	ASMD 10	No
10-Jun-16	81*	1115/1119	De Ruyter	ASMD 10	No
10-Jun-16	82*	1126/1129	De Ruyter	ASMD 10	No
10-Jun-16	83*	1135/1138	De Ruyter	ASMD 10	No
10-Jun-16	84*	1144/1147	De Ruyter	ASMD 10	No
10-Jun-16	85*	1152/1157	De Ruyter	ASMD 10	No
10-Jun-16	86*	1202/1204	De Ruyter	ASMD 10	No
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* DA-20 aircraft flew in formation

Appendix 3 Summary of Lear IOTA-MIKE Runs

UNCLASSIFIED					
Date	**Run**	**Start/Stop Time(Z)**	**Ship**	**Series**	**Decoy**
8-Jun-16	3	1424/1426	Blas de Lezo	ASMD 01	No
8-Jun-16	4	1435/1436	Blas de Lezo	ASMD 03	No
8-Jun-16	5	1444/1436	Blas de Lezo	ASMD 02	Yes
8-Jun-16	6	1453/1456	Blas de Lezo	ASMD 03	No
8-Jun-16	7	1503/1506	Blas de Lezo	ASMD 04	No
8-Jun-16	8	1511/1514	Blas de Lezo	ASMD 04	No
					UNCLASSIFIED

Appendix 4 Summary of FOXTROT Portable (Shore) Runs

UNCLASSIFIED

Date	Run	Start/Stop Time(Z)	Ship	NEMO Objective	Decoy
7-Jun-16	1	0639/0647	Blas de Lezo	S1	No
7-Jun-16	2	0648/0649	Blas de Lezo	S1	No
7-Jun-16	3	0651/0652	Blas de Lezo	S1	No
7-Jun-16	4	0655/0702	Blas de Lezo	S1	No
7-Jun-16	5	0707/0709	Blas de Lezo	S1	No
7-Jun-16	6	0715/0719	Blas de Lezo	S1	No
7-Jun-16	7	0722/0725	Blas de Lezo	S1	No
7-Jun-16	8	0735/0738	Blas de Lezo	S1	No
7-Jun-16	9	0815/0820	Blas de Lezo	S1	No
7-Jun-16	10	0825/0830	Blas de Lezo	S1	No
7-Jun-16	11	0831/0835	Blas de Lezo	S1	No
7-Jun-16	12	1124/1131	Blas de Lezo	S1	No
7-Jun-16	13	1205/1210	De Ruyter	S1	No
7-Jun-16	14	1227/1231	De Ruyter	S1	No
7-Jun-16	15	1239/1243	De Ruyter	S1	No
7-Jun-16	16	1254/1259	De Ruyter	S1	No
7-Jun-16	17	1305/1311	Niels Juel	S1	No
7-Jun-16	18	1325/1330	Niels Juel	S1	No
7-Jun-16	19	1356/1402	Niels Juel	S1	No
7-Jun-16	20	1422/1427	Niels Juel	S1 (3.2)	No
7-Jun-16	21	1442/1447	Niels Juel	S1 (3.2)	No
7-Jun-16	22	1448/1454	Niels Juel	S1 (1.1)	No
7-Jun-16	23	1456/1459	Niels Juel	S1 (1.1)	No
7-Jun-16	24	1502/1505	Niels Juel	S1 (1.1)	No
7-Jun-16	25	1514/1518	Niels Juel	S1 (1.5)	No
8-Jun-16	1	1035/1036	Roald Amundsen	S1	No
8-Jun-16	2	1049/1050	Roald Amundsen	S1	No
8-Jun-16	3	1056/1059	Roald Amundsen	S1 (1.1)	No
8-Jun-16	4	1116/1119	Roald Amundsen	S1 (1.5)	No
8-Jun-16	5	1120/1122	Roald Amundsen	S1 (1.5)	No
8-Jun-16	6	1129/1131	Roald Amundsen	S1 (1.5)	No
8-Jun-16	7	1132/1134	Roald Amundsen	S1 (1.5)	No
8-Jun-16	8	1441/1415	Roald Amundsen	D1	Yes
8-Jun-16	9	1719/1723	De Ruyter	U7	Yes
8-Jun-16	10	1733/1737	Roald Amundsen	U7	Yes
8-Jun-16	11	1743/1745	Roald Amundsen	U7	Yes

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Date	**Run**	**Start/Stop Time(Z)**	**Ship**	**NEMO Objective**	**Decoy**
8-Jun-16	12	1747/1751	Roald Amundsen	U7	Yes
9-Jun-16	12a	0646/0650	Mjølner	U7	Yes
9-Jun-16	13	0655/0659	Mjølner	U7	Yes
9-Jun-16	14	0703/0705	Mjølner	U7	Yes
9-Jun-16	15	0707/0710	Mjølner	U7	Yes
9-Jun-16	16	0713/0715	Mjølner	U7	Yes
9-Jun-16	17	0718/0721	Mjølner	U7	Yes
9-Jun-16	18	0729/0733	Mjølner	U7	Yes
9-Jun-16	19	0841/0845	Storm	S1 (1.1)	No
9-Jun-16	20	0904/0908	Storm	S1	No
9-Jun-16	21	0912/0917	Storm	S1 (1.5)	No
9-Jun-16	22	0919/0923	Storm	S1 (1.2)	No
9-Jun-16	23	0926/0930	Storm	S1 (1.2)	No
9-Jun-16	24	1142/1147	Storm	S1 (3.2)	No
9-Jun-16	25	1155/1200	Roald Amundsen	N/S	No
9-Jun-16	26	1213/1218	Leopold I	N/S	No
9-Jun-16	27	1241/1246	Storm	U7	Yes
9-Jun-16	28	1249/1254	Storm	U7	Yes
9-Jun-16	29	1301/1306	Storm	U7	Yes
10-Jun-16	30	0659/0701	Barbaros	S1	No
10-Jun-16	31	0702/0703	Barbaros	S1	No
10-Jun-16	32	0707/0708	Barbaros	S1	No
10-Jun-16	33	0733/0734	Barbaros	S1 (1.5)	No
10-Jun-16	34	0736/0740	Barbaros	S1 (1.5)	No
10-Jun-16	35	0816/0819	Barbaros	S1 (1.3)	No
10-Jun-16	36	1050/1052	Aquitaine	N/S	No
10-Jun-16	37	1127/1129	Barbaros	U7 (4.1)	Yes
10-Jun-16	38	1137/1140	Barbaros	U7 (4.1)	Yes
10-Jun-16	39	1149/1152	Barbaros	U7 (4.3)	Yes
10-Jun-16	40	1205/1207	Barbaros	U7 (4.4)	Yes
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Appendix 5 Summary of CAWS Runs

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Event Run #	CAWS Run #	Time On	Time Off	Test Unit	Notes
2	1	082407	082609		Target called as NOVEMBER by RF, AIS shows NOVEMBER in port. Appears to be OSCAR
3	2	083305	083509		
4	3	083903	084132		
5	4	084502	084703		
1	5	095008	095232	Steil	
1	6	095604	100133	Steil	
2	7	100422	100512	Steil	
3	8	100815	101015	Steil	
4	9	101308	101417	Steil	
5	10	104842	100529	Steil	
6	11	105534	105727	Steil	
7	12	110012	110205	Steil	
8	13	110516	110656	Steil	
9	14	111133	111315	Steil	
10	15	111704	111925	Steil	
12	16	112908	113053	Steil	
13	17	113628	113648	Steil	
14	18	113911	114046	Steil	
15	19	114308	114525	Steil	
16	20	114905	115128	Steil	
17	21	115419	115652	Steil	
1	1	131349	131709	Leopold I	

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Appendix 6 Results of ROSY Demo Runs

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Date	Run	Start/Stop Time(Z)	Ship	Series	Sim	Result Seduction
9-Jun-16	12a	0646/0650	Mjølner	ASMD 02	Foxtrot Portable	No
9-Jun-16	13	0655/0659	Mjølner	ASMD 02	Foxtrot Portable	Yes
9-Jun-16	14	0703/0705	Mjølner	ASMD 02	Foxtrot Portable	No
9-Jun-16	15	0707/0710	Mjølner	ASMD 02	Foxtrot Portable	No
9-Jun-16	16	0713/0715	Mjølner	ASMD 02	Foxtrot Portable	No
9-Jun-16	17	0718/0721	Mjølner	ASMD 02	Foxtrot Portable	Yes
9-Jun-16	18	0729/0733	Mjølner	ASMD 02	Foxtrot Portable	Yes
9-Jun-16	12	0656/0657	Mjølner	ASMD 02	Foxtrot SIP	N/A
9-Jun-16	13	0658/0700	Mjølner	ASMD 02	Foxtrot SIP	N/A
9-Jun-16	14	0702/0703	Mjølner	ASMD 02	Foxtrot SIP	N/A
9-Jun-16	15	0705/0707	Mjølner	ASMD 02	Foxtrot SIP	N/A
9-Jun-16	16	0709/0711	Mjølner	ASMD 02	Foxtrot SIP	No
9-Jun-16	17	0713/0714	Mjølner	ASMD 02	Foxtrot SIP	Yes
9-Jun-16	18	0718/0720	Mjølner	ASMD 02	Foxtrot SIP	Yes
9-Jun-16	19	0724/0725	Mjølner	ASMD 02	Foxtrot SIP	Yes
9-Jun-16	38	0855/0857	Mjølner	ASMD 02	Foxtrot SIP	N/A
9-Jun-16	39	0901/0903	Mjølner	ASMD 02	Foxtrot SIP	Yes
9-Jun-16	40	0905/0907	Mjølner	ASMD 02	Foxtrot SIP	Yes
9-Jun-16	41	0910/0911	Mjølner	ASMD 02	Foxtrot SIP	Yes
9-Jun-16	42	0917/0918	Mjølner	ASMD 02	Foxtrot SIP	Yes
9-Jun-16	43	0923/0924	Mjølner	ASMD 02	Foxtrot SIP	N/A
9-Jun-16	44	0928/0929	Mjølner	ASMD 02	Foxtrot SIP	N/A
9-Jun-16	45	0933/0934	Mjølner	ASMD 02	Foxtrot SIP	N/A

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Appendix 7 Acronyms

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Acronym	**Description**
ASCM	Anti-Ship Cruise Missile
ASM	Anti-Ship Missile
ASMD	Anti-Ship Missile Defense
AWWCG	NATO Above Water Warfare Capabilities Group reporting to NNAG
CAWS	NRL Complex Arbitrary Waveform Synthesizer – Programmable I and J Band Radar Stimulator
ENEWS	NRL Effectiveness of Navy Electronic Warfare Systems Program
EO	Electro Optical
IIR	Imaging Infra-Red
JEWCS	NATO military organization tasked with providing a wide variety of capabilities related to the domain of Electronic Warfare (EW)
MARCSS	Norwegian Navy Operational Logistics Unit
NATO	North Atlantic Treaty Organization
NEMO	Naval Electro-Magnetic Operations
NNAG	NATO Naval Armaments Group
NOL	NEMO Objectives List
NRL	United States Naval Research Laboratory
RF	Radio Frequency
ROSY	Rheinmetall Rapid Obscuring System capable of rapidly obscuring the line of sight, the ROSY 40 mm countermeasure system protects vessels from littoral and riverine threats such as small arms fire, RPGs and missiles
SCI	Systems Concepts and Integration (SCI) Panel is to advance knowledge concerning advanced systems, concepts, integration, engineering techniques and technologies across the spectrum of platforms and operating environments to assure cost-effective mission area capabilities
SCI-224	NATO Scientific Concepts and Integration Group for EO and IR Countermeasures against Anti-Ship Missiles
SCI-293	NATO Scientific Concepts and Integration Group providing continuity of annual NEMO Trials
SIP	Standard Instrumentation Pod
STO	NATO Science and Technology Organization responsible for scientific research, technology development, transition, application and field-testing, experimentation and a range of related scientific activities that include systems engineering, operational research and analysis, synthesis, integration and validation of knowledge derived through the scientific method
TEWD	Tactical Electronic Warfare Division of US Naval Research Laboratory
UAS	Unmanned Aerial System
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