SOP A-352-2: Preliminary Trial Plan

Trial Name: ARC_U_41ai_20220820 OP NANOOK Long-Range Underwater Acoustic Communication Experiment

Planned Trial Dates: August 20-to-23 2022

Document version: 2

Written By:
BLOUIN, STEPHANE 892
Digitally signed by BLOUIN, STEPHANE 892
Date: 2022.05.18 15:22:41 -03'00'

Signature, Date
Stephane Blouin, Trial Lead
stephane.blouin2@forces.gc.ca

Approved by:

Signature, Date
Michel Couillard, DRDC ARC Centre Director
michel.couilard@forces.gc.ca

1. Trial Overview

Under the Defend North America (DNA) Strategic Focus Areas (SFA) Warning Architecture Line of Effort, the ISLANDS (Integrated Surveillance via Layered Arctic Networked Defence Sensors) project proposes to enhance the range of underwater acoustic communications in the Canadian Arctic. The distance at which reliable underwater acoustic communications can be performed will strongly impact the required density of future assets in such an environment.

This experiment will take place thanks to the participation of the HMCS GOOSE BAY (GBY) MCDV-class RCN vessel that will deploy both transmitter and recorders. Key objectives include: (a) collection of acoustic and non-acoustic data, (b) experiment new buoyancy and fairings, and (c) achieve 50-to-100 km communication range by testing different communication schemes at relatively low frequencies. As a reference, a very similar experiment was conducted on board HMCS KINGSTON in 2019 and successful communication ranges of the order of 35 km were achieved (Ref. [1]-to-[3] in Section 22).

2. Classification of Trial

Data produced will be managed iaw Section 12. Overall, recorded data will be UNCLASS.

3. Scientific & Technical Objectives

The main scientific objectives of the trial are:

1) Data collection: Acquire transmit and ambient acoustic data as well as non-acoustic data including node orientation and depth, wind speed, AIS, and ice cover;
2) Engineering: Test new buoyancy elements (distributed along VLA) and fairings meant to reduce vertical dives and strumming due to tidal changes and underwater currents;
3) Analysis: During post-processing, extract each transmission and assess overall performance.

4. High-Level Trial Activities

Note that all the necessary equipment will be loaded on GBY prior to departure from Halifax (N.S.).

The trial will mostly consist of the following activities:

1. August 20 2022 (day #1 on GBY)

   STEPS: 1.a) Pick up personnel at Gascoyne Inlet Camp (GIC); 1.b) Prepare two DUSN recorders; 1.c) Deploy two DUSN recorders, CTD array, and ADCP at positions specified in Section 7; 1.d) Move to first waypoint for transmitting, collect CTD, deploy equipment, transmit, recover, collect CTD, and then move to the next waypoint and repeat. Notional waypoints are provided in Section 7 but ice/weather/personnel conditions will dictate what is reasonably feasible.

   EQUIPMENT: As per Table 1 in Section 5.

   DURATION: Whole day starting upon GBY arrival (10-hr day).

2. August 21 2022 (day #2 on GBY)

   STEPS: Same as above step 1.d

   EQUIPMENT: Same as before

   DURATION: Whole day (10-hr day).

3. August 22 2022 (day #3 on GBY)

   STEPS: Same as above step 1.d

   EQUIPMENT: Same as before

   DURATION: Whole day (10-hr day).

4. August 23 2022 (day #4 on GBY)

   STEPS (reverse of August 20): 4.a) Perform transmissions at last few waypoints, 4.b) recover DUSN recorders and CTD array, 4.c) wash out all equipment with fresh water and pack it (except for hard drives), 4.c) Return personnel and datasets/hard drives to GIC.

   EQUIPMENT: Same as before

   DURATION: Whole day (10-hr day).

5. August 24 and onward

   STEPS: 5.a) post-trial data analysis.

Note that prior to August 20, a DUSN recorder magnetometer must be calibrated at GIC or Resolute Bay.

5. List of Major Equipment

Table 1 lists the main assets.

Table 1 Main assets

#	Asset	Main Components	Photo	Deploy/recover
1	Transmitter	-DACS acoustic projector (photo) -20-foot ISO container (not shown) -winch (not shown)		LARS or crane
2	Recorder (450 lbs/each)	-Two (2) DUSN recorders -NTP server -acoustic-release box -modem box (just in case) -laptop -release hook		Crane/RHIB+crane
3	CTD array	String with 20+ CTD loggers	N/A	Crane/RHIB
4	ADCP	Single-beam ADCP with mooring	N/A	Crane/RHIB
5	CTD sensor	Valport or “football’	N/A	Manual
6	Lazy-suzan	Lazy-suzan	N/A	GIC/Resolute Bay

In the absence of the LARS (Launch and Recovery) frame, the ship crane will be used to deploy/recover DACS. The ship crane will be used to deploy/recover the DUSN recorders, with the help of the RHIB to connect the recovery line to the crane hook. Another DUSN recorder will be sent to GIC or Resolute Bay to complete the magnetic calibration over there. This calibration will also necessitate the lazy-suzan.

6. Trial Schedule and Travel Schedule

As per Section 0, core activities will take place from August 20 to 23 2022. All participants will embark GBY from GIC on August 20 and will disembark at GIC from GBY on August 23.

7. Location

The trial will take place as shown in Figure 1.

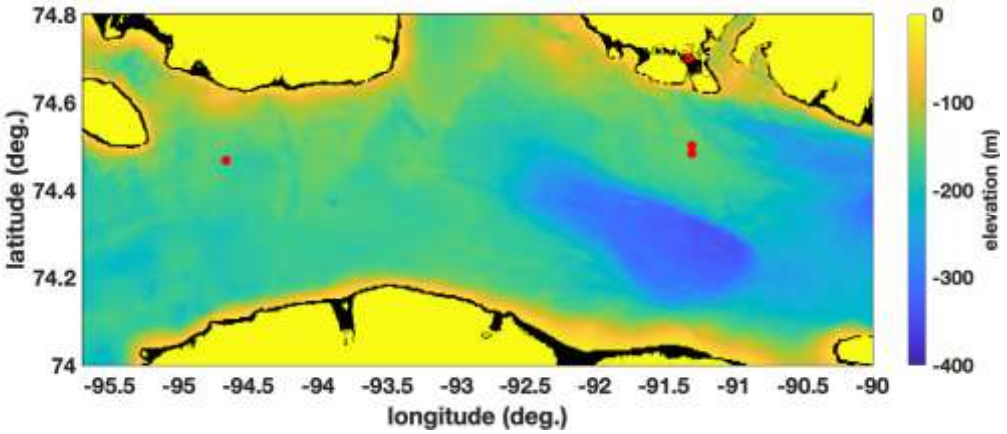

Figure 1 Trial location (Parry Channel). Bathymetry from GEBCO database (ref. [4] Section 21)

In Figure 1, red circles mark GIC, the two nearby DUSN recorders, and the 100-km waypoint for GBY. All coordinates can be found in Table 2. Note that even though the whole experiment will take place in the Parry Channel, the DUSN recorders will be positioned in Lancaster Sound and the GBY will mostly navigate in Barrow Strait.

Table 2 Asset locations

#	Asset	Latitude	Longitude (West)	Depth (m)	Note
1	DUSN #1	74.502° / 74° 30.125’	91.3° / 91° 18’	151	Straight South of GIC
2	DUSN #2	74.484° / 74° 29.0451’	91.3° / 91° 18’	145	2-km separation
3	CTD array	Between DUSN #1 & #2	Between DUSN #1 & #2	~147	---
4	ADCP	Between DUSN #1 & #2	Between DUSN #1 & #2	~147	---
5	GBY 100-km waypoint	74.4676° / 74° 28.0579’	94.6625° / 94° 39.7474’	N/A	---

Note that once the duration of the deploy-and-recover cycle and the ice conditions are known, exact waypoints will be provided. The goal is to accomplish hops in the order of 10 km (or 5.4 nautical miles).

8. Permissions / Clearances – Water, Air and Land Space

Water, air, and land space clearances will be arranged by the MCC Planners for Op NANOOK.

9. Contact List

1. Trial Lead: Stephane Blouin, Mobile: (902) 233-7224, stephane.blouin@forces.gc.ca

2. Trial Technical Team Lead: Gordon Murray, (902) 407-0477, gordon.murray@forces.gc.ca

3. UWW Section head: Warren Connors, (902) 407-0524, Mobile: 902-478-6519, warren.connors@forces.gc.ca

10. Required from Ship

The following will be required from GBY:

- Power to an ISO container
- Bunks and meals for DRDC personnel
- Crane availability and crane operator (if LARS is absent)
- A small deck crew to support deployment and recovery
- Deployment of RHIB for equipment recovery
- Data: Wind speed/direction,
- Log book of entries (and data if transferable) about nearby vessels and ice cover
- If RCN photographer onboard, then some photos and videos would be appreciated
- Marine mammal watch during transmissions

11. Participants

Participants are (This list is subject to change as the trial planning progresses):

Table 3 Proposed participants and their roles

#	Name	Group	Role in Trial	Email (@forces.gc.ca)	Location
1	Stephane Blouin	UWW	DRDC main contact/lead	Stephane.blouin2	GIC/GBY
2	Michael Simms	RED	Technical Lead winch/LARS	Michael.simms2	GIC/GBY
3	Gordon Murray	RED	Technical Lead DACS	Gordon.murray	GIC/GBY
4	Mark Baldin	RED	Technical Support	Mark.baldin	GIC/GBY
5	Alan Polvi	RED	Support DACS	Alan.polvi	GIC/GBY

* = support for preparing DUSN recorders

12. Data Types and Handling

The following data / types of data will be collected during the trial:

Table 4 Data and information required

Data	Security Requirements	Special Data Handling
Non-acoustic DACS data (playlist timing, voltage peak-to-peak, current peak-to-peak, etc.)	None (UNCLASS)	None planned
DUSN : Acoustic and non-acoustic data (orientation, depth, etc.)	None (UNCLASS)	None planned
CTD : both manual unit and array	None (UNCLASS)	None planned
Notes, photos, videos, etc.	None (UNCLASS)	None planned
AIS tracks and ID data	None (UNCLASS)	None planned
ADCP data	None (UNCLASS)	None planned
Ship position data	None (UNCLASS)	None planned
Environmental conditions and data (wind speed, direction, etc.)	None (UNCLASS)	None planned

13. Data Exploitation Plan

The exploitation of the collected data make take various forms. At the time of this write-up, we foresee the following elements of exploitation: (1) internal publications like Reference Document (RD) and Scientific Report (SR), (2) External Literature (EL) like conference proceedings or journal venue.

14. Security

There are no significant security risks for the trial. The trial itself is unclassified and all data collected will be UNCLASS as per Section 12. Physical security of personnel and equipment will be controlled by GBY and DRDC staff.

Note: SOP A-734 Trial Security will provide additional guidance on trial security risk assessment and mitigation (at the time of writing, SOP A-734 had not been developed).

15. Health & Safety

The main health and safety risks associated to this trial relate to getting on/off boats and lifting equipment. All personnel will abide by the DRDC COVID-19 risk mitigation procedures as outlined in the "DRDC Atlantic COVID-19 Measured Risk Response Guideline" and based on the risk posture in effect at the time of the trial.

16. Environmental Impacts

For the EED (Environmental Effects Determination), acoustic projection conditions will be:

- Source level: Not to exceed 170 dB rel. 1 micro-pascal @ 1 m. for a tone centered in signal band
- Source depth: Approximately 50 meters
- Source speed: Drifting, therefore low speed
- Source bandwidth: A 10-to-50 Hz band between 150 Hz and 360 Hz
- Source duty cycle: About 30% (1-hr transmit, 2-hr for commute and deployment/recovery)

Note: SOP A-781 Environmental Impact Assessments (EIA) will provide additional guidance on trial environmental impact assessment and mitigation (at the time of writing, SOP A-781 had not been developed).

17. Overtime

Given the tight GBY vessel schedule for the level of work to be executed, overtime (OT) will be required for performing longer-than-usual workdays. Overtime (OT) for DRDC personnel must be pre-approved iaw DRDC Atlantic SOP A-109 Overtime Approval and Administration.

18. Travel

Besides getting to/from GIC and transiting between GIC and GBY, there is no additional travel associated with this trial for DRDC personnel.

19. Reporting

The following reports will be produced during or after the trial:

1. Logbook
2. Trial Report (post-trial report)

20. Communication Plan

No communication plan with Public Affairs is required for this trial.

21. Glossary of Abbreviations

Table 5 Abbreviations

Abbreviation	Description
AIS	Automatic Identification System
ARC	DRDC Atlantic Research Centre
DRDC	Defence Research and Development Canada
CTD	Conductivity, temperature, and depth
DS	Defence Scientist
DUSN	Distributed Underwater Sensor Network
EED	Environmental Effects Determination
GBY	HMCS Goose Bay MCDV
GIC	Gascoyne Inlet Camp
iaw	In accordance with
LARS	Launch and Recovery A-frame

LRUWACE	Long-Range Underwater Acoustic Communication Experiment
OT	Overtime
RED	Research, Engineering and Design
RHIB	Rigid-hull Inflatable Boat
TVR	Transmit Voltage Response
UWW	Underwater Warfare

22. References

[1] M.Barbeau, S.Blouin, A.Traboulsi, “Frame Design for Adaptability in Long-range Underwater Communication”, Conference proceedings, 13th EAI International Conference on Ad Hoc Networks (ADHOCNETS), December 2021.

[2] M.Barbeau, A.Traboulsi, S.Blouin, “Performance of an Underwater Communication System in a Sea Trial Done in the Canadian Arctic”, Conference proceedings, IEEE International Mediterranean Conference on Communications and Networking, September 2021.

[3] K.Pelekanakis, S.Blouin, D.Green, “Performance Analysis of Underwater Acoustic Communications in Barrow Strait”, IEEE Journal of Oceanic Engineering (JOE), 2021.

[4] https://download.gebco.net/

23. Annex

Figure 2 shows the DACS acoustic projector calibrated TVR (Transmit Voltage Response) curves. Note that the source can be considered omnidirectional.

Figure 2 DACS acoustic projector Transmit Voltage Response (TVR). Left pane shows nearly full band and right pane shows the lower portion of the frequency response.