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HMCS Harry DeWolf dynamic sound range trial plan 2021

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Abstract

HMCS HARRY DEWOLF (HDW) is the first-of-class ship procured under the Arctic Offshore Patrol Vessel (AOPV) project. Originally designed with no underwater noise requirement, there is interest at Defence Research and Development Canada (DRDC) and the Director for Naval Platform Systems (DNPS) in quantifying HDW's acoustic signature for future operational and research needs.

This plan document details a series of acoustic measurements, planned for small availability windows to run on a non-interference basis with HDW's Ship-Helicopter Operational Limits (SHOL) trial, led by other DRDC staff. The trial plan calls for a complete speed range acoustic profile, cavitation inception analysis, single-diesel configuration, fin stabilizer, and bow thruster hydrophone measurements at Ferguson's Cove dynamic sound range.

Significance to defence and security

Developing doctrine or containerized systems for anti-submarine warfare (ASW), other sonar applications, or marine mammal mitigation (MMM) for the Harry DeWolf-class will require formally quantifying the acoustic signature of the Harry DeWolf-class. This trial plan is not a full acoustic ranging, but the data collected during this trial will provide an early assessment of operational profile as well as identifying areas where more work may be required. The data will also support DRDC in advancing acoustic signature management research and development (R&D) for the Canadian Surface Combatant.

Résumé

Le NCSM HARRY DEWOLF (HDW) est le navire de première classe acquis dans le cadre du projet Arctic Offshore Patrol Vessel (AOPV). Conçu à l'origine sans exigence de bruit sous-marin, Recherche et développement pour la défense Canada (RDDC) et le directeur des systèmes de plate-forme navale (DNPS) s'intéressent à quantifier la signature acoustique de HDW pour les futurs besoins opérationnels et de recherche.

Ce document de plan détaille une série de mesures acoustiques, prévues pour de petites fenêtres de disponibilité afin de fonctionner sans interférence avec l'essai des limites opérationnelles des hélicoptères et des navires (SHOL) de HDW, dirigé par d'autres membres du personnel de RDDC. Le plan d'essai prévoit un profil acoustique complet de la plage de vitesse, une analyse du début de la cavitation, une configuration monodiesel, un stabilisateur d'aileron et des mesures d'hydrophones du propulseur d'étrave à la plage sonore dynamique de Ferguson's Cove.

Importance pour la défense et la sécurité

Le développement d'une doctrine ou de systèmes conteneurisés pour la guerre anti-sous-marine (ASW), d'autres applications de sonar ou l'atténuation des mammifères marins (MMM) pour la classe Harry DeWolf nécessitera une quantification formelle de la signature acoustique de la classe Harry DeWolf. Ce plan d'essai n'est pas une mesure acoustique complète, mais les données recueillies au cours de cet essai fourniront une évaluation précoce du profil opérationnel ainsi que l'identification des zones où des travaux supplémentaires pourraient être nécessaires. Les données aideront également RDDC à faire progresser la R et D sur la gestion de la signature acoustique pour le navire de combat de surface canadien.

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Acknowledgements

The authors would like to thank HMCS HARRY DEWOLF and her crew for their flexibility in developing this trial plan.

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1 Introduction

HMCS HARRY DEWOLF (HDW) is the first-of-class ship delivered to the Royal Canadian Navy (RCN) under the Arctic Offshore Patrol Vessel (AOPV) project. In preparation for full operations, Defence Research and Development Canada (DRDC) is coordinating ship-helicopter operational limits (SHOL) trials during May 31–June 18. HDW has expressed support of a DRDC-led acoustic sound ranging during nights in the same time window, with details outlined in this plan. DRDC and the range have agreed to keep all nights during May 31–June 18 open for HDW to range.

The trial has been broken into separate "trial events" prioritized for DRDC objectives. These events are planned to be achievable in four hours of ship range time. Completing all of these trial events will achieve roughly half of a full standard dynamic sound ranging.

Despite the project intent of the Harry DeWolf-class as a non-combatant, there is growing interest in developing containerized anti-submarine warfare and/or surveillance capabilities for use on the class. Ship's own noise is an important consideration when developing such capabilities. Furthermore, there is a government-wide initiative in marine mammal mitigation (MMM), which requires developing an understanding of RCN platform noise profiles under different operational states.

With the above in mind, a full dynamic sound ranging could provide insight into the following for HDW:

1. Sound profile across the ship's speed range,
2. Propeller cavitation inception speed (CIS),
3. Advice on acoustically quiet operational states and speeds,
4. Quantifing bow thruster noise profile,
5. Quantifing acoustic effects attributable to stabilizer fins, and
6. Determining base parameters for future passive sonar capabilities on HDW.

DRDC, HDW, and FMF Cape Scott have agreed to a flexible trial plan which will require regular updating of this document up until June 18, 2021. This plan is written assuming four 4-hour windows will be available.

This trial will proceed on a non-interference basis with the HDW SHOL trial. HDW crew fatigue management is an important consideration because the current HDW requirement is for Special Sea Dutymen (SSD) to close up for the entire time of ranging events.

Due to COVID-19 restrictions, no additional DRDC personnel will embark on HDW beyond those already assigned for the SHOL trial during May 31–June 18.

2 Trial contact information and providing intent to range

Fergusons Cove range staff can accommodate HDW schedule with 24+ hours of notice. DRDC will continue to liaise with both HDW and the range. Jasper Dupuis should be primary point of contact for HDW except for during range activities, when very high frequency (VHF) channel 18A should be tried initially.

Contact information for organizations involved in sound range activities are provided in Table 1.

Table 1: *Trial contact list.*

Name	Organization	Contact
Jasper Dupuis	DRDC	Jasper.dupuis@ecn.forces.gc.ca
Layton Gilroy		Layton.gilroy@ecn.forces.gc.ca
Alexander Ritchie		Embarked on HDW
Dang Phan		Embarked on HDW
Range Operations	FERGUSON COVE RANGE	VHF 18A 902 427 7215
Range Supervisor Gord Bennet		Gordon.bennet3@forces.gc.ca 902 448 1533
OOW	HDW	VHF 18A
XO LCdr Jim Little		Jim.little@forces.gc.ca
OPSO Lt(N) John Sutherland		John.sutherland2@forces.gc.ca
NAVO & VDR POC Lt(N) Richard Pougnet		Richard.Pougnet@forces.gc.ca
IPMS POC MS Robert Bourque		Robert.Bourque2@forces.gc.ca

OOW: Officer of the Watch; XO: Executive Officer; OPSO: Operations Officer; NAVO: Navigation Officer; POC: Point of Contact.

3 Range details

The ranging brief typically provided to Halifax-class frigates has already been shared with HDW staff. Details on contacting and running the range are included here.

The range is reachable during normal work hours and ranging operations via standard 10-digit dialing at 902-427-7215. During ranging operations, VHF radio contact is maintained on channel 18A.

The centre of the range, often referred to as CPA, is at 44° 36.31', 63° 42.39'. Range measurement begins and ends 100 m from CPA. Runs are conducted on bearings of 159°/339°. These headings are colloquially referred to as SOUTH/NORTH, and will be referred to as such in the rest of this plan. A chart showing Ferguson Cove range is shown in Figure 1, reproduced from the standard brief package shared with Halifax-class.

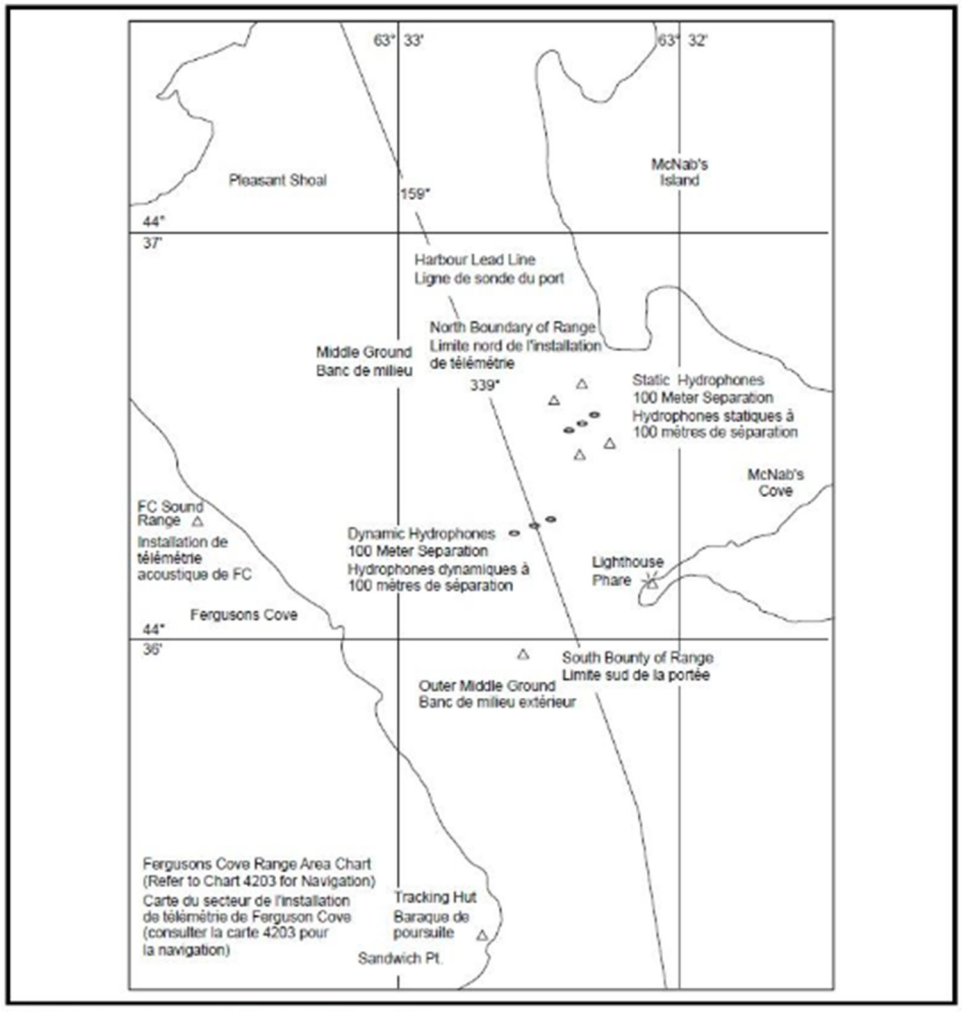

Figure 1: *Chart of the approaches to Halifax Harbour showing Ferguson Cove sound ranges.*

A range run begins with the call of “COMEX” and ends at “FINEX.” The range will announce this using global positioning system (GPS) data available from gear installed by DRDC. As a target, the delta from the harbour lead line should be no more than 10 m. The range will be able to provide near-instant feedback on course deviation. HDW should be on course with desired configuration well before COMEX and FINEX to reduce noise unrelated to the target measurement (largely due to rudder movements).

4 Data collection

The data to be collected are hydrophone data, GPS data, configuration data, Integrated Platform Management System (IPMS) data, voyage data recorder (VDR) data, and accelerometer data.

Hydrophone data will be collected by the dynamic sound range, with a timestamp synchronized to GPS time.

GPS data, tracking HDW through the range, will be acquired by range-owned but DRDC-deployed GPS beacons on-board HDW. One of these beacons will be on midline at the stern, and one 5.8 m to starboard outside of FLYCO. A signal repeater station will be installed on the starboard railing outside FLYCO. All installations are temporary and will be removed at ship's requirement or at end of trial. In the event GPS signal fails, Automatic Identifications System (AIS) data can be used by the range.

HDW AIS broadcast is requested to be activated while conducting sound ranging as a backup to GPS tracking failure.

HDW configuration data will refer only to changes in main diesel generator configuration. Diesel configuration is a key parameter in sound ranging and this must be coordinated between DRDC, range staff, and HDW OOW and HDW engineer on duty during ranging. DRDC will record this information from the range facility.

HDW IPMS data at 10 s frequency will be collected by DRDC embarked staff each day after a ranging event. IPMS data is ZULU timestamped. IPMS data includes all machinery on/off status as well as on/off status for each main diesel generator (DG), in addition to power information. DRDC embarked staff rounds will include verifying IPMS logging configuration before each ranging event. The identified HDW POC for this is MS Bourque.

HDW VDR data will be collected by DRDC embarked staff each day after a ranging event. VDR data is ZULU timestamped. VDR data includes shaft RPM data for later analysis. DRDC embarked staff rounds will include verifying VDR logging configuration before each ranging event. The identified HDW POC for this is Lt(N) Pougnet.

Accelerometer data will be collected solely by DRDC embarked staff. Accelerometer data will be GPS timestamped using an ORCA timeserver. Hardware will be installed and secured for sea in the port motor room. DRDC staff embarked on HDW have HV awareness training and may enter this room. DRDC embarked staff rounds will include starting and ending data collection for each ranging event.

5 Security

Except for hydrophone data, which is classified SECRET, all data collected in the course of this trial is UNCLASSIFIED. Hydrophone and GPS data will be given to DRDC on CD/DVD storage discs and stored appropriately at DRDC offices. The range will also keep copies of hydrophone and GPS data and stored according to their own SECRET storage procedures.

6 HDW configuration management

It is requested HDW turn off her depth sounder for ranging activities as the transmissions interfere with the acoustic measurements.

Notwithstanding potential bow thruster and fin stabilizer configurations, there are seven core machinery configurations. HDW should feel free to modify this table (Table 2), subject to making sure DRDC and range staff are aware of any changes. A diagram mapping the DG labels to their physical plant is provided (see Figure 2).

Bow thruster and fin stabilizer configurations will be addressed in their respective trial section.

Table 2: *Diesel generator configuration states.*

CONFIGURATION	MDG1	MDG2	MDG3	MDG4
ALPHA	X			
BRAVO		X		
CHARLIE			X	
DELTA				X
ECHO	X	X		
FOXTROT	X	X	X	
GOLF	X	X	X	X

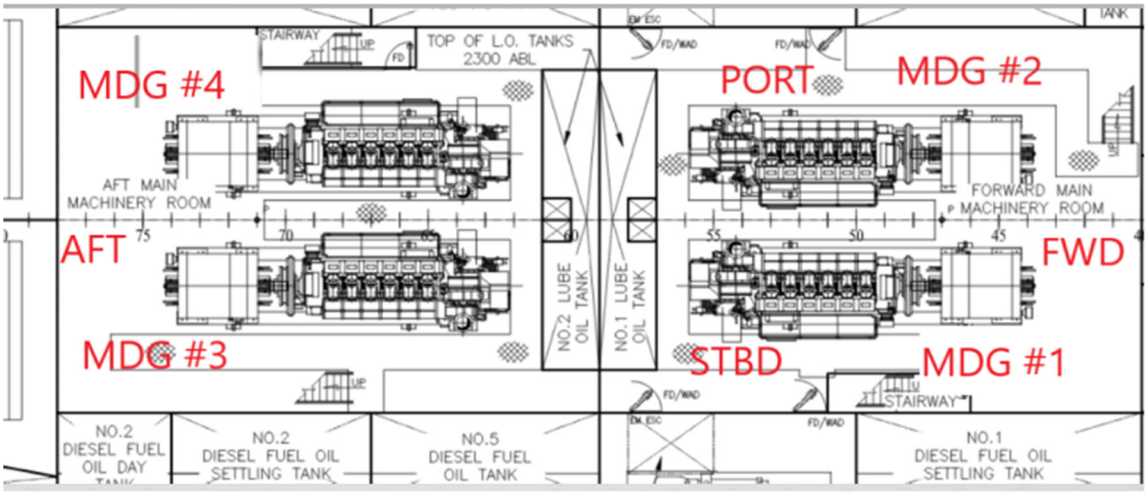

Figure 2: *HMCS Harry DeWolf main diesel generator layout and labelling as identified in IPMS data.*

7 Run naming convention

All runs will follow the following string designations, where “Z” indicates an integer 0–9 and S represents an alphabet character. This was selected for similarity to other trial run IDs DRDC has used in the past while allowing for future change of use.

ZZZ—ab.c decimal nominal knots.

SS—Range location, HF for Halifax.

ZZ—Repeat runs if required or designated.

S—Machinery configuration (unused).

S—Diesel configuratoin.

S—Heading.

Taking as example run “050HF00AAN,” this run was at 5.0 knots nominal, in Halifax, in machinery configuration A, in diesel configuration A, sailing north. The run was the first attempt as denoted by “00.”

To demonstrate the use of the repeat run integers, “03” will refer to the fourth repeated run due to experimental error, while “70” will refer to the 8th repeat run called for by plan.

8 Trial event 1: overall acoustic profile

The objective of this trial is to develop a broad understanding of HDW's acoustic signature at various speeds. Trial event 2, focussing on cavitation inception examination, will be governed in part by results from Trial event 1.

At this time, speed is assigned by knots. However, it may be more convenient, practical, or otherwise to do so by target motor RPM or shaft RPM. These values should be recorded, over and above the recording happening in VDR. The planned runs are shown in Table 3.

Table 3: *Planned runs for trial night 1.*

RUN ID	HEADING	CONFIGURATION	SPEED (kts)	SPEED (MOTOR OR SHAFT RPM)
050HF00AAN	NORTH	ALPHA	5	
050HF00AAS	SOUTH	ALPHA	5	
070HF00AAN	NORTH	ALPHA	7	
070HF00AAS	SOUTH	ALPHA	7	
090HF00AEN	NORTH	ECHO	9	
090HF00AES	SOUTH	ECHO	9	
110HF00AFN	NORTH	FOXTROT	11	
110HF00AFS	SOUTH	FOXTROT	11	
170HF00AGN	NORTH	GOLF	17	
170HF00AGS	SOUTH	GOLF	17	

9 Trial event 2: cavitation inception study

The objective of this trial is to develop a broad understanding of HDW's cavitation inception profile. This trial event takes as input Trial event 1: overall acoustic profile. In ten runs, it is desired to attempt to move through sub- and above-cavitation speeds in smaller speed increments. As such, it's expected that values in this trial event might be modified until trial event 1 is completed. It is possible the trial will target increments of 0.25 knots rather than 0.5 knots.

This trial should be completed in one single diesel configuration, determined by the highest target speed.

At this time, speed is assigned by knots. However, it may be more convenient, practical, or otherwise to do so by target motor RPM or shaft RPM. These values should be recorded, over and above the recording happening in VDR. The planned runs are shown in Table 4.

Table 4: *Planned runs for trial night 2.*

RUN ID	HEADING	CONFIGURATION	SPEED (kts)	SPEED (MOTOR OR SHAFT RPM)
065HF00AAN	NORTH	ECHO	6.5	
065HF00AAS	SOUTH	ECHO	6.5	
070HF00AAS	NORTH	ECHO	7	
070HF00AAS	SOUTH	ECHO	7	
075HF00AAS	NORTH	ECHO	7.5	
075HF00AAS	SOUTH	ECHO	7.5	
080HF00AAS	NORTH	ECHO	8	
080HF00AAS	SOUTH	ECHO	8	
085HF00AAS	NORTH	ECHO	8.5	
085HF00AAS	SOUTH	ECHO	8.5	

10 Trial event 3: sub-cavitation configuration changes

The objective of this trial is to quantify the difference in HDW acoustic signature, if any, due to changes in diesel configuration.

At this time, speed is assigned by knots. However, it may be more convenient, practical, or otherwise to do so by target motor RPM or shaft RPM. These values should be recorded, over and above the recording happening in VDR. The planned runs are shown in Table 5.

Table 5: *Planned runs for trial night 3.*

RUN ID	HEADING	CONFIGURATION	SPEED (kts)	SPEED (MOTOR OR SHAFT RPM)
050HF00ABN	NORTH	BRAVO	5	
050HF00ABS	SOUTH	BRAVO	5	
050HF00ACN	NORTH	CHARLIE	5	
050HF00ACS	SOUTH	CHARLIE	5	
050HF00ADN	NORTH	DELTA	5	
050HF00ADS	SOUTH	DELTA	5	

If time permits, a pair of runs under configuration ALPHA may be requested, depending on the acceptability of the result from Trial event 1.

11 Trial event 4: bow thruster and fin stabilizers

DRDC and range operators do not have experience ranging ships with fin stabilizers or bow thrusters. This trial event is therefore highly dependent on feedback from HDW on what's possible, safe, and realistic. A proposed run table is below.

Runs with "HFF" in them refer to runs where the stabilizer fins should be deployed. These are straight runs like those during Trial event 1.

Runs with "HFB" in them refer to runs where the bow thruster should be used. 0CCHFB0AFN is a clockwise turn on the range. CCWHFB0AFS is a counter-clockwise turn on the range. An ideal experiment would be stopping HDW at CPA on the range and executing a 360° rotation, but the novelty of a bow thruster and its impact on ranging and ship operations on the range must be restated.

At this time, speed is assigned by knots. However, it may be more convenient, practical, or otherwise to do so by target motor RPM or shaft RPM. These values should be recorded, over and above the recording happening in VDR. The planned runs are shown in Table 6.

Table 6: *Planned runs for trial night 4.*

RUN ID	HEADING	CONFIGURATION	SPEED (kts)	SPEED (MOTOR OR SHAFT RPM)
050HFF0AAN	NORTH	ALPHA	5	
070HFF0AAS	SOUTH	ALPHA	7	
090HFF0AEN	NORTH	ECHO	9	
110HFF0AFS	SOUTH	FOXTROT	11	
170HFF0AGN	NORTH	GOLF	17	
0CWHFB0AFS	SOUTH	FOXTROT	-	
CCWHFB0AFS	SOUTH	FOXTROT	-	

12 Conclusion

A flexible trial plan has been prepared and may be executed in separate ranging events with 24 or more hours notice from HDW to arrange range staffing. Outcomes of the trial will depend on HDW availability due to crew fatigue and weather conditions.

List of symbols/abbreviations/acronyms/initialisms

AIS	Automatic Identifications System
AOPV	Arctic Offshore Patrol Vessel
ASW	anti-submarine warfare
CIS	cavitation inception speed
CPA	closest point of approach
DND	Department of National Defence
DNPS	Director for Naval Platform Systems
DRDC	Defence Research and Development Canada
GPS	global positioning system
HDW	HMCS Harry DeWolf
HMCS	Her Majesty's Canadian Ship
IPMS	Integrated Platform Management System
MMM	marine mammal mitigation
NAVO	Navigation Officer
OOW	Officer of the Watch
OPSO	Operations Officer
POC	Point of Contact
RCN	Royal Canadian Navy
SHOL	ship-helicopter operational limits
SSD	Special Sea Dutymen
VDR	voyage data recorder
VHF	very high frequency

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