National Defence | Défense nationale

A-CR-CCP-625/PG-001

CANADIAN CADET ORGANIZATIONS

NAVIGATION MANUAL

(ENGLISH)

(Cette publication est disponible en français sous le numéro A-CR-CCP-625/PG-002)

Issued on Authority of the Chief of the Defence Staff

Canada

National Defence | Défense nationale

A-CR-CCP-625/PG-001

CANADIAN CADET ORGANIZATIONS

NAVIGATION MANUAL

(ENGLISH)

Issued on Authority of the Chief of the Defence Staff

OPI: D COS Trg Ops/Plans/Dev Natl CJCR Sp Gp **2017-04-01**

Canada

LIST OF EFFECTIVE PAGES

Insert latest changed pages and dispose of superseded pages in accordance with applicable orders.

NOTE

The portion of the text affected by the latest change is indicated by a black vertical line in the margin of the page. Changes to illustrations are indicated by miniature pointing hands or black vertical lines.

Dates of issue for original and changed pages are:

Original	0	2017-04-01	Ch	3	
Ch	1		Ch	4	
Ch	2		Ch	5	

Zero in Change No. column indicates an original page.

Page No.	Change No.	Page No.	Change No.
Cover	0	Page	0
Title	0	A	0

Contact Officer: J7 - Natl CJCR Sp Gp

FOREWORD AND PREFACE

1. **Issuing Authority.** This document was developed under the authority of the Commander, National Cadet and Junior Canadian Rangers Support Group (Comd Natl CJCR Sp Gp) in accordance with Cadet Administrative and Training Order (CATO) 11-03, *Cadet Program Mandate*, CATO 11-04, *Cadet Program Outline*, and CATO 31-03, *Sea Cadet Program Outline*, and is issued on the authority of the Chief of Defence Staff.

2. A-CR-050-803/PC-001, *Qualification Standard, Developmental Period 1 – Cadet Instructors Cadre, Sea Environmental Training* and A-CR-050-803/PH-001, *Training Plan, DP1 – Cadet Instructors Cadre, Sea Environmental Training Course* are issued on the authority of the Comd Natl CJCR Sp Gp.

3. **Development.** Development of this document was in accordance with the performance oriented concept of training outlined in the Canadian Forces Individual Training and Education System A-P9-050 Series, *Manual of Individual Training and Education*, with modifications to meet the needs of the Canadian Cadet Organizations (CCO).

4. **Purpose of the Document.** This document is to be used by Royal Canadian Sea Cadet Corps, Cadet Training Centres (CTCs) and Cadet Instructor Cadre (CIC) Training to conduct navigation training.

5. The Lesson Specifications (LSs) and Instructional Guides (IGs) in Chapter 4 are to be used by Technical Establishments (TEs) in conjunction with other resources to conduct navigation training.

6. This publication is effective upon receipt.

7. **Suggested Changes.** Suggested changes to this document shall be forwarded to cadetraining@forces.gc.ca.

TABLE OF CONTENTS

SECTION 2 INSTRUCTIONAL GUIDES

CHAPTER 1

GENERAL

AIM

1. The aim of the training resulting from this document is to develop navigation skills.

USE OF THE NAVIGATION MANUAL

2. Navigation training shall be conducted using this document as a support document to:

a. A-CR-CCP-616/PG-001, *Royal Canadian Sea Cadets, Ship's Boat Operator Qualification Standard and Plan*,

b. A-CR-CCP-616/PF-001, *Royal Canadian Sea Cadets, Ship's Boat Operator Instructional Guides*,

c. A-CR-CCP-617/PG-001, *Royal Canadian Sea Cadets, Boatswain Mate Qualification Standard and Plan*,

d. A-CR-CCP-617/PF-001, *Royal Canadian Sea Cadets, Boatswain Mate Instructional Guides*,

e. A-CR-CCP-604/PG-001, *Royal Canadian Sea Cadets, Phase Four Qualification Standard and Plan,*

f. A-CR-CCP-604/PF-001, *Royal Canadian Sea Cadets, Phase Four Instructional Guides*,

g. A-CR-CCP-605/PG-001, *Royal Canadian Sea Cadets, Phase Five Qualification Standard and Plan,*

h. A-CR-CCP-605/PF-001, *Royal Canadian Sea Cadets, Phase Five Instructional Guides,*

i. A-CR-CCP-605/PW-001, *Royal Canadian Sea Cadets, Phase Five Logbook*,

j. A-CR-050-803/PH-001, *Training Plan – Developmental Period 1 – Cadet Instructors Cadre – Sea Environmental Training*, and

k. A-CR-050-803/PC-001, *Qualification Standard – Developmental Period 1 – Cadet Instructors Cadre – Sea Environmental Training*.

CHAPTER 2

TRAINING MANAGEMENT DETAILS

1. The Designated Training Authority (DTA) for navigation training is Commander, National Cadet and Junior Canadian Rangers Support Group (Comd Natl CJCR Sp Gp). The conduct of training is the responsibility of the Regional Cadet Support Units (RCSUs) through authorized Training Establishments (TEs), to include,

a. Royal Canadian Sea Cadet Corps (RCSCC);
b. Cadet Training Centres (CTC); and
c. Regional Cadet Instructor Schools (RCIS).

TRAINING DELIVERY

2. Navigation training is conducted for cadets during Phases Four and Five, Ship's Boat Operator (SBO) and Boatswain Mate (BM) CTC courses and for Cadet Instructors Cadre (CIC) Officers during the Sea Environmental Training Course (SETC).

3. **Period Allocation.** Periods are 30 minutes in duration for Phases Four and Five and 40 minutes in duration for CTC courses and the SETC.

4. The lessons are to be conducted as follows:

a. SBO – EOs X51.01 to X51.05,
b. Phase Four – EO X51.02 and the following teaching points (TP) from X51.04:

(1) TP 1 – 60 min,
(2) TP 2, 3, 4 and 5 (30 min each) – 120 min, and
(3) TP 6 – 60 min,

c. BM – EOs X51.06 to X51.09,
d. Phase Five – EO X51.10, and
e. SETC – EOs X51.01 to X51.03, and the following TPs from X51.04:

(1) TP 1 – via Distance Learning (DL),
(2) TP 2, 3 – 60 min,
(3) TP 4 – 25 min,
(4) TP 5 – 25 min, and
(5) TP 6 – 40 min.

RESOURCE REQUIREMENTS

5. The following navigational instruments are required at the quantity indicated:

   a. pencil (one per student),
   b. eraser (one per student),
   c. parallel ruler (one per student),
   d. divider (one per student),
   e. drafting compass (one per student), and
   f. speed-time-distance calculator (one per two students).

RELATED DOCUMENTS

6. This document is to be used in conjunction with:

   a. Cadet Administration and Training Orders (CATOs),

   b. Natl CJCR Sp Gp Orders,

   c. A-CR-CCP-030/PT-001, *Water Safety Orders*,

   d. A-CR-CCP-616/PG-001, *Royal Canadian Sea Cadets, Ship's Boat Operator Qualification Standard and Plan*,

   e. A-CR-CCP-616/PF-001, *Royal Canadian Sea Cadets, Ship's Boat Operator Instructional Guides*,

   f. A-CR-CCP-617/PG-001, *Royal Canadian Sea Cadets, Boatswain Mate Qualification Standard and Plan*,

   g. A-CR-CCP-617/PF-001, *Royal Canadian Sea Cadets, Boatswain Mate Instructional Guides*,

   h. A-CR-CCP-604/PG-001, *Royal Canadian Sea Cadets, Phase Four Qualification Standard and Plan,*

   i. A-CR-CCP-604/PF-001, *Royal Canadian Sea Cadets, Phase Four Instructional Guides*,

   j. A-CR-CCP-605/PG-001, *Royal Canadian Sea Cadets, Phase Five Qualification Standard and Plan,*

   k. A-CR-CCP-605/PF-001, *Royal Canadian Sea Cadets, Phase Five Instructional Guides,*

l. A-CR-CCP-605/PW-001, *Royal Canadian Sea Cadets, Phase Five Logbook*,

m. A-CR-050-803/PH-001, *Training Plan – Developmental Period 1 – Cadet Instructors Cadre – Sea Environmental Training*, and

n. A-CR-050-803/PC-001, *Qualification Standard – Developmental Period 1 – Cadet Instructors Cadre – Sea Environmental Training*.

CHAPTER 3

NAVIGATION EVALUATION

PURPOSE

1. The purpose of this chapter is to outline the specific evaluation requirements for achievement of PO 423 in Phase 4, PO 523 in Phase 5, PO S351 in Ship's Boat Operator, PO S451 in Boatswain Mate and PO 107 in the Sea Environmental Training Course (SETC).

ASSESSMENT OF LEARNING PLAN

2. The Assessment of Learning Plan located at Annex A, provides an overall strategy for using assessment activities to determine if the student meets the navigation requirements to complete the requisite PO.

ASSESSMENT INSTRUMENTS

3. Specific assessment instruments have been designed to support each assessment activity within the assessment of learning plan. These are meant to standardize assessment activities and evaluation for all students. Assessment instruments are located in Annexes B, C and D.

RECOGNITION OF ENHANCED PROFICIENCY ACHIEVEMENT

4. Certain POs within the Assessment of Learning Plan allow for recognition of an enhanced proficiency level of achievement. The assessment instructions for the applicable PCs outline how proficiency levels are achieved and recorded on the Qualification Record. This information highlights the student's strength(s) within the achievement of the qualification. The following definitions differentiate baseline proficiency and enhanced proficiency levels of achievement:

a. **Baseline Proficiency.** A student achieves baseline proficiency by demonstrating the performance standard outlined in the applicable PO; and

b. **Enhanced Proficiency.** A student achieves enhanced proficiency by exceeding the performance standard outlined in the applicable PO.

STUDENTS NOT MEETING THE STANDARD

5. A student who does not meet the qualification standard for the PO shall be given a reasonable opportunity to achieve the standard. There is no limit to the number of

additional opportunities that may be afforded to the student, provided it is within the time and resource limitations of the training centre and is not a hindrance to the progression of others, or the course / phase in general.

6. If, by the end of the course, a student has yet to successfully complete the PO, they will be assessed as “Incomplete”.

ANNEX A

ASSESSMENT OF LEARNING PLAN – NAVIGATION

EC / PC	Scope	Purpose	Target	Method	How	When	Resources	Limitations
PO S351 – Ships Boat Operator								
S351 PC	PO S351	The purpose of this PC is to assess the cadet's ability to locate a position on a chart.	Knowledge and Skills	Selected Response and Short Answer	Cadets are required to complete a fixing paper.	Upon completion of lessons related to EO S351.	Chapter 3, Annex B.	Limited Assistance.
PO M423 – Phase 4								
M423 PC	PO M423	The purpose of this PC is to assess the cadet's ability to locate a position on a chart.	Knowledge and Skills	Selected Response and Short Answer	Cadets are required to complete a fixing paper.	Upon completion of lessons related to PO 423.	Chapter 3, Annex C.	Nil.
PO S451 – Boatswain Mate								
S451 PC	PO S451	The purpose of this PC is to assess the cadet's ability to execute a passage.	Knowledge and Skills	Performance Assessment	Cadets are required to complete a fixing paper to a standard of 60%.	Upon completion of lessons related to PO S451 and PO S455.	Chapter 3, Annex D.	Limited assistance.
PO 523 – Phase 5								
Nil.								
PO 107 – Sea Environmental Training Course								
Nil.								

ANNEX B

S351 PC

ASSESSMENT INSTRUCTIONS

GENERAL

The purpose of this PC is to assess the cadet's ability to independently execute a passage by completing a fixing paper.

PRE-ASSESSMENT INSTRUCTIONS

Gather the required resources:

- Navigation instruments,
- *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*,
- *Symbols Abbreviations Terms (Chart 1),*
- Appendix 1 – S351 PC Worksheet,
- Appendix 2 – S351 PC Assessment Checklist,
- Appendix 3 – S351 PC Worksheet – Answer Key,
- Appendix 4 – S351 PC Worksheet – Pictorial Answer Key,
- Appendix 5 – S351 PC Worksheet – Rewrite,
- Appendix 6 – S351 PC Worksheet – Rewrite Answer Key, and
- Appendix 7 – S351 PC Worksheet – Rewrite Pictorial Answer Key.

CONDUCT OF ASSESSMENT

1. Distribute navigation instruments, Chart 3441, Chart 1, and PC to each cadet. Cadets will have 110 minutes to complete the assessment.

2. Evaluate the cadet’s completed fixing paper using the assessment rubric and Answer Key.

3. Fixing paper will be scored out of a total of 80 points. Marking criteria for the fixing paper will be:

    a. Section A. Two points for each correct response (except Question 4, which is 0.5 points each), for a total of ten points;

    b. Section B. Two points for each correct response (plus or minus 0.5 NM), for a total of ten points;

c. Section C. Two points for each correct response, for a total of ten points;

d. Section D. Possible four points per fix (one point each for accuracy, correct symbol, proper label, and time) for a total of 40 points;

e. Section E. Two points for correct response plus or minus 0.5 knot; and

f. Section F. Five points for the correct response.

4. Conduct a debriefing to discuss the overall performance results and have the cadet reflect on and assess their own performance.

5. Provide the cadet with a copy of the completed assessment checklist.

POST-ASSESSMENT INSTRUCTIONS

1. Place a copy of the Assessment Checklist in the cadet's training file.

2. Record the overall result on the Ship’s Boat Operator Qualification Record indicating one of:

   a. **Incomplete.** The cadet has not achieved the performance standard by completing the PC with a mark of 60 percent or more in three attempts or did not attempt the PC;

   b. **Completed With Difficulty.** The cadet has achieved the performance standard by completing the PC with a mark of 60 percent or more but required more than one attempt;

   c. **Completed Without Difficulty.** The cadet has achieved the performance standard by completing the PC with a mark of 60 percent but less than 89 percent on the first attempt; or

   d. **Exceeded Standard.** The cadet has achieved the performance standard by completing the PC with a mark of 90 percent or more on the first attempt.

S351 PC WORKSHEET

CHART 3441 FIXING PAPER

Cadet's Name: _____ Division: _____

Date: _____

Section A—Find the following information on the chart:

1. What is the scale of this chart?_____

2. How are depths measured in this chart? _____

3. What date was the Traffic Separation Scheme revised from Victoria to Vancouver?

   _____

4. Identify the chart numbers for:

   a. Eastern end of President Channel: _____

   b. Bedwell Harbour: _____

   c. Fulford Harbour:_____

   d. Areas North of Burgoyne Bay: _____

5. What is the date this chart has been corrected to? _____

Section B—Measure the distance:

Number	From	To	Distance
1.	D'Arcy I. light	Starboard Hand Buoy in Sidney Channel	
2.	Dock I. light	Canoe Rk. light	
3.	Gowlland Pt. light	Turn Pt. light	
4.	Greig I. Day mark	Charmer Pt.	
5.	Senanus I. light	Coal Pt.	

Section C—Find the symbols at the specified latitude and longitude:

Number	Latitude	Longitude	Symbol
1.	48° 37.07' N	123° 30.75' W	
2.	48° 41.34' N	123° 14.25' W	
3.	48° 37.56' N	123° 16.00' W	
4.	48° 45.9' N	123° 18.31' W	
5.	48° 32.60' N	123° 09.89' W	

Section D—Plot the following fixes:

Time	Fix	
0730	48° 32.84' N 123° 11.75' W	
0800	48° 37.70' N 123° 13.41' W	
0830	Green Pt. Lt Limestone Pt. RHE Davison Hd.	083° 112° 236°
0900	48° 39.45’ N 123° 07.12' W	
0930	RHE Blunden I. Taylor Pt. RHE Java I.	305° 344° 005°
1000	48° 42.65' N 123° 12.50' W	
1030	Tom Pt. light Turn Pt. light Pt. Fairfax light	150° 075° 344°
1100	48° 37.70’ N 123° 16.80’ W	
1130	48° 34.94’ N 123° 12.48' W	
1200	48° 35.50' N 123° 18.23' W	

Section E—Complete the Speed-Time-Distance Table:

Speed	Time	Distance
	2 hours	26 NM
15 knots		45 NM
2 knots	12 hours	
	30 minutes	10 NM
5 knots		20 NM

Section F—Bonus

At what average speed did the vessel travel between the fixes from 0730 to 1200?

S351 PC ASSESSMENT CHECKLIST

Cadet's Name: _____ Division: _____

Assessor's Comments:

Overall Performance Assessment:

Fixing Paper Mark:_____%

	PO Assessment							
Check One	**Incomplete**		**Completed With Difficulty**		**Completed Without Difficulty**		**Exceeded Standard**	
Overall Performance	The cadet has not achieved the performance standard by completing the PC with a mark of 60 percent or more in three attempts or did not attempt the PC.		The cadet has achieved the performance standard by completing the PC with a mark of 60 percent or more but required more than one attempt.		The cadet has achieved the performance standard by completing the PC with a mark of 60–89 percent on the first attempt.		The cadet has achieved the performance standard by completing the PC with a mark of 90 percent or more on the first attempt.	

Assessor's Name: _____	**Position:**_____
Assessor's Signature:_____	**Date:** _____

S351 PC WORKSHEET – ANSWER KEY

CHART 3441 FIXING PAPER

Cadet's Name: _____ Division: _____

Date: _____

Section A—Find the following information on the chart:

1. What is the scale of this chart? **1: 40 000**

2. How are depths measured in this chart? **In meters**

3. What date was the Traffic Separation Scheme revised from Victoria to Vancouver? **July 1, 2005**

4. Identify the chart numbers for:

   a. Eastern end of President Channel: **Chart 18421 USA**

   b. Bedwell Harbour: **Chart 3477**

   c. Fulford Harbour: **Chart 3478**

   d. Areas North of Burgoyne Bay: **Chart 3477**

5. What is the Notices to Mariners date this chart has been corrected to? **October 10, 2008 (May vary)**

Section B—Measure the distance:

Number	From	To	Distance
1.	D'Arcy I. light	Starboard Hand Buoy in Sidney Channel	**4.27 NM**
2.	Dock I. light	Canoe Rk. Light	**3.75 NM**
3.	Gowlland Pt. light	Turn Pt. light	**3.55 NM**
4.	Greig I. Day mark	Charmer Pt.	**1.01 NM**
5.	Senanus I. light	Coal Pt.	**5.01 NM**

Section C—Find the symbols at the specified latitude and longitude:

Number	Latitude	Longitude	Symbol
1.	48° 37.07' N	123° 30.75' W	**Daymark on Tozier Rk.**
2.	48° 41.34' N	123° 14.25' W	**Turn Pt. Light**
3.	48° 37.56' N	123° 16.00' W	**East Cardinal Buoy by Mandarte I.**
4.	48° 45.9' N	123° 18.31' W	**Beddis Rk.**
5.	48° 32.60' N	123° 09.89' W	**Low I.**

Section D—Plot the following fixes: **Refer to the pictorial guide at Appendix 4.**

Time	Fix		Symbol for Accuracy Check
0730	48° 32.84' N 123° 11.75' W		**Direction of traffic flow arrow**
0800	48° 37.70' N 123° 13.41' W		**Submarine cable**
0830	Green Pt. Lt Limestone Pt. RHE Davison Hd.	083° 112° 236°	**'C' in Channel**
0900	48° 39.45' N 123° 07.12' W		**100m depth contour**
0930	RHE Blunden I. Taylor Pt. RHE Java I.	305° 344° 005°	**15 degree mark of the compass rose**
1000	48° 42.65' N 123° 12.50' W		**Canada / USA border**
1030	Tom Pt. light Turn Pt. light Pt. Fairfax light	150° 075° 344°	**Limit of special operating area**
1100	48° 37.70' N 123° 16.80' W		**20m contour**
1130	48° 34.94' N 123° 12.48' W		**29m depth patch near southern limit of chart**
1200	48° 35.50' N 123° 18.23' W		**Drying rock near Sidney I**

Section E—Complete the Speed-Time-Distance Table:

Speed	Time	Distance
13 knots	2 hours	26 NM
15 knots	**3 hours**	45 NM
2 knots	12 hours	**24 NM**
20 knots	30 minutes	10 NM
5 knots	**4 hours**	20 NM

Section F—Bonus

Lay tracks between each of the fixes from 0730 to 1200, inserting additional waypoints as required to avoid running aground. At what average speed did the vessel travel for this passage? **36 NM travelled in 4.5 hours - 8 knots**

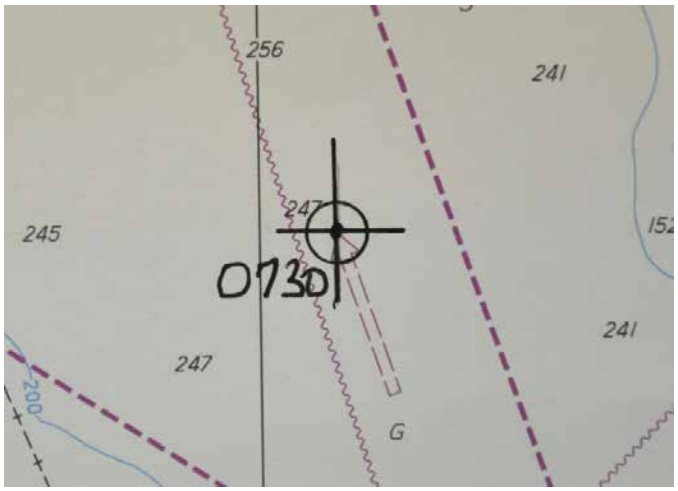
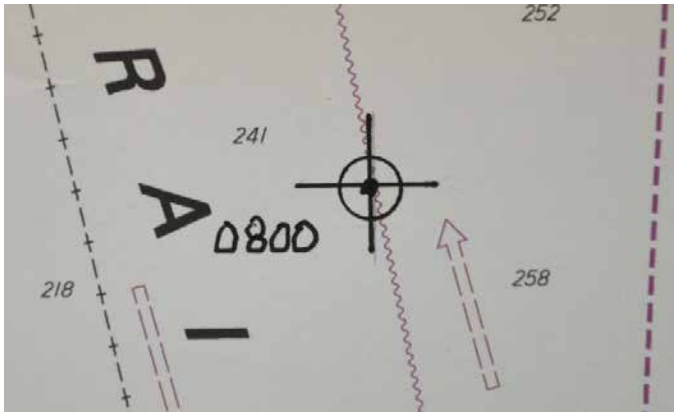
S351 PC WORKSHEET

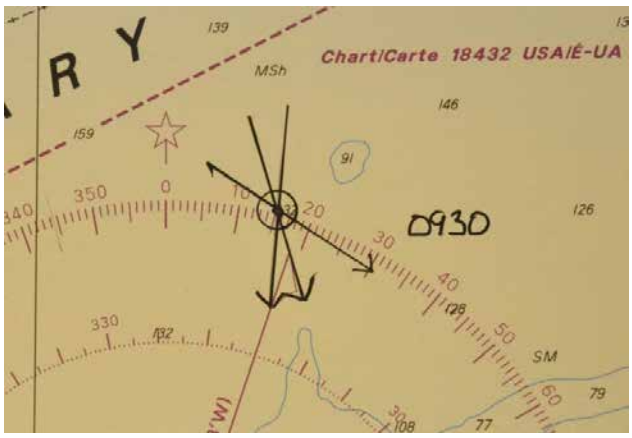
PICTORAL ANSWER KEY
(Based on 3441 Corrected 21 February 2014)

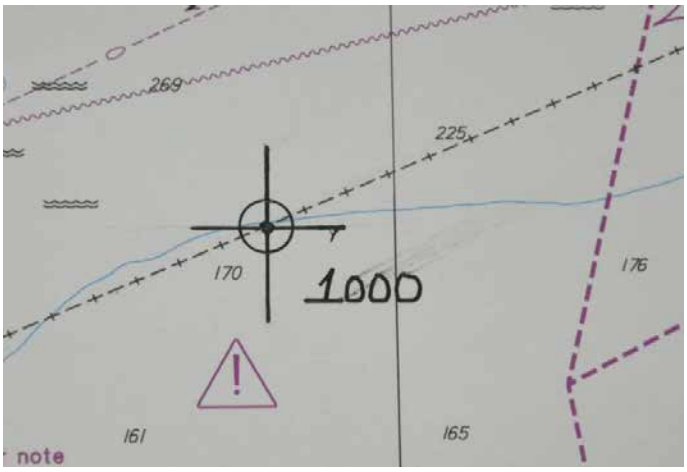
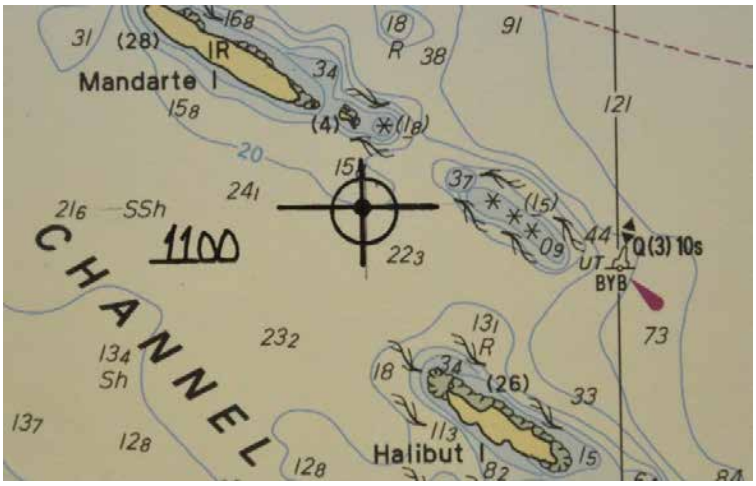
Some pictures will have portions of the required elements removed for clarity in determining accuracy or are provided for information purposes only.

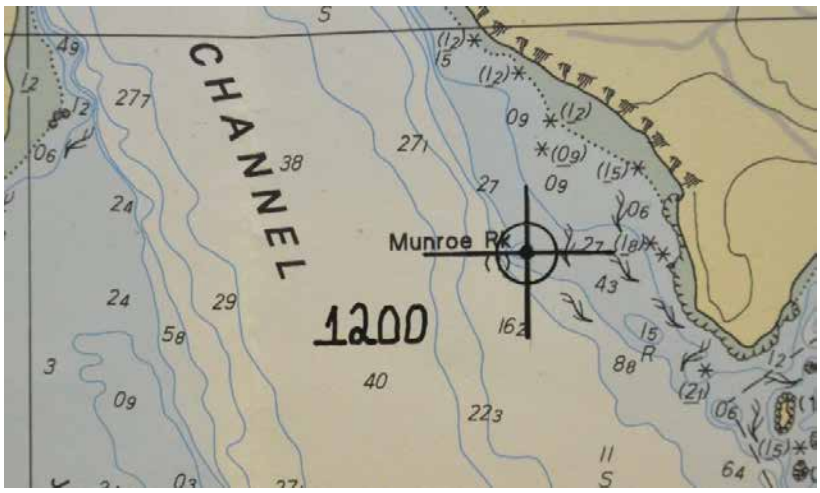
Accuracy of answer(s) will vary depending on the version of chart used. All answers should be verified against the chart used for the Performance Check.

Section D—Plot the following fixes:

TIME	FIX	ANSWER
0730	48° 32.84' N 123° 11.75' W	
0800	48° 37.70' N 123° 13.41' W	

0830	Green Pt. Lt 083° Limestone Pt. 112° RHE Davison Hd. 236°	
0900	48° 39.45' N 123° 07.12' W	
0930	RHE Blunden I. 305° Taylor Pt. 344° RHE Java I. 005°	

1000	48° 42.65' N 123° 12.50' W	
1030	Tom Pt. light 150° Turn Pt. light 075° Pt. Fairfax light 344°	
1100	48° 37.70' N 123° 16.80' W	

1130	48° 34.94’ N 123° 12.48' W	
1200	48° 35.50' N 123° 18.23' W	

S351 PC WORKSHEET

CHART 3441 FIXING PAPER

REWRITE

Cadet's Name: _____ Division: _____

Date: _____

Section A—Find the following information on the chart:

1. What is the projection of this chart?_____

2. How are depths measured in this chart? _____

3. To find additional information concerning the Turn Point Special Operating Area, which document shall be consulted?

   _____

4. Identify the chart numbers for:

   a. Cowichan Bay: _____

   b. Satellite Channel: _____

   c. Waters surrounding San Juan Island: _____

   d. Areas North of Plumper Sound: _____

5. Which organization published this chart? _____

Section B—Measure the distance:

Number	From	To	Distance
1.	Kelp Reefs light	Kellett Bluff light	
2.	Turn Pt. light	Tom Pt. light	
3.	Sandy Pt.	Gowlland Pt. light	
4.	Arachne Rf light	Pt. Fairfax light	
5.	Light at north end of Sidney Spit	Light at north end of James Island	

Section C—Find the symbols at the specified latitude and longitude:

Number	Latitude	Longitude	Symbol
1.	48° 43.40' N	123° 31.70' W	
2.	48° 47.84' N	123° 32.70' W	
3.	48° 45.00' N	123° 35.90' W	
4.	48° 45.47’ N	123° 35.65' W	
5.	48° 41.28' N	123° 29.95' W	

Section D—Plot the following fixes:

Time	Fix
1230	48° 47.50' N 123° 31.64' W
1300	48° 47.70' N 123° 33.50' W
1330	Separation Pt. light 223° Patey Rk. light 151° Cherry Pt. 173°
1400	Genoa Bay daymark 009° Separation Pt. light 108° Patey Rk. light 134°
1430	48° 43.21' N 123° 32.71' W
1500	48° 40.66' N 123° 30.70' W
1530	Tanner Rk daymark 240° Tozier Rk daymark 199° Platform in Saanich Inlet 166°
1600	48° 36.90’ N 123° 29.48’ W
1630	48° 34.94’ N 123° 28.93 W
1700	48° 34.35’ N 123° 27.90’ W

Section E—Complete the Speed-Time-Distance Table:

Speed	Time	Distance
	2 hours	9 NM
8 knots		48 NM
3 knots	5 hours	
	20 minutes	12 NM
9 knots		18 NM

Section F—Bonus

At what average speed did the vessel travel between the fixes from 0730 to 1200?

S351 PC WORKSHEET - REWRITE ANSWER KEY

CHART 3441 FIXING PAPER

Cadet's Name: _____ Division: _____

Date: _____

Section A—Find the following information on the chart:

1. What is the projection of this chart? **Mercator**

2. How are depths measured in this chart? **Meters**

3. To find additional information concerning the Turn Point Special Operating Area, which document shall be consulted? **CHS Sailing Directions**

4. Identify the chart numbers for:

   a. Cowichan Bay: **3478**

   b. Satellite Channel: **3479**

   c. Waters surrounding San Juan Island: **18433 USA**

   d. Areas North of Plumper Sound: **3442**

5. Which organization published this chart? **Canadian Hydrographic Service**

Section B—Measure the distance:

Number	From	To	Distance
1.	Kelp Reefs light	Kellett Bluff light	**2.82 NM**
2.	Turn Pt. light	Tom Pt. light	**2.14 NM**
3.	Sandy Pt.	Gowlland Pt. light	**4.93 NM**
4.	Arachne Rf light	Pt. Fairfax light	**0.90 NM / 9c**
5.	Light at north end of Sidney Spit	Light at north end of James Island	**2.56 NM**

Section C—Find the symbols at the specified latitude and longitude:

Number	Latitude	Longitude	Symbol
1.	48° 43.40' N	123° 31.70' W	**Tidal stream with rate**
2.	48° 47.84' N	123° 32.70' W	**Submarine Cable**
3.	48° 45.00' N	123° 35.90' W	**Anchor Berth**
4.	48° 45.47’ N	123° 35.65' W	**Starboard Daymark**
5.	48° 41.28' N	123° 29.95' W	**Obstruction**

Section D—Plot the following fixes: **Refer to pictorial guide located at Attachment 7.**

Time	Fix
1230	48° 47.50' N 123° 31.64' W
1300	48° 47.70' N 123° 33.50' W
1330	Separation Pt. light 223° Patey Rk. light 151° Cherry Pt. 173°
1400	Genoa Bay daymark 009° Separation Pt. light 108° Patey Rk. light 134°
1430	48° 43.21' N 123° 32.71' W
1500	48° 40.66' N 123° 30.70' W
1530	Tanner Rk daymark 240° Tozier Rk daymark 199° Platform in Saanich Inlet 166°
1600	48° 36.90’ N 123° 29.48’ W
1630	48° 34.94’ N 123° 28.93 W
1700	48° 34.35’ N 123° 27.90’ W

Section E—Complete the Speed-Time-Distance Table:

Speed	Time	Distance
4.5 knots	2 hours	9 NM
8 knots	**6 hours**	48 NM
3 knots	5 hours	**15 NM**
36 knots	20 minutes	12 NM
9 knots	**2 hours**	18 NM

Section F—Bonus

At what average speed did the vessel travel between the fixes from 1230 to 1700?

Speed = distance / time

Total distance ~18.5 NM
Total time = 4.5 hours

Average speed ~ 4.1 kts

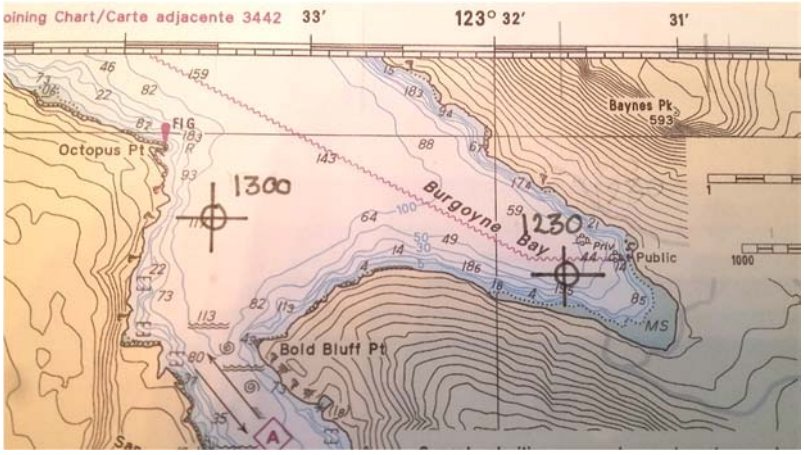
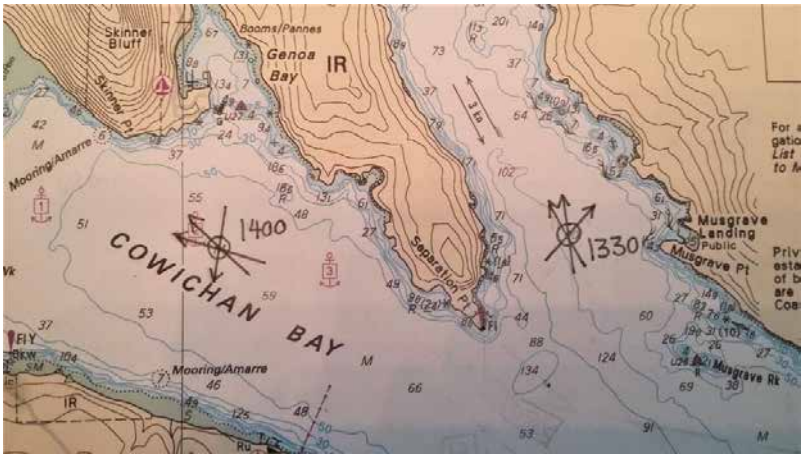
S351 PC WORKSHEET

REWRITE PICTORAL REFERENCE
(Based on 3441 Corrected 21 February 2014)

Some pictures will have portions of the required elements removed for clarity in determining accuracy or are provided for information purposes only.

Accuracy of answer(s) will vary depending on the version of chart used. All answers should be verified against the chart used for the Performance Check.

Section D—Plot the following fixes:

TIME	FIX	ANSWER
1230	48° 47.50' N 123° 31.64' W	
1300	48° 47.70' N 123° 33.50' W	
1330	Separation Pt. light 223° Patey Rk. Light 151° Cherry Pt. 173°	
1400	Genoa Bay daymark 009° Separation Pt. light 108° Patey Rk. Light 134°	

1430	48° 43.21' N 123° 32.71' W	
1500	48° 40.66' N 123° 30.70' W	
1530	Tanner Rk daymark 240° Tozier Rk daymark 199° Platform in Saanich Inlet 166°	
1600	48° 36.90' N 123° 29.48' W	
1630	48° 34.94' N 123° 28.93 W	
1700	48° 34.35' N 123° 27.90' W	

ANNEX C

M423 PC

ASSESSMENT INSTRUCTIONS

GENERAL

The purpose of this PC is to assess the cadet's ability to locate a position on a chart.

PRE-ASSESSMENT INSTRUCTIONS

Gather the required resources:

- Navigation instruments,
- *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*,
- *Symbols Abbreviations Terms (Chart 1),*
- Appendix 1 – M423 PC Worksheet,
- Appendix 2 – M423 PC Assessment Checklist,
- Appendix 3 – M423 PC Worksheet – Answer Key, and
- Appendix 4 – M423 PC Worksheet – Pictorial Answer Key.

CONDUCT OF ASSESSMENT

1. Distribute navigation instruments, Chart 3441, Chart 1, and PC to each cadet. Cadets will have 55 minutes to complete the assessment.

2. Evaluate the cadet’s completed fixing paper using the assessment rubric and Answer Key

3. Fixing paper will be scored out of a total of 50 points. Marking criteria for the fixing paper will be:

    a. Section A. One point for each correct response, for a total of eight points.

    b. Section B**.** Three points for each correct response (plus or minus 0.5 NM), for a total of six points.

    c. Section C**.** Two points for each correct response, for a total of six points.

    d. Section D**.** Possible six points per fix, for a total of 30 points. Marking criteria for each fix will be:

(1) two points for accuracy,
(2) one point for accuracy of the navigational track,
(3) two points for accuracy of DRs, and
(4) one point for correct labelling.

e. General tolerances of accuracy are as follows:

(1) distance – plus or minus 0.5 NM,
(2) time – plus or minus 10 minutes,
(3) speed – plus or minus 0.5 knot, and
(4) bearings – plus or minus 2 degrees.

f. Section E. Five points for bonus question.

4. Conduct a debriefing to discuss the overall performance results and have the cadet reflect on and assess their own performance.

5. Provide the cadet with a copy of the completed assessment checklist.

POST-ASSESSMENT INSTRUCTIONS

1. Place a copy of the Assessment Checklist in the cadet's training file.

2. Record the overall result on the Phase Four Qualification Record indicating one of:

a. **Incomplete.** The cadet has not achieved the performance standard by completing the PC with a mark of 60 percent or more in three attempts or did not attempt the PC;

b. **Completed With Difficulty.** The cadet has achieved the performance standard by completing the PC with a mark of 60 percent or more but required more than one attempt;

c. **Completed Without Difficulty.** The cadet has achieved the performance standard by completing the PC with a mark of 60 percent but less than 89 percent on the first attempt; or

d. **Exceeded Standard.** The cadet has achieved the performance standard by completing the PC with a mark of 90 percent or more on the first attempt.

M423 PC WORKSHEET

CHART 3441 FIXING PAPER

Cadet's Name: _____ Division: _____

Date: _____

Section A—Find the following information on the chart:

1. What is the scale of this chart?_____

2. How are depths measured in this chart? _____

3. What date was the Traffic Separation Scheme revised from Victoria to Vancouver?
   _____

4. Identify the chart numbers for:

   a. Eastern end of President Channel: _____

   b. Bedwell Harbour: _____

   c. Fulford Harbour:_____

   d. Areas North of Burgoyne Bay: _____

5. For which Notice to Mariners date has this chart been been corrected? _____

Section B—Measure the distance:

Number	From	To	Distance
1.	Dock I. light 48° 40.50' N 123° 21.40' W	Canoe Rk. light 48° 44.00' N 123° 20.43' W	
2.	Gowlland Pt. light 48° 44.15' N 123° 11.05' W	Turn Pt. light 48° 41.34' N 123° 14.25' W	

Section C—Find the latitude and longitude or geographic feature:

Number	Latitude	Longitude	Geographic Feature
1.			Arachne Rf.
2.	48° 45.9' N	123° 18.3' W	

Section D—Plot the following fixes. Include DRs for 6 and 12 minutes.

Time	Fix
0700	48° 36.00' N 123° 04.00' W Course 014°, Speed 4 knots
0800	RHE Flattop Is 261° Pt. Disney 357° Sandy Pt. 337° Course 330°, Speed 6 knots
0900	Sandy Pt. 000° Pt. Disney 107° Green Pt. Light 205° Course 330°, Speed 6 knots
1000	Taylor Pt. 341° RHE Java I. 006° Skipjack Is Light 071° Course 245°, Speed 6 knots
1100	Turn Pt. Light 229° Pt. Fairfax Light 266° Arachne Rf Light 251° Course 282°, Speed 15 knots

Section E— Bonus

1100 fix – How long can you stay on course 282° with a speed made good (SMG) of 15 knots?

M423 PC ASSESSMENT CHECKLIST

Cadet's Name: _____ Division: _____

Assessor's Comments:

Overall Performance Assessment:

Fixing Paper Mark:_____%

	PO Assessment							
Check One	**Incomplete**		**Completed With Difficulty**		**Completed Without Difficulty**		**Exceeded Standard**	
Overall Performance	The cadet has not achieved the performance standard by completing the PC with a mark of 60 percent or more in three attempts or did not attempt the PC.		The cadet has achieved the performance standard by completing the PC with a mark of 60 percent or more but required more than one attempt.		The cadet has achieved the performance standard by completing the PC with a mark of 60–89 percent on the first attempt.		The cadet has achieved the performance standard by completing the PC with a mark of 90 percent or more on the first attempt.	

Assessor's Name: _____	**Position:**_____
Assessor's Signature:_____	**Date:** _____

M423 PC WORKSHEET – ANSWER KEY

CHART 3441 FIXING PAPER

Cadet's Name: _____ Division: _____

Date: _____

Section A—Find the following information on the chart:

1. What is the scale of this chart? **1 : 40 000**

2. How are depths measured in this chart? **In metres**

3. What date was the Traffic Separation Scheme revised from Victoria to Vancouver? **July 1, 2005**

4. Identify the chart numbers for:

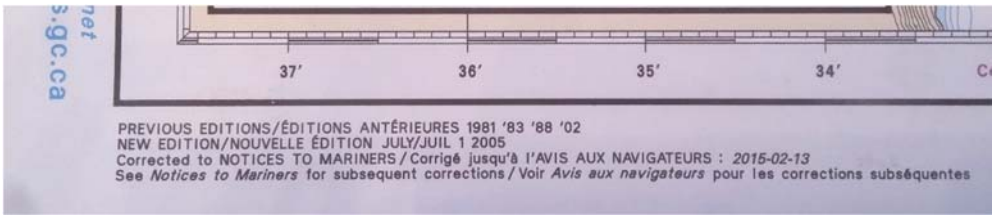
   a. Eastern end of President Channel: **Chart 18421 USA**

   b. Bedwell Harbour: **Chart 3477**

   c. Fulford Harbour: **Chart 3478**

   d. Areas North of Burgoyne Bay: **Chart 3442**

5. For which Notice to Mariners date has this chart been been corrected? **Varies on chart being used. Refer to the lower left corner of the chart:**



Section B—Measure the distance:

Number	From	To	Distance
1.	Dock I. light 48° 40.50' N 123° 21.40' W	Canoe Rk. light 48° 44.00' N 123° 20.43' W	**3.78 NM**

2.	Gowlland Pt. light 48° 44.15' N 123° 11.05' W	Turn Pt. light 48° 41.34' N 123° 14.25' W	**3.54 NM**

Section C—Find the latitude and longitude or geographic feature:

Number	Latitude	Longitude	Geographic Feature
1.	**48° 41.10' N**	**123° 17.61' W**	Arachne Rf.
2.	48° 45.9' N	123° 18.3' W	**Beddis Rk.**

Section D—Plot the following fixes. Include DRs for 6 and 12 minutes: **Refer to the pictorial guide at Appendix 4.**

Time	Fix
0700	48° 36.00' N 123° 04.00' W Course 014°, Speed 4 knots
0800	RHE Flattop Is 261° Pt. Disney 357° Sandy Pt. 337° Course 330°, Speed 6 knots
0900	Sandy Pt. 000° Pt. Disney 107° Green Pt. Light 205° Course 330°, Speed 6 knots
1000	Taylor Pt. 341° RHE Java I. 006° Skipjack Is Light 251° Course 245°, Speed 6 knots
1100	Turn Pt. Light 229° Pt. Fairfax Light 266° Arachne Rf Light 251° Course 282°, Speed 15 knots

Section E— Bonus

1100 fix – How long can you stay on course 282° with a speed made good (SMG) of 15 knots?

Distance	**3.1 NM**
Speed	**15 knots**
Time	**~12.5 minutes**

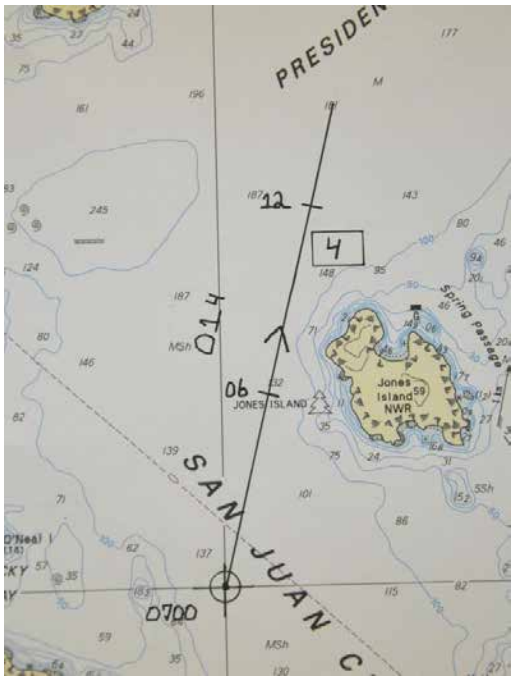
423 PC WORKSHEET

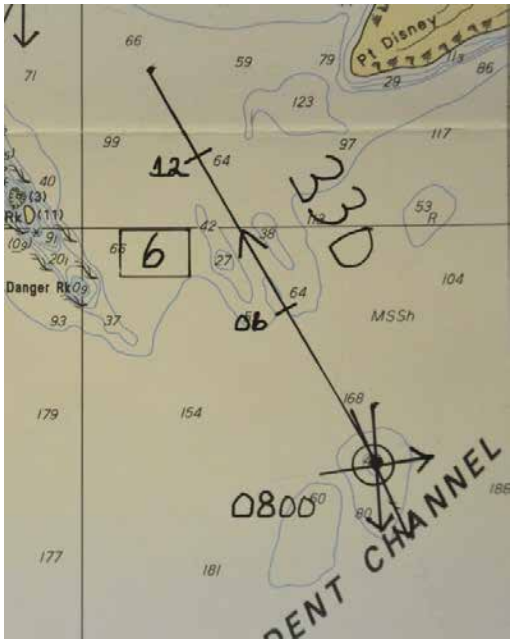
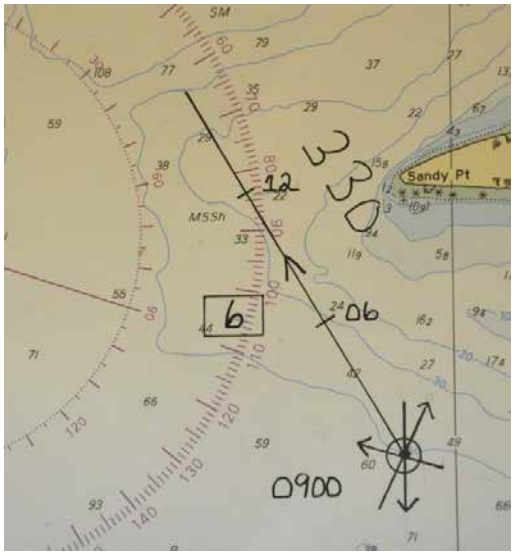
PICTORAL ANSWER KEY
(Based on 3441 Corrected 21 February 2014)

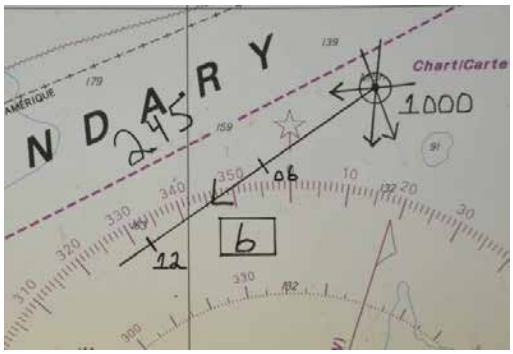
Some pictures will have portions of the required elements removed for clarity in determining accuracy or are provided for information purposes only.

Accuracy of answer(s) will vary depending on the version of chart used. All answers should be verified against the chart used for the Performance Check.

Section D—Plot the following fixes complete with navigational track and two DRs (six and 12 minutes):

TIME	QUESTION	ANSWER
0700	48° 36.00’ N 123° 04.00’ W Course 014° Speed 4 knots **(Parallel and Meridian lines)**	

TIME	QUESTION	ANSWER
0800	RHE Flattop Is 261° Pt. Disney 357° Sandy Pt. 337° Course 330° Speed 6 knots **(Presidents Channel 48m Sounding Mark)**	
0900	Sandy Pt. 000° Pt. Disney 107° Green Pt. Light 205° Course 330° Speed 6 knots **(50m Sounding Mark)**	

TIME	QUESTION	ANSWER
1000	Taylor Pt. 341° RHE Javi Is 006° Skipjack Is Light 251° Course 245° Speed 6 knots **(Mud and Shells (MSh) Mark)**	
1100	Turn Pt. Light 229° Pt. Fairfax Light 266° Arachne Rf Light 251° Course 282° Speed 15 knots **(Lower left corner of special note symbol in Boundary Pass)**	

Section E—Bonus 1100 Fix – How long can you stay on course 282° with a speed made good (SMG) of 15 knots?

Distance **3.1 NM**
Speed **15 knots**
Time **~12.5 minutes**

ANNEX D

S451 PC

ASSESSMENT INSTRUCTIONS

GENERAL

The purpose of this PC is to assess the cadet's ability to independently execute a passage by completing a fixing paper.

PRE-ASSESSMENT INSTRUCTIONS

Gather the required resources:

- Navigation instruments,
- *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*,
- *Symbols Abbreviations Terms (Chart 1),*
- Appendix 1 – S451 PC Worksheet,
- Appendix 2 – S451 Assessment Checklist,
- Appendix 3 – S451 PC Worksheet – Answer Key,
- Appendix 4 – S451 PC Worksheet – Pictorial Answer Key,
- Appendix 5 – S451 PC Worksheet – Rewrite,
- Appendix 6 – S451 PC Worksheet – Rewrite Answer Key, and
- Appendix 7 – S451 PC Worksheet – Rewrite Pictorial Answer Key.

CONDUCT OF ASSESSMENT

1. Distribute navigation instruments, Chart 3441, Chart 1, and PC to each cadet. Cadets will have 110 minutes to complete the assessment.

2. Evaluate the cadet’s completed fixing paper using the assessment rubric and Answer Key. Marking criteria will be based on the accuracy tolerances as follows:

   a. Distance – plus or minus 0.1 NM;
   b. Time – plus or minus 2 minutes;
   c. Speed – plus or minus 0.5 knot; and
   d. Bearing – plus or minus 2 degrees.

3. Conduct a debriefing to discuss the overall performance results and have the cadet reflect on and assess their own performance.

4. Provide the cadet with a copy of the completed assessment checklist.

POST-ASSESSMENT INSTRUCTIONS

1. Place a copy of the Assessment Checklist in the cadet's training file.

2. Record the overall result on the Boatswain Mate Qualification Record indicating one of:

   a. **Incomplete.** The cadet has not achieved the performance standard by completing the PC with a mark of 60 percent or more in three attempts or did not attempt the PC;

   b. **Completed With Difficulty.** The cadet has achieved the performance standard by completing the PC with a mark of 60 percent or more but required more than one attempt;

   c. **Completed Without Difficulty.** The cadet has achieved the performance standard by completing the PC with a mark of 60 percent but less than 89 percent on the first attempt; or

   d. **Exceeded Standard.** The cadet has achieved the performance standard by completing the PC with a mark of 90 percent or more on the first attempt.

S451 PC WORKSHEET

CHART 3441 FIXING PAPER

Cadet: _____ Division: _____

Date: _____

Q#	TIME	QUESTION	ANSWER
1.		Plot the following points on Chart 3441: AA 48°33.00' N 123°11.80' W BB 48°37.00' N 123°13.40' W CC 48°39.69' N 123°10.09' W Label the tracks.	
2.	1000	Kellett Bluff light 355° RHE Henry I 020° Kelp Reefs light 265° Plot this fix. Assume Speed 10 kts. Include DRs for six and 12 minutes.	
3.		What type of bottom is under the 1000 fix?	
4.	1006	Kellett Bluff light 005° LHE Halibut I 318° Kelp Reefs light 226° Plot this fix. Include EPs to minute 18. What is the CMG and SMG?	
5.		Place a Clearing Bearing on Kellett Bluff using RHE Stuart I as a reference mark and an LDL of 5 m. What is the clearing bearing value? NMT or NLT?	
6.		How far from Kellett Bluff light would you be if you were on the clearing bearing?	
7.		What is the navigational scheme called that you are currently operating in?	
8.		What time will you be at position BB?	
9.	1016	LHE Battleship I in transit with Spieden Bluff 035° Kellett Bluff 130° Plot this fix. What is the gyro error? High or low?	

Q#	TIME	QUESTION	ANSWER
10.		Assume a Gyro error of 2° low. What is the course to steer to maintain the 345° track?	
11.	1022	North end of Battleship I 1.93 NM South end of Stuart I 1.93 NM South end of Halibut I 1.53 NM Plot this fix. Does the fix work? What could be the problem?	
12.		What was the index error you found above?	
13.		Plot a wheelover bearing on Spieden Bluff on a course of 040°. Assume that you have a DNC of 200x. What is the wheelover bearing? What is the DR Time to the wheelover position?	
		Your vessel travels past the planned wheelover position, so you alter course to 040° with double standard helm to come around on track.	
14.	1030	Davison Head in transit with LHE Battleship I 090° LHE Stuart I 342° Plot this fix. What is the gyro error?	
		Your vessel's gyro has been reset and proven correct.	
15.		Draw a clearing bearing for Danger Shoal based off Spieden Bluff (LDL 5m). What is the bearing?	
16.		If you replaced Center Reef port hand buoy with a cardinal buoy, which would it be?	
17.	1036	Spieden Bluff 068° @ 1.65 NM South tip of Stuart I 030° @ 1.40 NM Battleship I 142° @ 1.0 NM Plot this fix. Include EP for minute 42 What is the CMG and SMG?	
18.		What course would you steer to regain CC?	
19.		How long will it take you to regain CC @ 10 kts?	

S451 PC ASSESSMENT CHECKLIST

Cadet's Name: _____ Division: _____

Date: _____

Assessor's Comments:

Fixing Paper Mark: ____%

	PO S451 Overall Assessment			
Check One	**Incomplete**	**Completed With Difficulty**	**Completed Without Difficulty**	**Exceeded Standard**
Overall Performance	The cadet has not achieved the performance standard by completing the PC with a mark of 60 percent or more in three attempts or did not attempt the PC.	The cadet achieved the performance standard by completing the PC with a mark of 60 percent or more but required more than one attempt.	The cadet achieved the performance standard by completing the PC with a mark of 60 percent but less than 89 percent on the first attempt.	The cadet achieved the performance standard by completing the PC with a mark of 90 percent or more on the first attempt.

Assessor's Name:	**Position:**
Assessor's Signature:	**Date:**

S451 PC WORKSHEET – ANSWER KEY

Cadet: _____ Division: _____

Date: _____

Q#	Answers	Mark
1.	Plot Correct: ☐ AA, ☐ BB, ☐ CC, ☐ Course Labels, ☐ Speed Boxes	**/ 5**
2.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12	**/ 4**
3.	**Sand or Gravel.**	**/ 1**
4.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12, ☐ CMG: **355°**, ☐ SMG: **11 kts**	**/ 6**
5.	☐ Correct Symbol, ☐ Correct Position, ☐ Value: **347°**, ☐ **NLT**	**/ 4**
6.	**225x**	**/ 1**
7.	**Haro Strait traffic separation scheme.**	**/ 1**
8.	**14.5 minutes @ 1021**	**/ 1**
9.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12, ☐ Gyro Error: **3°**, ☐ **High**	**/ 6**
10.	**347°**	**/ 1**
11.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12, ☐ Work? **No**, ☐ Why? **RADAR index error**	**/ 6**

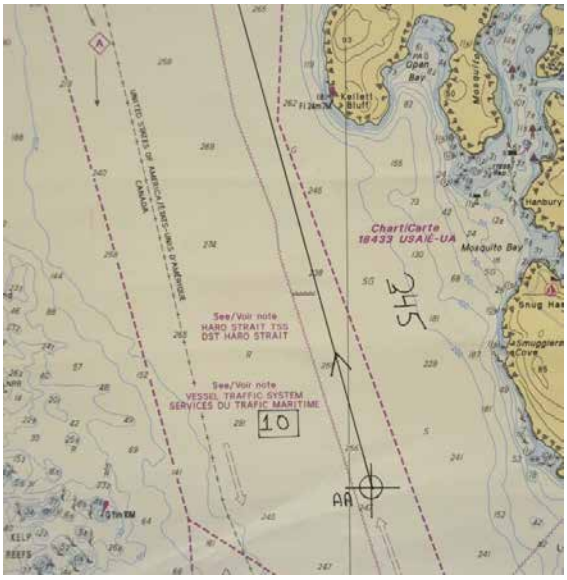
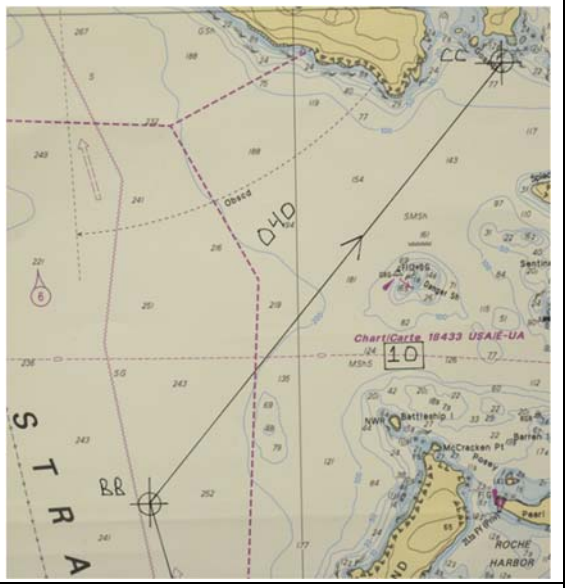
Q#	Answers	Mark
12.	**200x under ranging**	**/ 2**
13.	☐ w/o position correct, ☐ Symbol correct, ☐ Bearing: **047°**, ☐ DR Time: **1 minute @ 1023**	**/ 4**
14.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12, ☐ Gyro Error: **2°**, ☐ **Low**	**/ 6**
15.	☐ Correct Symbol, ☐ Correct Position, ☐ Value: **061°**, ☐ **NLT**	**/ 4**
16.	**South Cardinal Buoy**	**/ 1**
17.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12, ☐ CMG: **345°**, ☐ SMG: **12 kts**	**/ 6**
18.	**045°**	**/ 1**
19.	**12 minutes**	**/ 1**
		/ 61

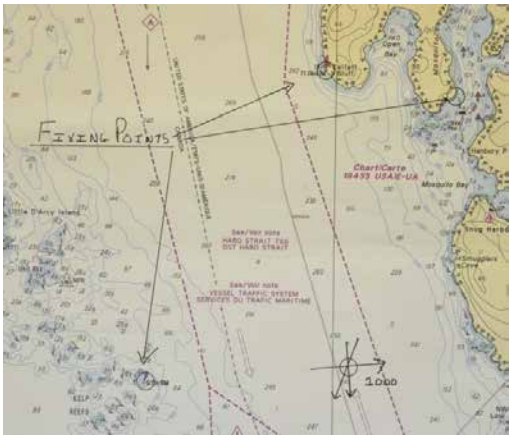
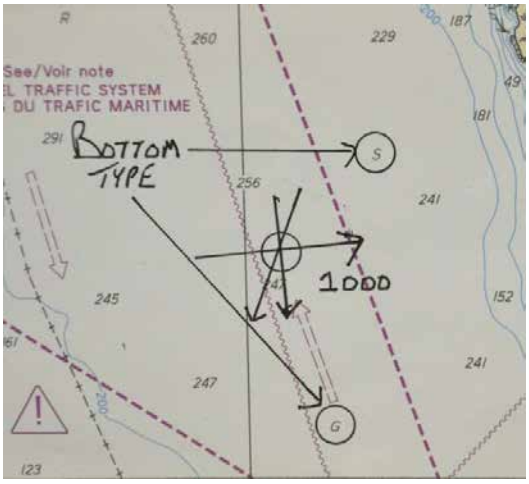
S451 PC WORKSHEET

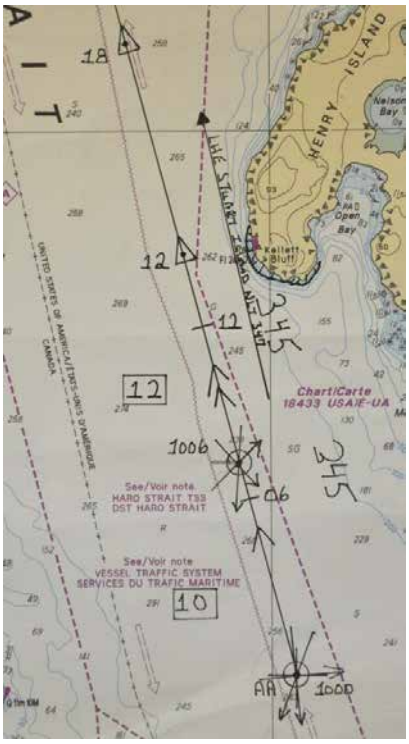
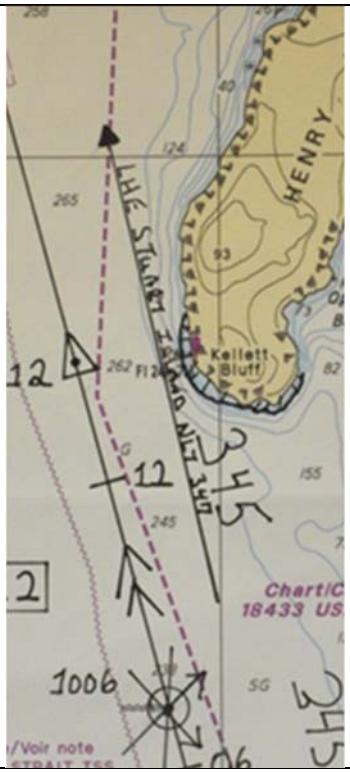
PICTORAL ANSWER KEY
(Based on 3441 Corrected 21 February 2014)

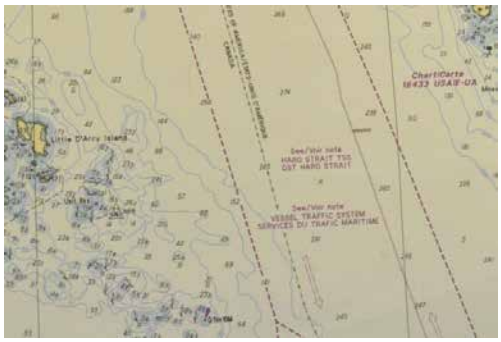
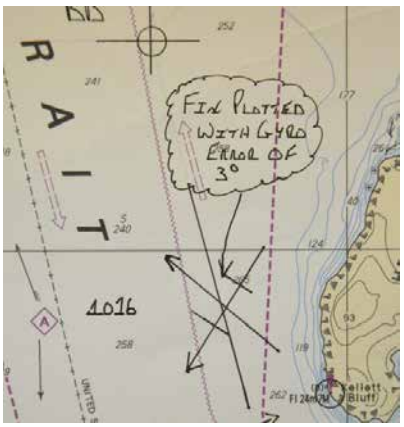
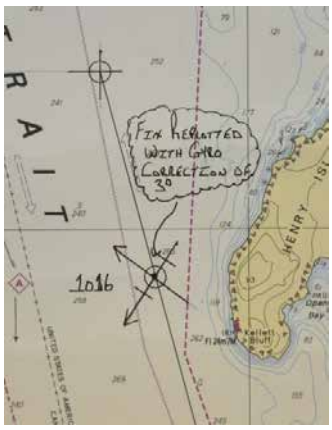
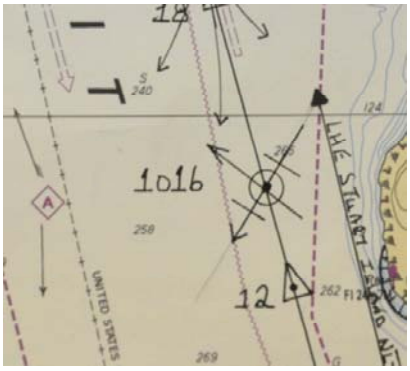
Some pictures will have portions of the required elements removed for clarity in determining accuracy or are provided for information purposes only.

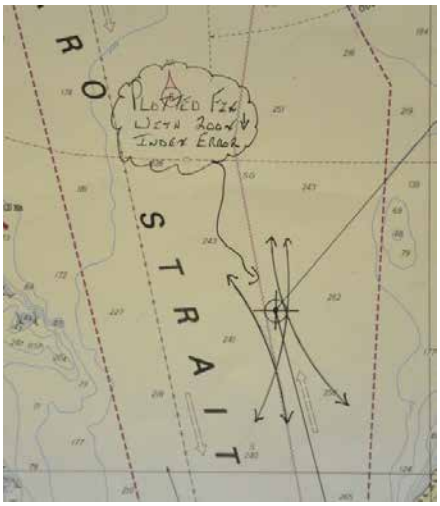
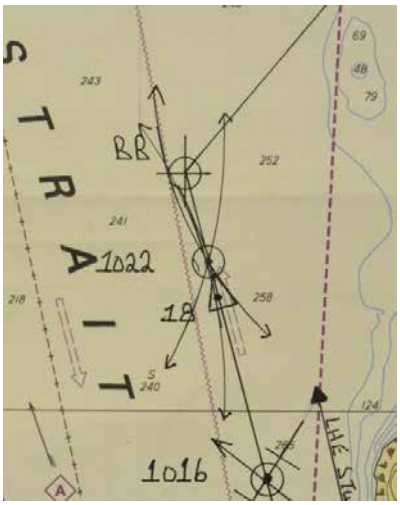
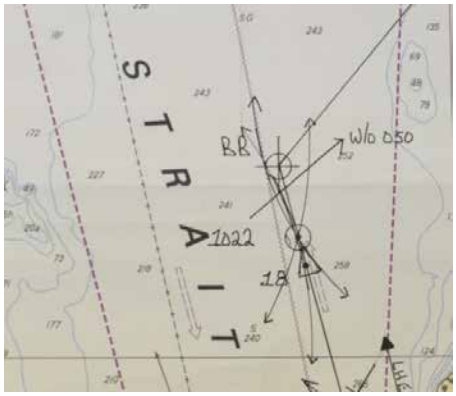
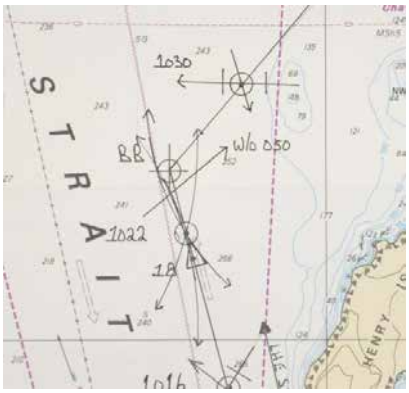
Accuracy of answer(s) will vary depending on the version of chart used. All answers should be verified against the chart used for the Performance Check.

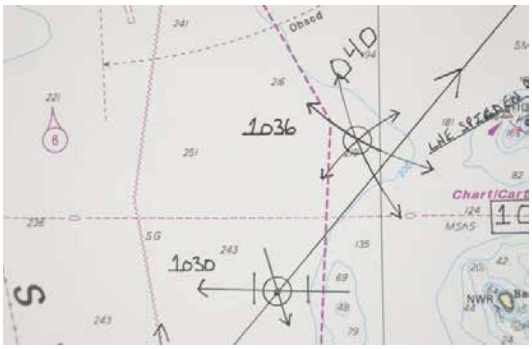
Q#	TIME	QUESTION	ANSWER
1.		Plot the following points on Chart 3441: AA 48°33.00' N 123°11.80' W BB 48°37.00' N 123°13.40' W CC 48°39.69' N 123°10.09' W Label the tracks.	
		 	
2.	1000	Kellett Bluff light 355° RHE Henry I 020° Kelp Reefs light 265° Plot this fix. Include DRs for six and 12 minutes.	

Q#	TIME	QUESTION	ANSWER
			
3.		What type of bottom is under the 1000 fix?	

Q#	TIME	QUESTION	ANSWER
4.	1006	Kellett Bluff light 005° LHE Halibut I 318° Kelp Reefs light 226° Plot this fix. Include EPs to minute 18. What is the CMG and SMG?	
5.		Place a Clearing Bearing on Kellett Bluff using RHE Stuart I as a reference mark and an LDL of 5 m. What is the clearing bearing value? NMT or NLT?	

Q#	TIME	QUESTION	ANSWER
7.		What is the navigational scheme called that you are currently operating in?	
9.	1016	LHE Battleship I in transit with Spieden Bluff 035° Kellett Bluff 130° Plot this fix. What is the gyro error? High or low?	
		  	
11.	1022	North end of Battleship I 1.93 NM South end of Stuart I 1.93 NM South end of Halibut I 1.53 NM Plot this fix. Does the fix work? What could be the problem?	

Q#	TIME	QUESTION	ANSWER
	 		
13.		Plot a wheelover bearing on Spieden Bluff on a course of 040°. Assume that you have a DNC of 200x. What is the wheelover bearing? What is the DR Time to the wheelover position?	
14.	1030	Davison Head in transit with LHE Battleship I 090° LHE Stuart I 342° Plot this fix. What is the gyro error?	
	 		

Q#	TIME	QUESTION	ANSWER
15.		Draw a clearing bearing for Danger Shoal based off Spieden Bluff (LDL 5m). What is the bearing?	
17.	1036	Spieden Bluff 068° @ 1.65 NM South tip of Stuart I 030° @ 1.40 NM Battleship I 142° @ 1.0 NM Plot this fix. Include EP for minute 42 What is the CMG and SMG?	
		 	

S451 PC WORKSHEET

CHART 3441 FIXING PAPER

REWRITE

Cadet: _____ Division: _____

Date: _____

Q#	TIME	QUESTION	ANSWER
1.		Plot the following points on Chart 3441: AA 48°35.70' N 123°30.00' W BB 48°42.50' N 123°30.85' W CC 48°44.35' N 123°33.80' W Label the tracks. Planned speed is 10 kts.	
2.	0800	Wain Rock light 004° Tozier Rk Daymark 338° Henderson Point 078° Plot this fix. Include DRs for six and 12 minutes.	
3.		Plan a gyro check with Tanner Rk and Tozier Rk daymarks. Plot this on the chart. What time will these two marks be in transit on your planned track?	
4.	0806	Tozier Rk daymark 301° @ 0.54 NM BC Ferries jetty light 276° Plot this fix. Include EPs to minute 18. What are the CMG and SMG?	
5.	0809	Reduce speed to 8 kts and alter course to 025. Plot a new fix: Wain Rk light 007° Patey Rk light 351° Mt Newton radio tower 112° DR the next 6 and 12 minutes	
6.		What area / zone will your vessel be at the DR for 0815?	

Q#	TIME	QUESTION	ANSWER
7.		Victoria Coast Guard Radio informs over Channel 16 that a fishing net is adrift and caught on the beacon at Patey Rk, with dangers extending 100x. Plot a clearing bearing to clear the dangers with an additional 200x, using Mt Tuam radio tower light as the reference mark. What is your clearing bearing? NMT or NLT?	
8.	0818	Plot this fix: 48° 38.42’ N 123° 29.30’ W	
9.		The OIC asks you for a new course recommendation in order to further clear the dangers at Patey Rock. Extend your second planned track (from BB to CC) further to the south east by 0.5 NM. Name this point DD. What is the course to steer between the 0818 fix and DD? Label this course on the chart.	
10.		The OIC orders your recommended course at speed 10. From the 0818 fix, plot DRs for the next 6 and 12 minutes.	
11.		If the ODAS buoy in Saanich Inlet is in its plotted position, how close do we expect to pass it on this track?	
12.		Moses Point in transit with Coal Point 010° Patey Rk light 338° Plot the fix. EP the next 6 and 12 minutes.	
13.		Is your gyro correct? If not, what is the error?	
14.		Plot a wheel over to the next planned track. Assume DNC is 400x and use Separation Point as the wheel over reference point. Label the 5, 3, 1 cable countdown.	
15.		What is your wheel over bearing?	
16.	0832	Hatch Point 1.55 NM Moses Point 0.70 NM Patey Rock 1.38 NM Plot the fix.	
17.		What time do you expect the ship to be at wheel over for your course alteration to port?	

Q#	TIME	QUESTION	ANSWER
18.	0840	Separation Pt 311° Cherry Pt 289° Patey Rk light 243° Plot the fix. What course and speed are required from this fix to make CC at 0900? DR the next 6 and 12 minutes based on this speed.	

S451 PC WORKSHEET – REWRITE ANSWER KEY

CHART 3441 FIXING PAPER

Cadet: _____ Division: _____

Date: _____

Q#	Answers	Mark
1.	Plot Correct: ☐ AA, ☐ BB, ☐ CC, ☐ Course Labels, ☐ Speed Boxes	**/ 5**
2.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12	**/ 4**
3.	☐ Correct Symbol ☐ Time: **0804**	**/ 2**
4.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12, ☐ CMG: **355°**, ☐ SMG: **11 kts**	**/ 6**
5.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12, ☐ Course Labels, ☐ Speed Boxes	**/ 6**
6.	**Military Exercise Area WD**	**/ 1**
7.	☐ Correct Symbol ☐ **NMT** ☐ **038**	**/ 3**
8.	☐ Fix	**/ 1**
9.	☐ DD Position ☐ **351** ☐ Course label	**/ 3**
10.	☐ DR 6, ☐ DR 12, ☐ Label speed	**/ 3**
11.	**200x**	**/ 1**

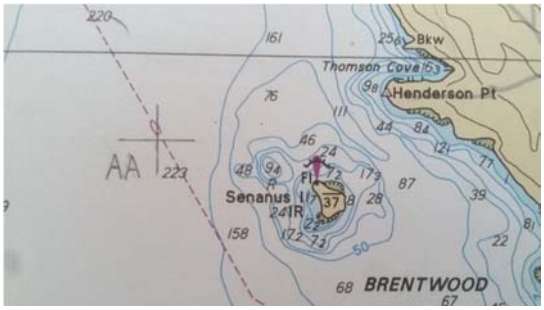
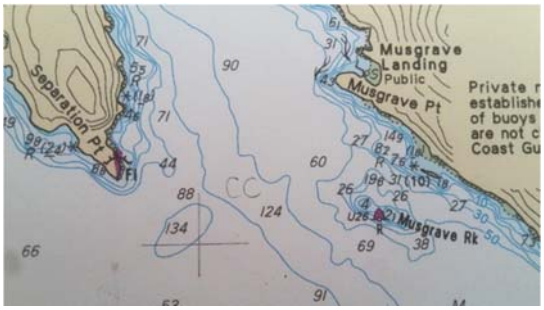
Q#	Answers	Mark
12.	☐ Fix, ☐ DR 6, ☐ DR 12,	**/ 3**
13.	Gyro correct	**/ 1**
14.	☐ w/o position correct, ☐ Symbol correct, ☐ 5, 3, 1 cable countdown label	**/3**
15.	☐ Bearing: **315°**	**/ 1**
16.	☐ Fix	**/ 1**
17.	**0838**	**/ 1**
18.	☐ Fix, ☐ Label Track, ☐ Label Speed, ☐ DR 6, ☐ DR 12, ☐ **Track 312**, ☐ **Speed 9**	**/ 6**
		/ 51

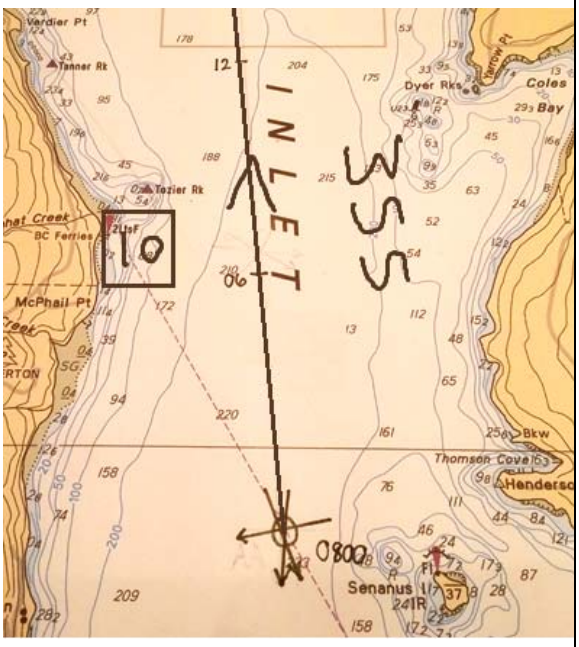
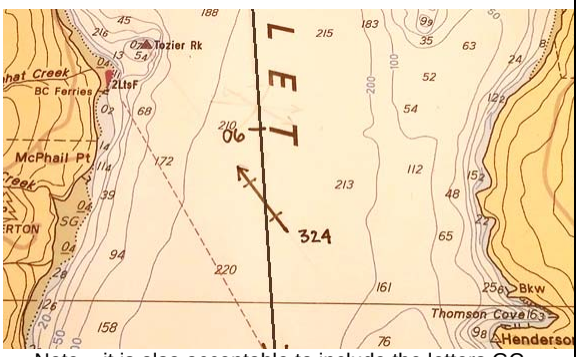
S451 PC WORKSHEET

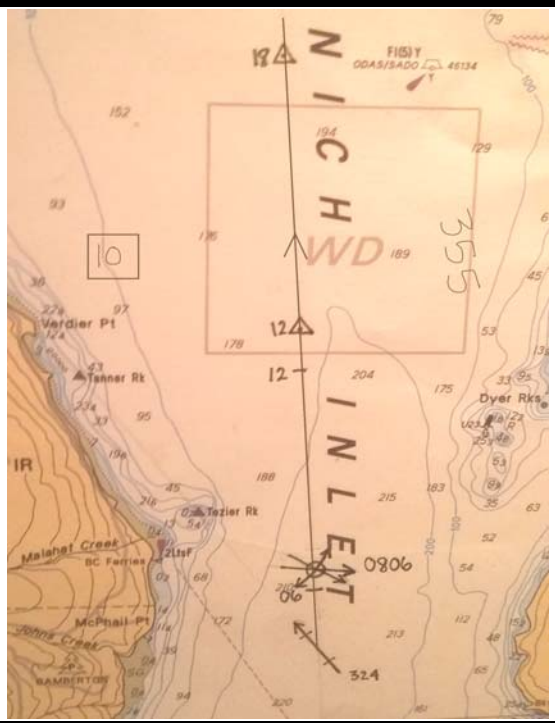
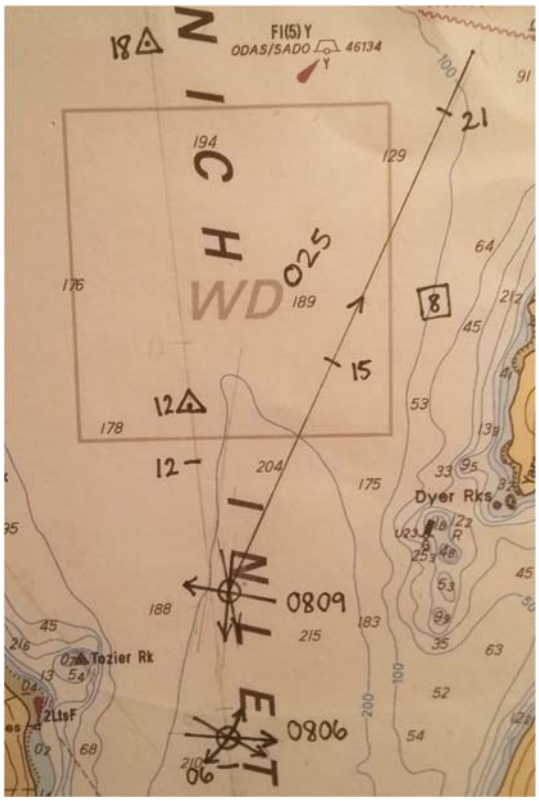
REWRITE PICTORAL REFERENCE
(Based on 3441 Corrected to 07 July 2011)

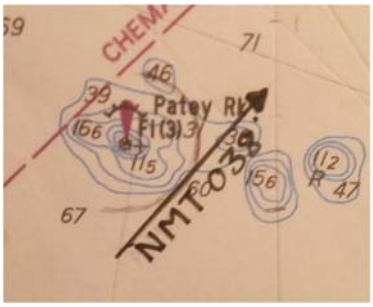
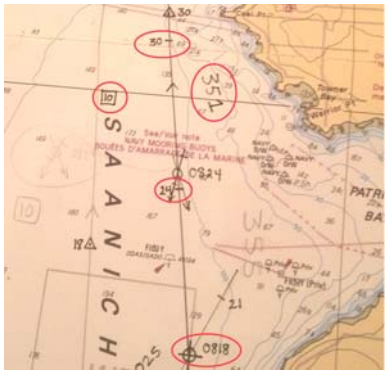
Some pictures will have portions of the required elements removed for clarity in determining accuracy or are provided for information purposes only.

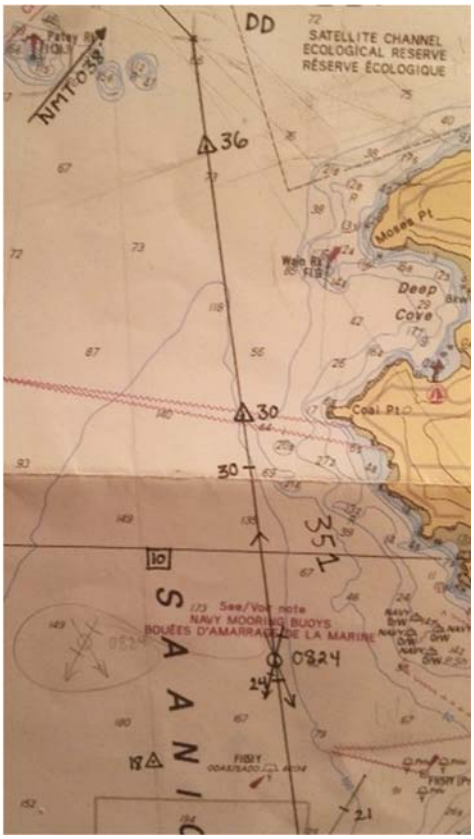
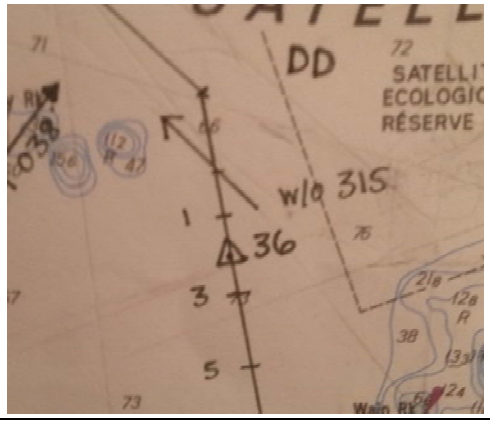
Accuracy of answer(s) will vary depending on the version of chart used. All answers should be verified against the chart used for the Performance Check.

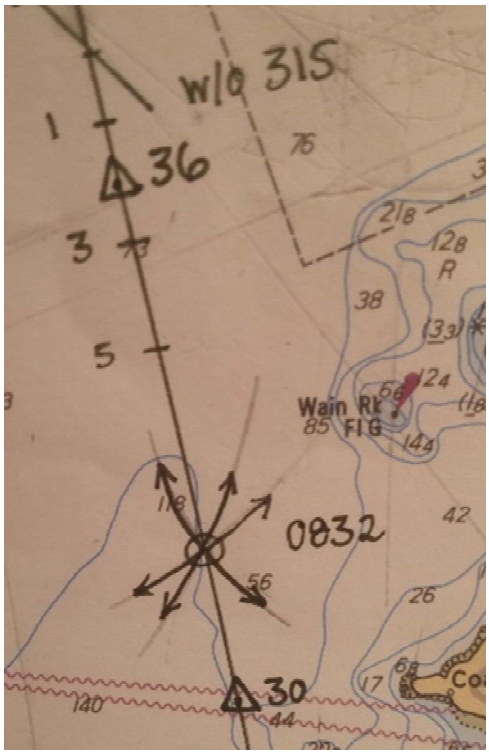
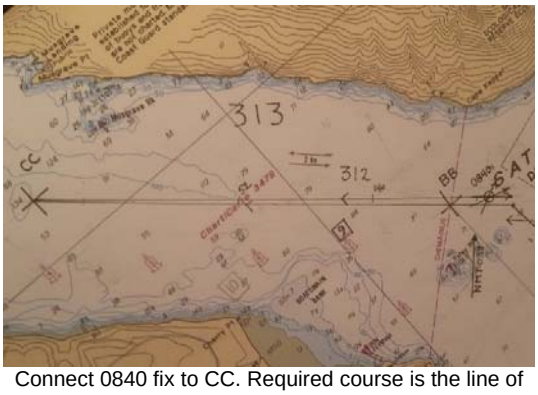
Q#	TIME	QUESTION	ANSWER
1.		Plot the following points on Chart 3441: AA 48°35.70' N 123°30.00' W BB 48°42.50' N 123°30.85' W CC 48°44.35' N 123°33.80' W Label the tracks. Planned Speed is 10 kts.	   Course number will depend on accuracy of plotted positions. This guide is based on the following: AA to BB – 355°, and BB to CC – 313°.

Q#	TIME	QUESTION	ANSWER
2.	0800	Wain Rock light 004° Tozier Rk Daymark 338° Henderson Point 078° Plot this fix. Include DRs for six and 12 minutes.	 Fix should be placed on AA. If the cadet does not correctly plot AA, but has the fix position correct, points shall be awarded.
3.		Plan a gyro check with Tanner Rk and Tozier Rk daymarks. Plot this on the chart. What time will these two marks be in transit on your planned track?	 Note – it is also acceptable to include the letters GC.

Q#	TIME	QUESTION	ANSWER
4.	0806	Tozier Rk daymark 301° @ 0.54 NM BC Ferries jetty light 276° Plot this fix. Include EPs to minute 18. What are the CMG and SMG?	
5.	0809	Reduce speed to 8 kts and alter course to 025. Plot a new fix: Wain Rk light 007° Patey Rk light 351° Mt Newton radio tower 112° DR the next 6 and 12 minutes	

Q#	TIME	QUESTION	ANSWER
7.		Victoria Coast Guard Radio informs over Channel 16 that a fishing net is adrift and caught on the beacon at Patey Rk, with dangers extending 100x. Plot a clearing bearing to clear the dangers with an additional 200x, using Mt Tuam radio tower light as the reference mark. What is your clearing bearing? NMT or NLT?	
8.	0818	Plot this fix: 48° 38.42' N 123° 29.30' W	
9.		The OIC asks you for a new course recommendation in order to further clear the dangers at Patey Rock. Extend your second planned track (from BB to CC) further to the south east by 0.5 NM. Name this point DD. What is the course to steer between the 0818 fix and DD? Label this course on the chart.	 Connect DD and the 0818 fix to establish new course.
10.		The OIC orders your recommended course at speed 10. From the 0818 fix, plot DRs for the next 6 and 12 minutes.	 Required components are circled in red.

Q#	TIME	QUESTION	ANSWER
12.		Moses Point in transit with Coal Point 010° Patey Rk light 338° Plot the fix. EP the next 6 and 12 minutes.	
14.		Plot a wheel over to the next planned track. Assume DNC is 400x and use Separation Point as the wheel over reference point. Label the 5, 3, 1 cable countdown.	

Q#	TIME	QUESTION	ANSWER
16.	0832	Hatch Point 1.55 NM Moses Point 0.70 NM Patey Rock 1.38 NM Plot the fix.	
18.	0840	Separation Pt 311° Cherry Pt 289° Patey Rk light 243° Plot the fix. What course and speed are required from this fix to make CC at 0900? DR the next 6 and 12 minutes based on this speed.	 Connect 0840 fix to CC. Required course is the line of postion between the fix at 0840 and CC.

PO X51

Refer to A-CR-CCP-616/PG-001, *Royal Canadian Sea Cadets, Ship's Boat Operator Qualification Standard and Plan* for PO S351, Navigate a Small Craft.

Refer to A-CR-CCP-604/PG-001, *Royal Canadian Sea Cadets, Phase Four Qualification Standard and Plan,* for PO M423, Locate a Position on a Chart.

Refer to A-CR-CCP-617/PG-001, *Royal Canadian Sea Cadets, Boatswain Mate Qualification Standard and Plan*, for PO S451, Act as a Navigator on a SCTV.

Refer to A-CR-CCP-605/PG-001, *Royal Canadian Sea Cadets, Phase Five Qualification Standard and Plan,* for PO M523, Serve in a Naval Environment.

Refer to A-CR-050-803/PC-001, *Qualification Standard – Developmental Period 1 – Cadet Instructors Cadre – Sea Environmental Training* for PO 107 Explain Small Craft Marine Navigation.

EO X51.01

1. **Performance**: Explain the Principles of Marine Navigation

2. **Conditions**:

   a. Given:

      (1) Publications, to include:

         (a) *Symbols Abbreviations Terms (Chart 1)*,
         (b) *Canadian Tide and Current Tables*,
         (c) *List of Lights, Buoys and Fog Signals*,
         (d) *Notice to Mariners (NOTMAR) Annual Edition*,
         (e) *Radio Aids to Marine Navigation*,
         (f) *Sailing Directions*, and
         (g) *The Canadian Aids to Navigation System*;

      (2) Supervision, and

      (3) Assistance as required.

   b. Denied: Nil.

   c. Environmental: Classroom or training area large enough to accommodate the entire group.

3. **Standard**: The student shall explain the principles of marine navigation by:

   a. identifying and describing the use of publications, to include:

      (1) *Symbols Abbreviations Terms (Chart 1)*,
      (2) *Canadian Tide and Current Tables*,
      (3) *List of Lights, Buoys and Fog Signals*,
      (4) *Notice to Mariners (NOTMAR) Annual Edition*,
      (5) *Radio Aids to Marine Navigation*,
      (6) *Sailing Directions*, and
      (7) *The Canadian Aids to Navigation System;*

   b. explaining tides and currents; and
   c. performing speed-time-distance calculations.

4. **Teaching Points**:

TP	Description	Method	Time	Refs
TP1	Explain navigation publications, to include: a. *Symbols Abbreviations Terms (Chart 1)*, b. *Canadian Tide and Current Tables*, c. Chart catalogues, d. *List of Lights, Buoys and Fog Signals*, e. *Notice to Mariners (NOTMAR) Annual Edition*, f. *Radio Aids to Marine Navigation*, g. *Sailing Directions*, and h. *The Canadian Aids to Navigation System*.	Interactive Lecture	20 min	7c. (pp. 151–161) 7d.
TP2	Explain: a. tide raising forces, and b. tidal terminology, to include: (1) reference port, (2) secondary port, (3) tidal range, (4) tidal current, (5) Chart Datum, (6) height of tide, (7) spring, (8) neap, (9) flood current, and (10) ebb current.	Interactive Lecture	20 min	7a. (pp. 99–101) 7d.
TP3	Identify and explain how to use the information found on a tide table.	Interactive Lecture	5 min	7d.
TP4	Demonstrate and have the students complete a tidal graph for a reference port.	Demonstration and Performance	25 min	7a. (pp. 100–101) 7d.
TP5	Demonstrate and have the students perform speed-time-distance calculations.	Demonstration and Performance	40 min	7b. (pp. 113–117)

5. **Time**:

a. Introduction / Conclusion: 10 min
b. Interactive Lecture: 45 min
c. Demonstration and Performance: 65 min
d. Total: 120 min

6. **Substantiation**:

a. An interactive lecture was chosen for TPs 1–3 as it allows the instructor to provide information on navigation publications and tidal theory.

b. A demonstration and performance was chosen for TPs 4 and 5 as it allows the instructor to demonstrate marine navigation skills while providing an opportunity for students to practice these skills under supervision.

7. **References**:

a. ISBN 0-920232-15-9 Neff, D. (1990). *Basic power boating skills*. Gloucester, ON: Canadian Yachting Association.

b. ISBN 0-07-137226-1 Brogdon, B. (1995). *Boat navigation for the rest of us: Second edition.* Camden, ME: International Marine.

c. C-57-007-002/AF-001 Royal Navy. (1987). *Admiralty manual of navigation* (Vol. 1). London, England: Her Majesty's Stationery Office.

d. Fisheries and Oceans Canada. *Tides, Currents and Water Levels*. (2008). Retrieved October 15, 2008, from http://www.waterlevels.gc.ca/english/relatedproducts.shtml

8. **Training Aids**:

a. Presentation aids (eg, whiteboard / flip chart / OHP / multimedia projector) appropriate for the classroom / training area,

b. Navigation publications, to include:

(1) *Symbols Abbreviations Terms (Chart 1)*,
(2) *Canadian Tide and Current Tables*,
(3) Chart catalogue,
(4) *List of Lights, Buoys and Fog Signals*,
(5) *Notice to Mariners (NOTMAR) Annual Edition*,
(6) *Radio Aids to Marine Navigation*,
(7) *Sailing Directions*, and
(8) *The Canadian Aids to Navigation System*;

c. Tide table handout,
d. Tidal graph worksheet, and
e. Speed-time-distance calculation handout.

9. **Learning Aids**:

a. Tide table handout,
b. Tidal graph worksheet, and

c. Speed-time-distance calculation handout.

10. Test Details: Nil

11. Remarks: Nil

EO X51.02

1. **Performance**: Identify Aspects of a Chart

2. **Conditions**:

   a. Given:

      (1) Chart 3441 *Haro Strait, Boundary Pass and / et Satellite Channel*,
      (2) Supervision, and
      (3) Assistance as required.

   b. Denied: Nil.

   c. Environmental: Classroom or training area large enough to accommodate the entire group using tables suitable for chartwork.

3. **Standard**: The student shall identify chart information by:

   a. describing Mercator chart projection;
   b. explaining chart maintenance;
   c. identifying title block and other information, to include:

      (1) chart title,
      (2) projection,
      (3) scale of the chart,
      (4) depth measurement,
      (5) elevation measurement,
      (6) sources,
      (7) cautionary notes,
      (8) chart number,
      (9) chart edition,
      (10) correction dates,
      (11) important information and warnings,
      (12) adjoining charts,
      (13) large scale chart numbers,
      (14) tidal diamonds,
      (15) inserts / continuations,
      (16) distance scales, and
      (17) compass rose.

4. **Teaching Points**:

TP	Description	Method	Time	Refs
TP1	Explain Mercator chart projection.	Interactive Lecture	5 min	7.
TP2	Describe how to care for and maintain a chart.	Interactive Lecture	5 min	
TP3	Describe and have the students find the chart title block and other information found on a chart, to include: a. chart title block information, to include: (1) chart title, (2) projection, (3) scale of the chart, (4) depth measurement, (5) elevation measurement, (6) sources, and (7) cautionary notes, and b. other information found on a chart, to include: (1) chart number, (2) chart edition, (3) correction dates, (4) important information and warnings, (5) adjoining charts, (6) large scale chart numbers, (7) tidal diamonds, (8) inserts / continuations, (9) distance scales, and (10) compass rose.	Interactive Lecture	40 min	7. (pp. 9–19)

5. **Time**:

a. Introduction / Conclusion: 10 min
b. Interactive Lecture: 50 min
c. Total: 60 min

6. **Substantiation**: An interactive lecture was chosen for TPs 1–3 to orient the students to information found on marine charts and to generate interest in small craft navigation.

7. **References**: ISBN 1-57409-052-6 Larkin, F. (1998). *Basic coastal navigation.* Dobbs Ferry, NY: Sheridan House Inc.

8. **Training Aids**:

   a. Presentation aids (eg, whiteboard / flip chart / OHP/ multimedia projector) appropriate for the classroom / training area, and
   b. Chart 3441 *Haro Strait, Boundary Pass and / et Satellite Channel*.

9. **Learning Aids**:

   a. Chart 3441 *Haro Strait, Boundary Pass and / et Satellite Channel* (one per two students), and
   b. Chart information worksheet.

10. **Test Details**: Nil.

11. **Remarks**: The timings for this EO are based on a 30 minute period so will need to be adjusted for Ship's Boat Operator.

EO X51.03

1. **Performance**: Identify Chart Symbols

2. **Conditions**:

   a. Given:

      (1) *Symbols Abbreviations Terms (Chart 1),*
      (2) Supervision, and
      (3) Assistance as required.

   b. Denied: Nil.

   c. Environmental: Classroom or training area large enough to accommodate the entire group using tables suitable for chartwork.

3. **Standard**: The student shall identify chart symbols by identifying symbols to include:

   a. hazards,
   b. landmarks,
   c. navigation marks,
   d. port facilities, and
   e. visible shore features.

4. **Teaching Point**: Have the students identify chart symbols.

5. **Time**:

a.	Introduction / Conclusion:	10 min
b.	Practical Activity:	50 min
c.	Total:	60 min

6. **Substantiation**: A practical activity was chosen for this TP as it is an interactive way to introduce students to identifying chart symbols. This activity contributes to the development of navigation skills in a fun and challenging setting.

7. **Reference**: Minister of Fisheries and Oceans. (2004). *Symbols abbreviations terms (Chart 1)*. Ottawa, ON: Canadian Hydrographic Service.

8. **Training Aids**:

   a. Presentation aids (eg, whiteboard / flip chart / OHP / multimedia projector) appropriate for the classroom / training area,
   b. *Symbols Abbreviations Terms (Chart 1)*, and
   c. Chart Symbols Answer Key.

9. **Learning Aids**:

   a. *Symbols Abbreviations Terms (Chart 1)* (one per two students),
   b. Symbols Abbreviations Terms (Chart 1) Worksheet,
   c. Chart symbols worksheets 1–3, and
   d. Chart symbols answer sheet.

10. **Test Details**: Nil.

11. **Remarks**: Nil.

EO X51.04

1. **Performance:** Locate a Position on a Chart

2. **Conditions:**

   a. Given:

      (1) *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*,
      (2) Navigation instruments (IAW Chapter 2),
      (3) Supervision.

   b. Denied: Assistance.

   c. Environmental: Classroom or training area large enough to accommodate the entire group with tables suitable for chartwork.

3. **Standard:** The student shall:

   a. locate a position on a chart using:

      (1) an electronic position with a navigational track and a dead reckoning (DR), and
      (2) a three-bearing fix with a navigational track and DR.

   b. complete a fixing paper to an accuracy of 60 percent.

4. **Teaching Points:**

TP	Description	Method	Time	Refs
TP1	Demonstrate and have the students practice using navigation instruments, to include: a. pencils, b. eraser, c. parallel ruler, d. dividers, e. drafting compass, and f. speed-time-distance calculator.	Demonstration and Performance	Para 11	7a. (pp. 61–64)
TP2	Describe latitude and longitude.	Interactive Lecture	Para 11	7c. (pp. 2–3)
TP3	Conduct an activity where the students will determine the latitude and longitude of a given point on a chart.	Practical Activity	Para 11	7c. (pp. 85–89) 7f. (pp.105–-118)
TP4	Demonstrate and have the students measure distances on	Demonstration	Para 11	7c. (pp.

TP	Description	Method	Time	Refs
	a chart.	and Performance		103–106)
TP5	Demonstrate and have the students plot a position on a chart using an electronic position to include: a. a navigational track, and b. a dead reckoning.	Demonstration and Performance	Para 11	7b. (pp. 207–208, pp. 224–229) 7c. (pp. 83–89) 7d. (pp. 218–219) 7e. (pp. 135–136) 7f. (pp.105–118)
TP6	Demonstrate and have the students plot a position on a chart using a three-bearing fix to include: a. a navigational track, and b. a dead reckoning.	Demonstration and Performance	Para 11	7b. (pp. 207–208, pp. 224–229) 7c. (pp. 83–89) 7d. (pp. 218–219) 7e. (pp. 135–136) 7f. (pp.105–118)

5. **Time:**

a. Introduction / Conclusion: 10 min
b. Demonstration and Performance: 290 min
c. Interactive Lecture: 20 min
d. Practical Activity: 40 min
e. Total: 360 min

6. **Substantiation:**

a. A demonstration and performance was chosen for TP 1, 4, 5, and 6 as it allows the instructor to explain and demonstrate the skills the student is expected to acquire while providing an opportunity for the student to practice the skills under supervision.

b. An interactive lecture was chosen for TP 2 to introduce latitude and longitude to the students.

c. A practical activity was chosen for TP 3 as it is an interactive way to allow students to experience determining the latitude and longitude of points and locating positions on a chart using different methods. This activity contributes to the development of navigation skills in a fun and challenging way.

7. **References:**

a. ISBN 0-07-137226-1 Brogdon, B. (1995). *Boat navigation for the rest of us* (2nd ed.). Camden, ME: International Marine.

b. C-57-007-002/AF-001 Royal Navy. (1987). *Admiralty manual of navigation* (Vol. 1). (Rev. 1987). London, England: Her Majesty's Stationery Office.

c. ISBN 1-57409-052-6 Larkin, F. (1998). *Basic coastal navigation.* Dobbs Ferry, NY: Sheridan House Inc.

d. ISBN 0-9694958-0-3 Saunders, A. E. (1990). *Small craft piloting & coastal navigation.* Halifax, NS: Binnacle Navigation Instruments.

e. ISBN 978-1-55750-248-3 Cutler, T.J. (2004). *Dutton's nautical navigation*. Annapolis, MD: Naval Institute Press.

f. NOTC Venture. (2012). *CFCD 131 bridge watchkeeping manual for the royal Canadian navy. (2015)*. Victoria, BC: NOTC Venture.

8. **Training Aids:**

a. Presentation aids (eg, whiteboard / flip chart / OHP / multimedia projector) appropriate for the classroom / training area,
b. Navigation instruments, and
c. Chart 3441 *Haro Strait, Boundary Pass and / et Satellite Channel*.

9. **Learning Aids:**

a. Navigation instruments (one set per two students),
b. Chart 3441 *Haro Strait, Boundary Pass and / et Satellite Channel* (one per two students),
c. *Symbols Abbreviations Terms (Chart 1)*,

d. Fixing paper,
e. Distances worksheet, and
f. Plotting exercises.

10. **Test Details:** This EO is assessed IAW Chapter 3.

11. **Remarks:**

a. Phase 4, the following periods are mandatory and a suggested time allocation is as follows:

(1) TP 1 – 60 min,
(2) TP 2, 3, 4 and 5 (30 min each) – 120 min, and
(3) TP 6 – 60 min.

b. Ship's Boat Operator, conduct all teaching points for a total of 360 min.

c. Sea Environmental Training Course (SETC):

(1) TP1 – via Distributed Learning,
(2) TP 2, 3 – 60 min,
(3) TP 4 – 25 min,
(4) TP 5 – 25 min, and
(5) TP 6 – 40 min.

EO X51.05

1. **Performance**: Locate a Position Using a Global Positioning System (GPS) Receiver

2. **Conditions**:

   a. Given:

      (1) GPS receiver,
      (2) Supervision, and
      (3) Assistance as required.

   b. Denied: Nil.

   c. Environmental: Classroom or training area large enough to accommodate the entire group.

3. **Standard**: The student shall locate a position using a GPS receiver.

4. **Teaching Points**:

TP	Description	Method	Time	Refs
TP1	Discuss the GPS, to include: a. what the GPS is, b. how it works, c. components, to include: (1) satellites, (2) ground stations, and (3) receivers.	Interactive Lecture	10 min	7b. (pp. 49–55)
TP2	Explain GPS terminology, to include: a. accuracy, b. differential GPS (DGPS), c. triangulation, d. three-dimensional (3D) coordinate, e. wide area augmentation service (WAAS), and f. waypoint.	Interactive Lecture	5 min	7c. (pp. 22–23)

TP	Description	Method	Time	Refs
TP3	Identify and describe the components of a GPS receiver, to include: a. antenna, b. screen, c. battery compartment, and d. buttons, to include: (1) on / off, (2) backlight, (3) enter, (4) escape, (5) zoom in, (6) zoom out, (7) menu, (8) NAV, (9) mark, (10) GOTO, and (11) arrow joystick (if fitted).	Interactive Lecture	10 min	7b. (pp. 64–65)
TP4	Explain and have the students scroll through the following screen pages on a GPS receiver: a. satellite status, b. position, to include: (1) coordinates, (2) accuracy, (3) date and time, and (4) battery condition; and c. compass navigation.	Demonstration and Performance	10 min	7a. (p. 20, p. 22, p. 24, pp. 37–38)
TP5	Conduct an activity where the students will locate a position using a GPS receiver.	Practical Activity	35 min	

5. **Time**:

a. Introduction / Conclusion: 10 min
b. Interactive Lecture: 25 min
c. Demonstration and Performance: 10 min
d. Practical Activity: 35 min
e. Total: 80 min

6. **Substantiation**:

a. An interactive lecture was chosen for TPs 1–3 to orient the students to the components of the GPS.

b. A demonstration and performance was chosen for TP 4 as it allows the instructor to explain and demonstrate how to scroll through the different screen pages of a GPS receiver while providing an opportunity for the students to practice under supervision.

c. A practical activity was chosen for TP 5 to allow the students to experience navigating with a GPS in a safe, controlled environment.

7. **References**:

a. Thales Navigation Incorporated. (2004). *Magellen explorist 200 gps user manual*. San Dimas, CA: Thales Navigation Inc.

b. ISBN 0-7645-6933-3 McNamara, J. (2004). *GPS for dummies.* Hoboken, NJ: Wiley Publishing, Inc.

c. ISBN 0-07-223171-8 Broida, R. (2004). *How to do everything with your GPS.* Emerville, CA: McGraw-Hill.

8. **Training Aids**:

a. Presentation aids (eg, whiteboard / flip chart / OHP / multimedia projector) appropriate for the classroom / training area,
b. GPS receiver,
c. GPS activity game pieces,
d. GPS activity handout,
e. Six watertight containers, and
f. GPS receiver handout.

9. **Learning Aids**:

a. GPS receiver (one per two students),
b. GPS receiver handout,
c. Tape, and
d. GPS activity handout.

10. **Test Details**: Nil.

11. **Remarks**: Nil.

EO X51.06

1. **Performance**: Locate a Position on a Chart Using RADAR

2. **Conditions**:

   a. Given:

      (1) *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*,
      (2) Navigation instruments (IAW Chapter 2),
      (3) Supervision, and
      (4) Assistance as required.

   b. Denied: Nil.

   c. Environmental: Classroom or training area large enough to accommodate the entire group.

3. **Standard**: The student shall locate a position on a chart using RADAR.

4. **Teaching Points**:

TP	Description	Method	Time	Refs
TP1	Discuss RADAR, to include: a. what RADAR is, b. how it works, and c. components, to include: (1) antenna, (2) transceiver, and (3) display unit.	Interactive Lecture	5 min	7a. (p. 405, p. 406) 7b. (p. 127, p. 128) 7c. (pp. 1–3)
TP2	Explain RADAR terminology, to include: a. beam width, b. gain, c. rain clutter, d. range, e. sea clutter, f. errors, to include: (1) index, and (2) bearing; and g. features, to include: (1) cursor, (2) echo trails,	Interactive Lecture	5 min	7a. (pp. 405–412, pp. 418–421, p. 424) 7b. (p. 129) 7c. (pp. 5–7)

TP	Description	Method	Time	Refs
	(3) electronic bearing line (EBL), and (4) variable range marker (VRM).			
TP3	Explain the procedure for obtaining a RADAR range fix.	Demonstration and Performance	5 min	7a. (p. 431, p. 432)
TP4	Explain, demonstrate and have the students locate a position on a chart using a RADAR range fix.	Demonstration and Performance	65 min	

5. **Time**:

   a. Introduction / Conclusion: 10 min
   b. Interactive Lecture: 10 min
   c. Demonstration and Performance: 60 min
   d. Total: 80 min

6. **Substantiation**:

   a. An interactive lecture was chosen for TPs 1 and 2 to orient the students to the components of RADAR.

   b. A demonstration and performance was chosen for TPs 3 and 4 as it allows the instructor to explain and demonstrate how to obtain a RADAR range fix and plot its position on a chart while providing an opportunity for the students to practice these skills under supervision.

7. **References**:

   a. C-57-007-002/AF-001 Royal Navy. (1987). *Admiralty manual of navigation* (Vol. 1) (Rev. 1987). London, England: Her Majesty's Stationery Office.

   b. ISBN 0-7153-0297-3 Davidson, P. (1995). *Glénans guides: Coastal navigation*. Newton Abbot, Devon: David & Charles.

   c. Furuno USA, Inc. (2008). *Operator's guide to marine RADAR*. Camas, WA: Furuno USA, Inc.

8. **Training Aids**:

   a. Presentation aids (eg, whiteboard / flip chart / OHP / multimedia projector) appropriate for the classroom / training area,
   b. *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*, and
   c. Navigation instruments (IAW Chapter 2).

9. **Learning Aids**:

   a. *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*,
   b. Navigation instruments (IAW Chapter 2), and
   c. RADAR picture handout.

10. **Test Details**: This EO is assessed IAW Chapter 3, Annex D.

11. **Remarks**: This EO should be taught on board a Sea Cadet Training Vessel (SCTV) alongside. This will allow the students to learn the operation of the specific RADAR that they will use during EO S455.05 (Act as a Member of an SCTV).

EO X51.07

1. **Performance**: Plan a Passage

2. **Conditions**:

   a. Given:

      (1) *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*,
      (2) Navigation instruments (IAW) Chapter 2),
      (3) Navigation publications (IAW *Charts and Nautical Publication Regulations, 1995 [SOR / 95-149]*),
      (4) Supervision, and
      (5) Assistance as required.

   b. Denied: Nil.

   c. Environmental: Classroom or training area large enough to accommodate the entire group using tables suitable for chartwork.

3. **Standard**: The student shall plan a passage.

4. **Teaching Points**:

TP	Description	Method	Time	Refs
TP1	Explain the symbols used to label the following on a passage: a. planned track, b. planned speed, c. leadmark / sternmark (LM / SM), d. chart change, e. point of no return (PNR), f. distance to go (DTG), g. calling-in point (CIP), h. gyro check, i. estimated position (EP), and j. course made good / course to steer (CMG / CTS).	Interactive Lecture	15 min	7b. (p. 174, p. 191, p. 361) 7c. (pp.105–118)
TP2	Explain, demonstrate and have the cadets label a limiting danger line (LDL).	Demonstration and Performance	10 min	7b. (pp. 345–347)
TP3	Explain, demonstrate and have the cadets label a clearing bearing.	Demonstration and Performance	25 min	7b. (pp. 358–360)
TP4	Explain, demonstrate and have the cadets label a clearing depth.	Demonstration and Performance	5 min	7b. (pp. 358–360)
TP5	Explain, demonstrate and have the cadets label a wheel	Demonstration	20 min	7b. (pp.

TP	Description	Method	Time	Refs
	over position.	and Performance		185–190)
TP6	Identify and explain the passage planning checklist.	Interactive Lecture	5 min	7c. pp.731–783)
TP7	Conduct an activity where the cadets will plan a passage.	Practical Activity	150 min	

5. **Time**:

a. Introduction / Conclusion: 10 min
b. Interactive Lecture: 20 min
c. Demonstration and Performance: 60 min
d. Practical Activity: 150 min
e. Total: 240 min

6. **Substantiation**:

a. An interactive lecture was chosen for TPs 1 and 6 to introduce the cadets to the chart symbols and planning checklist used in the passage planning process.

b. A demonstration and performance was chosen for TPs 2–5 as it allows the instructor to explain and demonstrate how to label LDLs, clearing bearings and wheel over positions on a chart while providing an opportunity for the cadets to practice these skills under supervision.

c. A practical activity was chosen for TP 7 as it allows the cadets to practice planning a passage in a safe and controlled environment.

7. **References**:

a. Naval Officer Training Centre Venture. (2009). *Checklist for passage planning*. Esquimalt, BC: Department of National Defence.

b. C-57-007-002/AF-001 Royal Navy. (1987). *Admiralty manual of navigation* (Vol. 1). (Rev. 1987). London, England: Her Majesty's Stationery Office.

c. NOTC Venture. (2012). *CFCD 131 bridge watchkeeping manual for the royal Canadian navy. (2015)*. Victoria, BC: NOTC Venture.

8. **Training Aids**:

   a. Presentation aids (eg, whiteboard / flip chart / OHP / multimedia projector) appropriate for the classroom / training area,
   b. *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*, and
   c. Navigation instruments (IAW Chapter 2).

9. **Learning Aids**:

   a. *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*,
   b. Navigation instruments (IAW Chapter 2),
   c. Navigation publications (IAW *Charts and Nautical Publication Regulations, 1995 [SOR / 95-149]*),
   d. Passage planning checklist, and
   e. Passage planning worksheet.

10. **Test Details**: This EO is assessed IAW Chapter 3, Annex D.

11. **Remarks**: Nil.

EO X51.08

1. **Performance**: Explain Electronic Chart Display and Information Systems (ECDIS)

2. **Conditions**:

   a. Given:

      (1) Supervision, and
      (2) Assistance as required.

   b. Denied: Nil.

   c. Environmental: Classroom or training area large enough to accommodate the entire group.

3. **Standard**: The student shall explain ECDIS, to include:

   a. chart standards,
   b. hardware, and
   c. software.

4. **Teaching Points**:

TP	Description	Method	Time	Refs
TP1	Explain electronic chart standards, to include: a. raster, and b. vector.	Interactive Lecture	25 min	7c.
TP2	Identify and explain the use of ECDIS hardware.	Interactive Lecture	5 min	7b.
TP3	Identify and explain ECDIS software screens.	Interactive Lecture	5 min	7a.–7c.

5. **Time**:

   a. Introduction / Conclusion: 5 min
   b. Interactive Lecture: 35 min
   c. Total: 40 min

6. **Substantiation**: An interactive lecture was chosen for this lesson to orient the students to electronic chart standards and ECDIS hardware and software.

7. **References**:

a. Fugawi Incorporated. (2006). *Fugawi global navigator screenshot*. Retrieved October 14, 2009, from www.fugawi.com/web/images/products/screen_fugawi_enc_bsb_hr.gif

b. Jeppeson Marine, Inc. (2006). *NobleTec MaxPRO user guide*. Retrieved October 14, 2009, from www.nobletec.com/products/pdf/userguide_maxpro.pdf

c. Offshore Systems Ltd. (2006). *ECPINS® M:The military ECDIS solution.* Retrieved October 14, 2009, from www.osigeospatial.com/offshoresystems/pdf/osi_ecpins-m.pdf

8. **Training Aids**:

a. Presentation aids (eg, whiteboard / flip chart / OHP / multimedia projector) appropriate for the classroom / training area, and

b. Program screen captures.

9. **Learning Aids**: Nil.

10. **Test Details**: This EO is assessed IAW Chapter 3, Annex D.

11. **Remarks**: Nil.

EO X51.09

1. **Performance**: Execute a Passage

2. **Conditions**:

   a. Given:

      (1) *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*,
      (2) Navigation instruments (IAW Chapter 2),
      (3) Navigation publications (IAW *Charts and Nautical Publication Regulations, 1995 [SOR / 95-149]*),
      (4) Fixing paper, and
      (5) Supervision.

   b. Denied: Assistance.

   c. Environmental: Classroom or training area large enough to accommodate the entire group using tables suitable for chartwork.

3. **Standard**: The student shall execute a passage by completing a fixing paper to an accuracy of 60 percent.

4. **Teaching Points**: Supervise the students while they execute a passage.

5. **Time**:

a.	Introduction / Conclusion:	10 min
b.	Practical Activity:	110 min
c.	Subtotal:	120 min
d.	Total (Three occurrences):	360 min

6. **Substantiation**: A practical activity was chosen for this lesson as it is an interactive way to allow students to experience executing a passage in a safe and controlled manner. This activity contributes to the development of navigation skills in a fun and challenging way.

7. **References**: Nil.

8. **Training Aids**: Nil.

9. **Learning Aids**:

   a. *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*,

b. Navigation instruments (IAW Chapter 2),,
c. Navigation publications (IAW *Charts and Nautical Publication Regulations, 1995 [SOR / 95-149]*), and
d. Fixing paper.

10. **Test Details**: This EO is assessed IAW Chapter 3, Annex D.

11. **Remarks**:

a. To accommodate the three fixing papers, this EO shall be conducted in three occurrences:

(1) the first occurrence being conducted prior to EO X51.06 (Locate a Position on a Chart Using RADAR), and

(2) the second and third occurrences being conducted after EO X51.07 (Plan a Passage).

b. The PC should be conducted after EO S455.05 (Act as a Member of a Crew of a Sea Cadet Training Vessel [SCTV]).

EO X51.10

1. **Performance**: Complete a Navigation Self Study Package

2. **Conditions**:

   a. Given:

      (1) *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*,
      (2) Navigation instruments (IAW Chapter 2),
      (3) Navigation publications (IAW *Charts and Nautical Publication Regulations, 1995 [SOR / 95-149]*),
      (4) Self study package,
      (5) Supervision, and
      (6) Assistance as required.

   b. Denied: Nil.

   c. Environmental: Classroom or training area suitable to complete the self study package.

3. **Standard**: The student shall complete a fixing paper by completing a self study package.

4. **Teaching Points**: Have the cadets complete the navigation self study package.

5. **Time**:

   a. Self study: 90 min
   b. Total: 90 min

6. **Substantiation**: A self study was chosen for this lesson as it allows the cadet to enhance their proficiency at their own learning pace. This encourages the cadet to become more self-reliant and independent by focusing on their own learning instead of learning directed by the instructor.

7. **References**: Nil.

8. **Training Aids**: Nil.

9. **Learning Aids**:

   a. Self study package,
   b. *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*, and

c. Navigation instruments (IAW Chapter 2).

10. **Test Details**: Nil

11. **Remarks**: Completion of the navigation self study package satisfies the requirement for EO C523.02.

CANADIAN CADET ORGANIZATIONS

NAVIGATION MANUAL

INSTRUCTIONAL GUIDE

SECTION 1

EO X51.01 – EXPLAIN THE PRINCIPLES OF MARINE NAVIGATION

Total Time:	120 min

PREPARATION

PRE-LESSON INSTRUCTIONS

This IG supports EO X51.01 (Explain the Principles of Marine Navigation).

Photocopy the tide table handout located at Annex A, two copies of the Tidal Graph Worksheet located at Annex B and the Speed, Time and Distance handout located at Annex C for each student.

Photocopy the Speed, Time and Distance (Answer Key) located at Annex D.

PRE-LESSON ASSIGNMENT

Nil.

APPROACH

An interactive lecture was chosen for TPs 1–3 as it allows the instructor to provide information on navigation publications and tidal theory.

A demonstration and performance was chosen for TPs 4 and 5 as it allows the instructor to demonstrate marine navigation skills while providing an opportunity for students to practice these skills under supervision.

INTRODUCTION

REVIEW

Nil.

OBJECTIVES

By the end of this lesson the student shall be expected to explain the principles of marine navigation.

IMPORTANCE

It is important for the students to explain the principles of marine navigation and how they are applied when planning to navigate. A solid understanding of these principles will ensure a safe and effective navigation plan can be created while providing flexibility for unforeseen circumstances.

Teaching Point 1	**Explain navigation publications.**
Time: 20 min	Method: Interactive Lecture

NAVIGATION PUBLICATIONS

The navigator uses many information sources when planning and conducting a voyage. Historically, the sources of this information have been found in printed publications. As technology advances, electronic sources are now available. The navigator must know what information is needed to navigate the ship safely and how to obtain it.

The following is a list of the most important documents that a navigator should have:

Symbols Abbreviations Terms (Chart 1)

This publication explains the symbols, abbreviations and terms used on charts published by the Canadian Hydrographic Service (CHS).

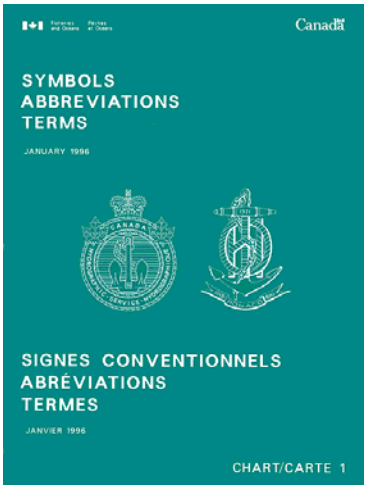


Figure 1 *Symbols Abbreviations Terms (Chart 1)*

Note. From Fisheries and Oceans Canada. (2008). *Tides, Currents and Water Levels*. Retrieved October 15, 2008, from http://www.waterlevels.gc.ca/english/relatedproducts.shtml

Canadian Tide and Current Tables

Canadian Tide and Current Tables is published annually in six volumes representing the different tidal regions in Canada. Each volume contains two tables:

- *Tide Tables* provides predicted times and heights of the high and low waters associated with the vertical movement of the tide.

- *Current Tables* provides predicted times for slack water and the times and velocities of maximum current, all of which are associated with the horizontal movement of the tide.

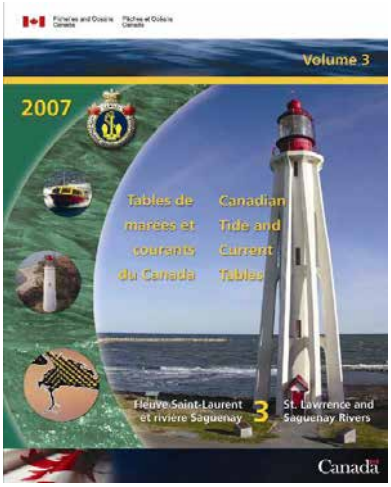


Figure 2 *Canadian Tide and Current Tables*

Note. From Fisheries and Oceans Canada. (2008). *Tides, Currents and Water Levels*. Retrieved October 15, 2008, from http://www.waterlevels.gc.ca/english/relatedproducts.shtml

Chart Catalogues

The Canadian Hydrographic Service (CHS) publishes four chart catalogues that illustrate chart coverage for the Atlantic Coast, the Pacific Coast, the Great Lakes and Central Canada, and the Arctic. These catalogues are available free of charge and are mandatory publications that must be carried by vessels as described in the *Charts and Publications Regulations* of the *Canada Shipping Act*.

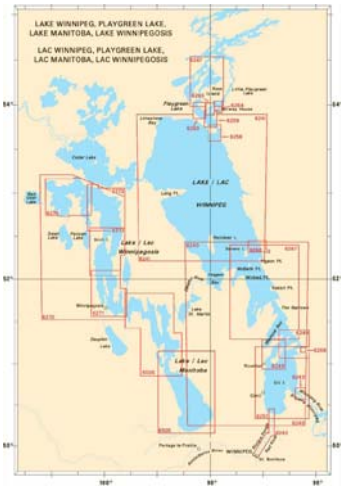
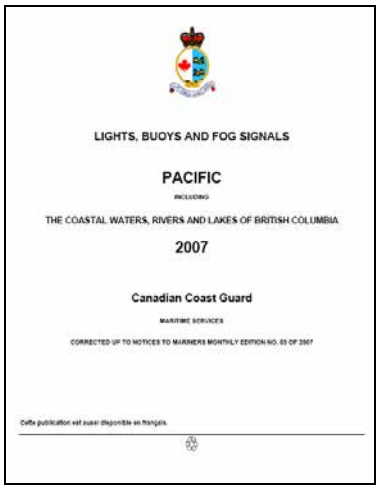


Figure 3 Example of a Chart Catalogue

Note. From Fisheries and Oceans Canada. (2008). *Tides, Currents and Water Levels*. Retrieved October 15, 2008, from http://www.waterlevels.gc.ca/english/relatedproducts.shtml

List of Lights, Buoys and Fog Signals

List of Lights, Buoys and Fog Signals is published in four volumes that contain information on the characteristics and position of shore lights, lighted buoys and fog signals for all regions.



LIGHTS, BUOYS AND FOG SIGNALS

PACIFIC

INCLUDING

THE COASTAL WATERS, RIVERS AND LAKES OF BRITISH COLUMBIA

2007

Canadian Coast Guard

MARITIME SERVICES

CORRECTED UP TO NOTICES TO MARINERS MONTHLY EDITION NO. 03 OF 2007

Cette publication est aussi disponible en français.

Figure 4 *List of Lights, Buoys and Fog Signals, Pacific 2007*

Note. From Canadian Coast Guard. (2008). *List of Lights*. Retrieved October 15, 2008, from http://www.notmar.gc.ca/go.php?doc=end/services/list/pacific-coast-2007

Notices to Mariners (NOTMAR) Annual Edition

NOTMAR is published annually at the beginning of each year and detail newly discovered hazards to shipping and changes in aids to navigation such as buoys and lights. They also contain information on a wide variety of subjects of concern to a mariner, such as:

- marine regulations,
- pollution,
- search and rescue,
- military exercise areas,
- charts and publications, and
- marine safety.

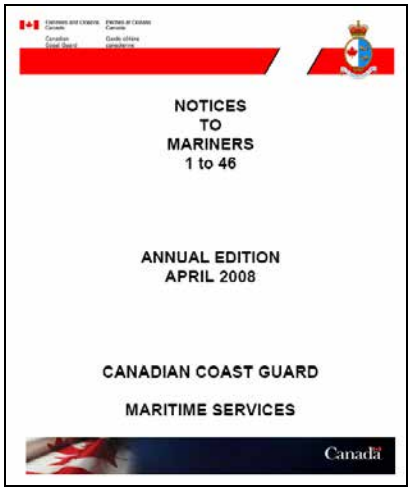


Figure 5 *Notices to Mariners Annual Edition 2008*

Note. From Canadian Coast Guard. (2008). *Notices to Mariners Annual Edition*. Retrieved October 15, 2008, from http://www.notmar.gc.ca/2008-annual/front-pages.pdf

Updates to *NOTMARs* are published monthly and are available electronically for download or as paper copies through the subscription service.

Radio Aids to Marine Navigation

Published annually in two volumes, it provides marine information concerning weather forecast areas, telephone service and radio communications procedures. It also lists the services provided by Canadian Coast Guard Radio Stations, vessel traffic and information services and the location and characteristics of marine radio aids to navigation (eg, Loran-C and radio beacons [RACONS]).

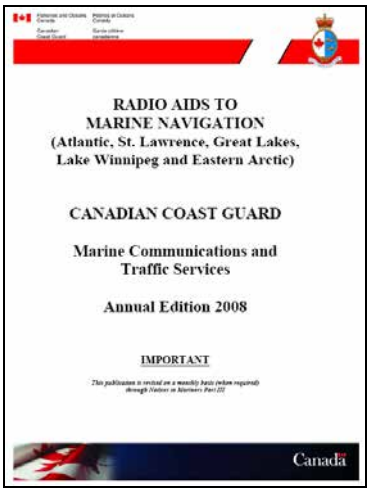


Figure 6 *Radio Aids to Marine Navigation*

Note. From Canadian Coast Guard. (2008). *Tides, Currents and Water Levels*. Retrieved October 15, 2008, from http://www.waterlevels.gc.ca/english/relatedproducts.shtml

Sailing Directions

These publications contain detailed information on natural characteristics, geography, climatic variations, and wharves for each region. *Sailing Directions* are the indispensable companions to charts. They include information not included on a chart such as descriptions (including photographs) of the best approaches to harbours, harbour facilities, anchorages, local history, rules, regulations and table of distances.

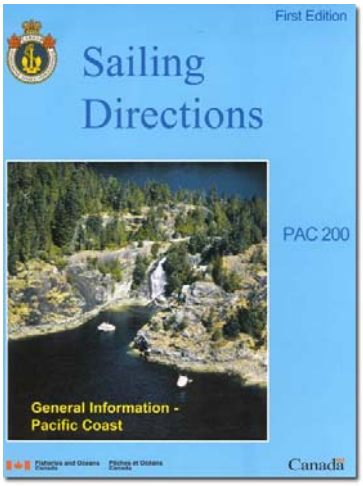


Figure 7 *Sailing Directions*

Note. From Fisheries and Oceans Canada. (2008). *Tides, Currents and Water Levels*. Retrieved October 15, 2008, from http://www.waterlevels.gc.ca/english/relatedproducts.shtml

The Canadian Aids to Navigation System

This publication defines the devices or systems, external to the vessel, which are used in Canadian waters to assist mariners in determining position and course, to warn of dangers or obstructions and to advise of the location of the best or preferred route.

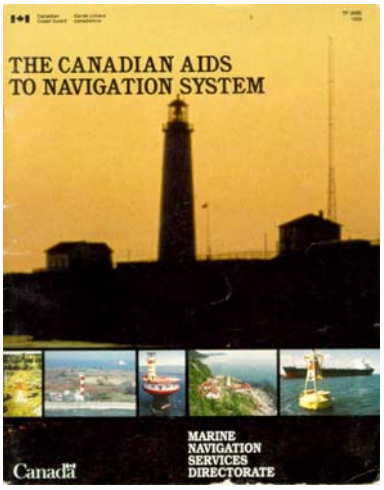


Figure 8 Canadian Aids to Navigation

Note. From Canadian Coast Guard. (2008). *Aids to Navigation*. Retrieved October 15, 2008, from http://www.notmar.gc.ca/go.php?doc=end/services/cans/front-pages.pdf

---

CONFIRMATION OF TEACHING POINT 1

QUESTIONS:

Q1. *Canadian Tide and Current Tables* is published in how many volumes?

Q2. When are *NOTMARs* published?

Q3. What information is included in *Sailing Directions*?

ANTICIPATED ANSWERS:

A1. Six.

A2. Annually at the beginning of the year.

A3. Information not included on a chart such as descriptions (including photographs) of the best approaches to harbours, harbour facilities, anchorages, local history, rules, regulations and table of distances.

Teaching Point 2	**Explain tidal theory.**
Time: 20 min	Method: Interactive Lecture

TIDAL THEORY

Tide Raising Forces

Tides are caused by the gravitational pull of the moon and to a lesser extent, other bodies in the solar system. Tides are greatest when the moon is new or full.

Tidal Terminology

The following terms are used when describing tidal theory:

Reference port. A port for which tidal predictions are provided in the form of daily tables giving the times and heights of high and low waters. The times given are in Standard Time for the location and the heights are measured from Chart Datum.

Secondary port. A port for which time and height differences relative to a reference port are given so that daily tidal predictions can be calculated.

Tidal range. The difference in height between low water and high water.

Tidal current. The horizontal movement of water due to the difference in the height of water caused by the tide. As the tide rises or falls in one area, the water will flow to or from another, creating a current.

Chart Datum. The plane of vertical reference to which all charted depths and drying heights are related. In non-tidal waters, it is also the vertical datum for elevations and clearances. It is chosen to show the least depth of water found in any place under "normal" meteorological conditions; it is a plane so low that the water level will seldom fall below it.

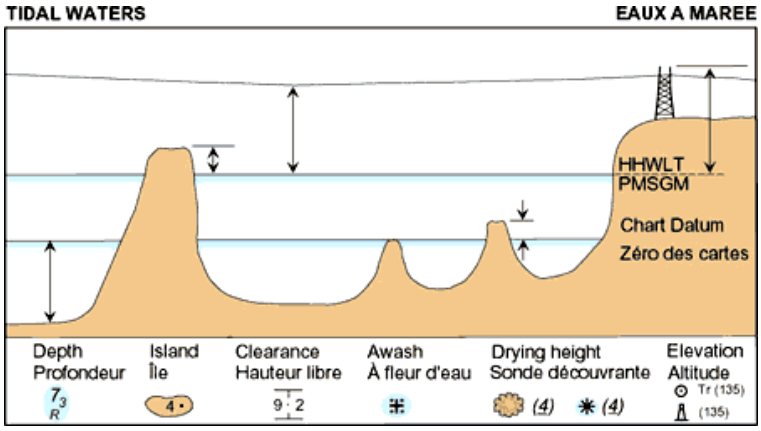


Figure 9 Chart Datum

Note. From Fisheries and Oceans Canada. (2008). *Tides, Currents and Water Levels*. Retrieved October 15, 2008, from http://www.waterlevels.gc.ca/english/glossary.shtml

Height of tide. The vertical distance between the surface of the sea and Chart Datum. The total depth of water is found by adding the height of the tide to the charted depth. In the case of some ports which are not navigable at low water and where vessels rest on keel blocks or mattresses during low tide, the heights of the tide are measured from those keel blocks or mattresses.

Spring. The tides of increased range occurring near the times of full moon and new moon.

Neap. The tides of decreased range or tidal currents of decreased speed occurring near the times of the first and last quarters of the moon.

Flood current. A tidal current that generally sets toward the shore or in the direction of the tide progression. Also called flood, flood current or ingoing stream.

Ebb current. A tidal current that generally sets seaward or in the opposite direction to the tide progression. Also called ebb, ebb current or outgoing stream.

The largest tidal ranges in the world occur in the Bay of Fundy (more exactly Minas Basin) and in Ungava Bay (more exactly Leaf Basin) on the East Coast of Canada, where a 16-m (53-foot) tide range can be observed.

The Bay of Fundy and Ungava Bay are "V" shaped, so that water entering at the wide mouth from the ocean end is funnelled into less and less space as it moves into the head of the bays and the water forms a large tide.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS:

Q1. When are the greatest tides found?

Q2. What vertical distance is used to measure the height of tide?

Q3. What is the name of a tidal current that sets seaward?

ANTICIPATED ANSWERS:

A1. At new or full moon.

A2. The surface of the sea and chart datum.

A3. Ebb.

Teaching Point 3 **Identify and explain how to use information found on a tide table.**

Time: 5 min Method: Interactive Lecture

TIDE TABLE

Distribute the tide table handout located at Annex A to each student.

Have the students refer to the tide table handout while referring to the example.

SAINT JOHN **AST Z+4** **2008** **TIDE TABLES**

July - julliet

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0325	2.0	0.6	16	0430	4.9	1.5
	0936	24.9	7.6		1040	22.6	6.9
TU	1547	3.3	1.0	WE	1644	6.2	1.9
MA	2158	27.2	8.3	ME	2252	24.3	7.4
2	0424	1.6	0.5	17	0511	4.6	1.4
	1035	25.3	7.7		1120	23.0	7.0
WE	1645	3.0	0.9	TH	1724	5.9	1.8
ME	2256	27.9	8.5	JE	2331	24.6	7.5

August-août

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0509	2.0	0.6	16	0518	3.9	1.2
	1119	25.6	7.8		1124	24.0	7.3
FR	1730	3.0	0.9	SA	1731	4.6	1.4
VE	2339	27.2	8.3	SA	2339	25.3	7.7
2	0601	1.6	0.5	17	0554	3.3	1.0
	1210	25.9	7.9		1159	24.6	7.5
SA	1821	2.6	0.8	SU	1808	3.6	1.1
SA				DI			

September-septembre

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0011	26.2	8.0	16	0556	2.3	0.7
	0627	2.3	0.7		1201	26.2	8.0
MO	1234	25.9	7.9	TU	1816	2.0	0.6
LU	1848	2.6	0.8	MA			
2	0055	25.9	7.9	17	0022	26.2	8.0
	0709	2.6	0.8		0635	2.0	0.6
TU	1316	25.9	7.9	WE	1240	26.9	8.2
MA	1931	3.0	0.9	ME	1857	1.3	0.4

Figure 10 Partial Tide Table

Note. From Fisheries and Oceans Canada. (2008). *Tides, Currents and Water Levels*. Retrieved October 15, 2008, from http://www.waterlevels.gc.ca/2008_predictions/vol_1/wlev_ref/00065.pdf

Figure 10 is part of the tide table for Saint John, New Brunswick in the summer of 2008. AST (following the name of the port) indicates the area is in the Atlantic Standard Time zone. 'Z+4' indicates that four hours must be added to local time to obtain Coordinated Universal Time (UTC), also known as Zulu time. To convert predictions into daylight savings time, add one hour.

Except in the province of Saskatchewan, daylight savings time is used throughout Canada from the first Sunday in March where the clocks go ahead one hour, until the first Sunday in November where the clocks are set back one hour.

To use the tide table, locate the month (top of column) and day. Times are to the right of the day. The bolded column lists the height of tide in feet with the next column listing the height in metres.

For example, at Saint John, on July 17, 2008:

- The high water is predicted for 1120 and 2331. The expected high water levels are 7 m (23 feet) and 7.5 m (24.6 feet).
- Low water is predicted for 0511 and 1724. The expected low water levels are 1.4 m (4.6 feet) and 1.8 m (5.9 feet).

As soundings on most Canadian charts are given in metres, water levels should also be referred to in metres.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS:

Q1. Where can the time zone be found on a tide table?

Q2. Which water level column is bolded?

Q3. How are the predicted times converted to daylight savings time?

ANTICIPATED ANSWERS:

A1. Beside the port name.

A2. Water level in feet.

A3. Add one hour.

Teaching Point 4	**Demonstrate and have the students complete a tidal graph for a reference port.**
Time: 25 min	Method: Demonstration and Performance

STEPS FOR MAKING A TIDAL GRAPH

Demonstrate and have the students perform the steps for making a tidal graph.

Distribute two copies of the tidal graph worksheet located at Annex B to each student.

For the following steps, use August 4, 2008 at Saint John, New Brunswick from the tide table located at Annex A.

The steps for making a tidal graph are as follows:

1. Record the port name and date to be graphed on the tidal graph worksheet.

2. On the tide table, locate the month and day needed.

3. Record the time and height of the tide in the corresponding boxes.

Tide	
Time 0117	Height 8.1 m
Correction	Height
Corrected Time	Corrected Height

Figure 11 Step 3

4. Add one hour to the correction box to convert the time to daylight saving time. Since we are creating a graph for a reference port, there is no correction for the height of tide. Enter a zero in the height box.

Tide	
Time 0117	Height 8.1 m
Correction 1 hr	Height 0 m
Corrected Time	Corrected Height

Figure 12 Step 4

5. Enter the corrected time and height of tide in the boxes. These are the values that will be used to create the tidal graph.

Tide	
Time 0117	Height 8.1 m
Correction 1 hr	Height 0 m
Corrected Time 0217	Corrected Height 8.1 m

Figure 13 Step 5

6. Repeat Steps 3–5 for the remaining prediction times.

7. Plot the results on the tidal graph. Above each point, record the predicted time and height of tide.

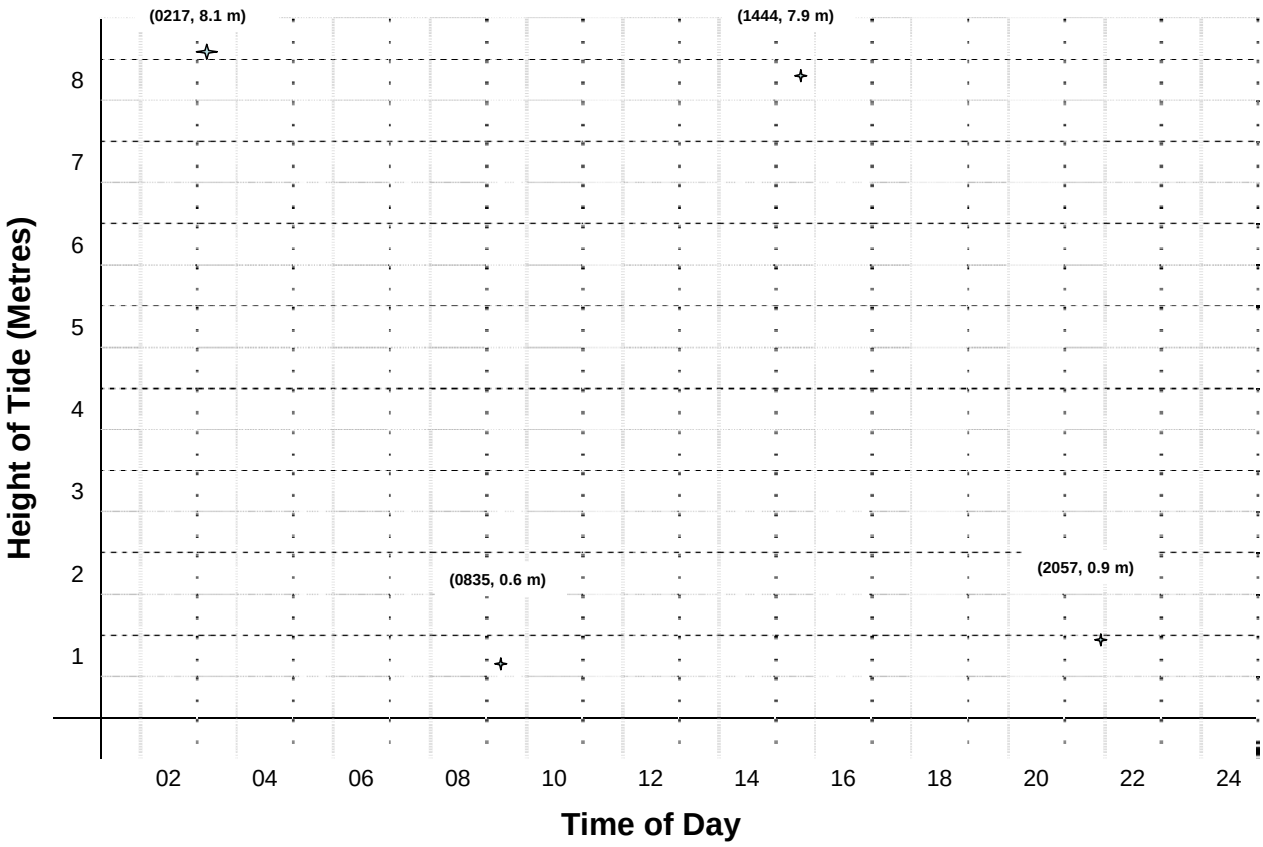


Figure 14 Step 7

8. Connect the plotted points using a sinusoid (as illustrated in Figure 15).

	The rise and fall of the tide is not constant—it decreases in rate as it nears its high or low water level. To represent this graphically, a sinusoid, or curve having the form of a sine wave, is used.

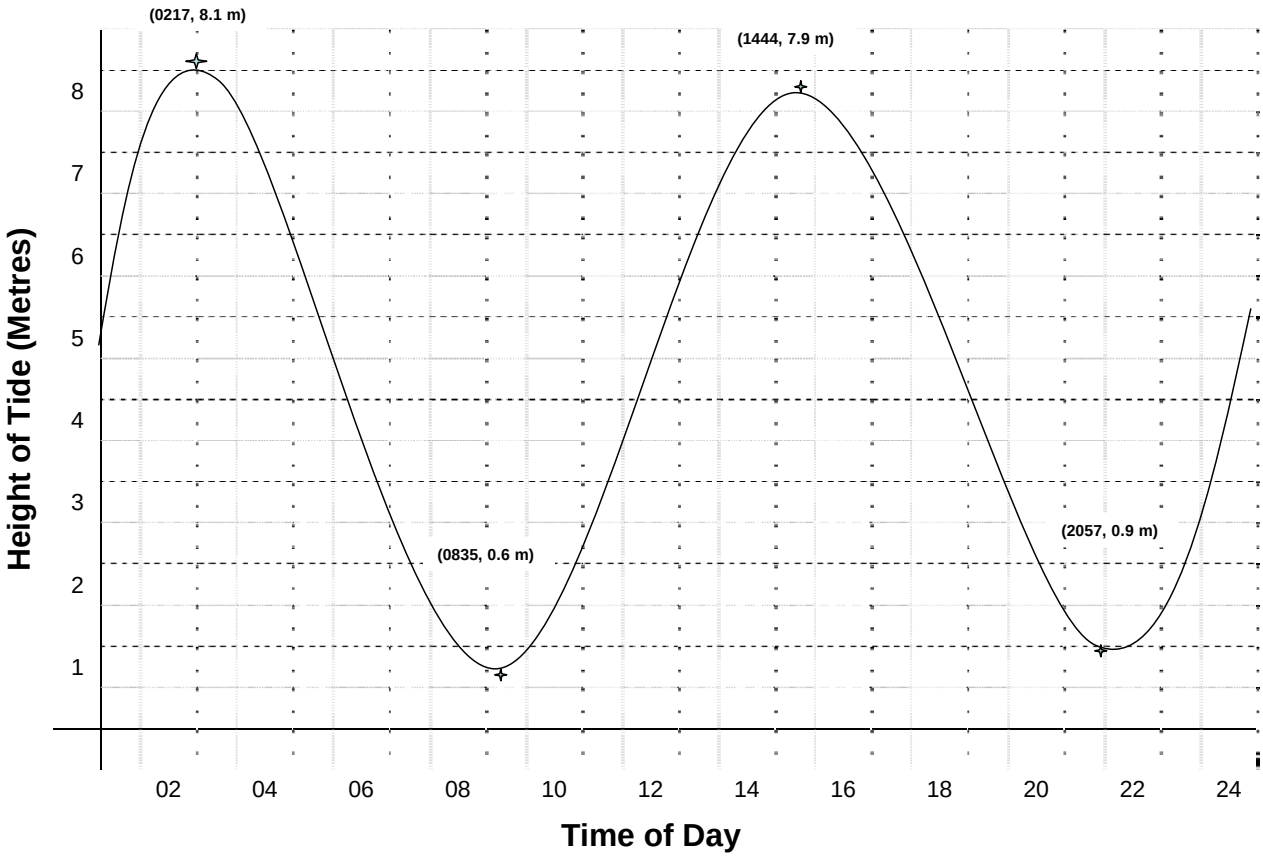


Figure 15 Step 8

Have the students choose a date from the tide table and create a tidal graph on the second tidal graph worksheet.

Have the students check each other's graphs when finished.

CONFIRMATION OF TEACHING POINT 4

The students' completion of a tidal graph will serve as the confirmation for this TP.

Teaching Point 5	**Demonstrate and have the students perform speed-time-distance calculations.**
Time: 40 min	Method: Demonstration and Performance

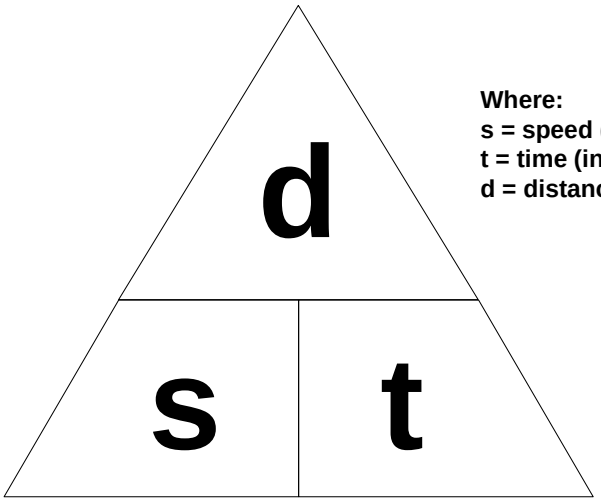
SPEED-TIME-DISTANCE CALCULATIONS

Demonstrate the relationship between speed, time and distance and how it is applied to navigation.

Distribute the Speed, Time and Distance handout located at Annex C to each student.

Speed on the water is measured in nautical miles per hour or knots.

The fundamental navigation calculations involve speed, time and distance. If two of these factors are known, the third can be calculated by using a formula. To remember the correct formula, a speed-time-distance triangle (as illustrated in Figure 16) can be used. When the needed factor is covered up on the triangle, the correct formula can be pictured.



Where:
s = speed (in knots [kts]),
t = time (in hours [h]), and
d = distance (in nautical miles [NM]).

$$\textbf{Speed} = \frac{\textbf{Distance}}{\textbf{Time}}$$

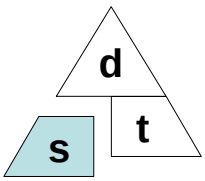
$$\textbf{Time} = \frac{\textbf{Distance}}{\textbf{Speed}}$$

Distance = Speed X Time

Figure 16 Speed-Time-Distance Triangle

Examples:

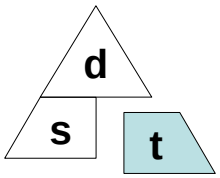
1. An anchorage is planned for lunch at an island that is 30 NM away. If its 3 h until lunchtime, how fast must the powerboat travel?



$$s = \frac{d}{t} = \frac{30\ \text{NM}}{3\ \text{h}} = 10\ \text{kts}$$

The powerboat must travel 10 kts to get there on time.

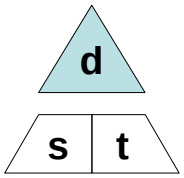
2. An offshore wreck lies 30 NM away from the mouth of the harbour. The powerboat cruises at 15 kts. How long will it take to reach the wreck?



$$t = \frac{d}{s} = \frac{30\ \text{NM}}{15\ \text{kts}} = 2\ \text{h}$$

It would take the powerboat 2 h to reach the wreck.

3. If it takes a powerboat 4 h to travel from Kingston to Cornwall at 20 kts, what is the distance travelled?



$$d = s \times t = 20\ \text{kts} \times 4\ \text{h} = 80\ \text{NM}$$

The distance travelled is 80 NM.

Have the students complete the calculations on the Speed, Time and Distance handout in the remaining time.

Review the answers with the students when finished.

CONFIRMATION OF TEACHING POINT 5

The students' performance of speed-time-distance calculations will serve as the confirmation for this TP.

END OF LESSON CONFIRMATION

QUESTIONS:

Q1. What information is contained in the *List of Lights, Buoys and Fog Signals*?

Q2. What is a tidal range?

Q3. What three factors are fundamental to navigation calculations?

ANTICIPATED ANSWERS:

A1. The characteristics and position of shore lights, lighted buoys and fog signals for various regions.

A2. The difference between low water and high water.

A3. Speed, time and distance.

CONCLUSION

HOMEWORK / READING / PRACTICE

Nil.

METHOD OF EVALUATION

Nil.

CLOSING STATEMENT

A solid understanding of the principles of marine navigation will ensure a safe and effective navigation plan can be created that provides flexibility for unforeseen circumstances while on the water.

INSTRUCTOR NOTES / REMARKS

Nil.

REFERENCES

ISBN 0-920232-15-9 Neff, D. (1990). *Basic power boating skills*. Gloucester, ON: Canadian Yachting Association.

ISBN 0-07-137226-1 Brogdon, B. (1995). *Boat navigation for the rest of us, second edition*. Camden, ME: International Marine.

C-57-007-002/AF-001 Royal Navy. (1987). *Admiralty manual of navigation* (Vol. 1). London, England: Her Majesty's Stationery Office.

Fisheries and Oceans Canada. *Tides, Currents and Water Levels*. (2008). Retrieved October 15, 2008, from http://www.waterlevels.gc.ca/english/relatedproducts.shtml

SAINT JOHN AST Z+4 **2008** **TIDE TABLES**

July - julliet

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0325	2.0	0.6	16	0430	4.9	1.5
	0936	24.9	7.6		1040	22.6	6.9
TU	1547	3.3	1.0	WE	1644	6.2	1.9
MA	2158	27.2	8.3	ME	2252	24.3	7.4
2	0424	1.6	0.5	17	0511	4.6	1.4
	1035	25.3	7.7		1120	23.0	7.0
WE	1645	3.0	0.9	TH	1724	5.9	1.8
ME	2256	27.9	8.5	JE	2331	24.6	7.5
3	0521	1.0	0.3	18	0549	4.3	1.3
	1131	25.6	7.8		1156	23.3	7.1
TH	1742	2.6	0.8	FR	1801	5.2	1.6
JE	2351	27.9	8.5	VE			
4	0615	1.0	0.3	19	0008	25.3	7.7
	1225	25.9	7.9		0625	3.6	1.1
FR	1836	2.6	0.8	SA	1231	24.0	7.3
VE				SA	1837	4.9	1.5
5	0045	27.6	8.4	20	0044	25.3	7.7
	0708	1.3	0.4		0659	3.6	1.1
SA	1318	25.9	7.9	SU	1305	24.3	7.4
SA	1929	3.0	0.9	DI	1913	4.3	1.3
6	0137	26.9	8.2	21	0119	25.6	7.8
	0759	2.0	0.6		0736	3.3	1.0
SU	1409	25.6	7.8	MO	1341	24.6	7.5
DI	2022	3.3	1.0	LU	1951	3.9	1.2
7	0229	26.2	8.0	22	0157	25.6	7.8
	0850	2.6	0.8		0813	3.3	1.0
MO	1501	25.3	7.7	TU	1418	24.9	7.6
LU	2114	3.9	1.2	MA	2031	3.9	1.2
8	0322	25.3	7.7	23	0237	25.3	7.7
	0941	3.6	1.1		0853	3.3	1.0
TU	1553	24.6	7.5	WE	1459	25.3	7.7
MA	2208	4.6	1.4	ME	2115	3.9	1.2
9	0417	24.3	7.4	24	0320	24.9	7.6
	1033	4.6	1.4		0937	3.6	1.1
WE	1647	24.3	7.4	TH	1545	25.3	7.7
ME	2304	5.2	1.6	JE	2203	3.9	1.2
10	0514	23.3	7.1	25	0409	24.3	7.4
	1128	5.2	1.6		1026	3.9	1.2
TH	1742	23.6	7.2	FR	1635	25.3	7.7
JE				VE	2257	3.9	1.2
11	0002	5.6	1.7	26	0504	24.0	7.3
	0613	22.6	6.9		1120	4.6	1.4
FR	1225	5.9	1.8	SA	1731	25.3	7.7
VE	1840	23.3	7.1	SA	2356	3.9	1.2
12	0102	5.9	1.8	27	0606	23.6	7.2
	0713	22.0	6.7		1221	4.9	1.5
SA	1324	6.6	2.0	SU	1834	25.3	7.7
SA	1937	23.3	7.1	DI			
13	0159	5.9	1.8	28	0101	3.9	1.2
	0812	22.0	6.7		0712	23.3	7.1
SU	1420	6.9	2.1	MO	1326	4.9	1.5
DI	2032	23.3	7.1	LU	1939	25.3	7.7
14	0255	5.6	1.7	29	0208	3.6	1.1
	0907	22.0	6.7		0819	23.6	7.2
MO	1513	6.9	2.1	TU	1432	4.6	1.4
LU	2123	23.6	7.2	MA	2046	25.9	7.9
15	0345	5.2	1.6	30	0313	3.0	0.9
	0956	22.3	6.8		0924	24.3	7.4
TU	1601	6.6	2.0	WE	1536	3.9	1.2
MA	2210	24.0	7.3	ME	2148	26.6	8.1
				31	0413	2.3	0.7
					1024	24.9	7.6
				TH	1635	3.3	1.0
				JE	2246	26.9	8.2

August-août

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0509	2.0	0.6	16	0518	3.9	1.2
	1119	25.6	7.8		1124	24.0	7.3
FR	1730	3.0	0.9	SA	1731	4.6	1.4
VE	2339	27.2	8.3	SA	2339	25.3	7.7
2	0601	1.6	0.5	17	0554	3.3	1.0
	1210	25.9	7.9		1159	24.6	7.5
SA	1821	2.6	0.8	SU	1808	3.6	1.1
SA				DI			
3	0029	26.9	8.2	18	0015	25.9	7.9
	0649	1.6	0.5		0629	2.6	0.8
SU	1258	25.9	7.9	MO	1234	25.3	7.7
DI	1910	3.0	0.9	LU	1845	3.0	0.9
4	0117	26.6	8.1	19	0051	25.9	7.9
	0735	2.0	0.6		0706	2.3	0.7
MO	1344	25.9	7.9	TU	1310	25.9	7.9
LU	1957	3.0	0.9	MA	1923	2.6	0.8
5	0204	25.9	7.9	20	0129	25.9	7.9
	0821	3.0	0.9		0744	2.3	0.7
TU	1430	25.6	7.8	WE	1349	26.2	8.0
MA	2045	3.6	1.1	ME	2004	2.6	0.8
6	0252	24.9	7.6	21	0210	25.6	7.8
	0907	3.6	1.1		0825	2.6	0.8
WE	1517	24.9	7.6	TH	1431	26.2	8.0
ME	2133	4.3	1.3	JE	2049	2.6	0.8
7	0342	24.0	7.3	22	0255	25.3	7.7
	0955	4.6	1.4		0910	3.3	1.0
TH	1606	24.3	7.4	FR	1518	25.9	7.9
JE	2224	4.9	1.5	VE	2138	3.0	0.9
8	0434	23.0	7.0	23	0346	24.3	7.4
	1046	5.9	1.8		1002	3.9	1.2
FR	1659	23.6	7.2	SA	1611	25.3	7.7
VE	2319	5.9	1.8	SA	2235	3.6	1.1
9	0530	22.0	6.7	24	0444	23.6	7.2
	1142	6.6	2.0		1059	4.9	1.5
SA	1755	23.0	7.0	SU	1711	24.9	7.6
SA				DI	2338	4.3	1.3
10	0018	6.6	2.0	25	0550	23.0	7.0
	0630	21.3	6.5		1205	5.2	1.6
SU	1241	7.2	2.2	MO	1819	24.6	7.5
DI	1855	22.3	6.8	LU			
11	0119	6.6	2.0	26	0048	4.6	1.4
	0732	21.0	6.4		0701	22.6	6.9
MO	1341	7.5	2.3	TU	1316	5.6	1.7
LU	1954	22.3	6.8	MA	1930	24.6	7.5
12	0217	6.6	2.0	27	0159	4.3	1.3
	0830	21.3	6.5		0812	23.0	7.0
TU	1438	7.5	2.3	WE	1425	4.9	1.5
MA	2049	22.6	6.9	ME	2039	24.9	7.6
13	0311	5.9	1.8	28	0304	3.6	1.1
	0922	21.7	6.6		0917	24.0	7.3
WE	1529	6.9	2.1	TH	1529	4.3	1.3
ME	2139	23.3	7.1	JE	2141	25.6	7.8
14	0358	5.2	1.6	29	0403	3.0	0.9
	1008	22.3	6.8		1014	24.6	7.5
TH	1613	6.2	1.9	FR	1625	3.6	1.1
JE	2223	24.0	7.3	VE	2236	26.2	8.0
15	0440	4.6	1.4	30	0455	2.6	0.8
	1047	23.0	7.0		1105	25.3	7.7
FR	1653	5.2	1.6	SA	1717	3.0	0.9
VE	2302	24.9	7.6	SA	2325	26.2	8.0
				31	0543	2.3	0.7
					1151	25.9	7.9
				SU	1804	2.6	0.8
				DI			

September-septembre

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0011	26.2	8.0	16	0556	2.3	0.7
	0627	2.3	0.7		1201	26.2	8.0
MO	1234	25.9	7.9	TU	1816	2.0	0.6
LU	1848	2.6	0.8	MA			
2	0055	25.9	7.9	17	0022	26.2	8.0
	0709	2.6	0.8		0635	2.0	0.6
TU	1316	25.9	7.9	WE	1240	26.9	8.2
MA	1931	3.0	0.9	ME	1857	1.3	0.4
3	0139	25.3	7.7	18	0103	26.2	8.0
	0751	3.3	1.0		0716	2.0	0.6
WE	1358	25.6	7.8	TH	1322	26.9	8.2
ME	2014	3.6	1.1	JE	1941	1.3	0.4
4	0222	24.6	7.5	19	0148	25.9	7.9
	0834	4.3	1.3		0801	2.6	0.8
TH	1442	24.9	7.6	FR	1407	26.9	8.2
JE	2059	4.3	1.3	VE	2028	2.0	0.6
5	0308	23.6	7.2	20	0237	25.3	7.7
	0918	5.2	1.6		0850	3.3	1.0
FR	1527	24.0	7.3	SA	1458	26.2	8.0
VE	2146	5.2	1.6	SA	2122	2.6	0.8
6	0356	22.6	6.9	21	0331	24.3	7.4
	1006	6.2	1.9		0946	4.3	1.3
SA	1617	23.3	7.1	SU	1556	25.3	7.7
SA	2237	5.9	1.8	DI	2222	3.6	1.1
7	0449	21.7	6.6	22	0433	23.3	7.1
	1058	7.2	2.2		1049	5.2	1.6
SU	1711	22.3	6.8	MO	1700	24.6	7.5
DI	2334	6.9	2.1	LU	2329	4.6	1.4
8	0547	21.0	6.4	23	0543	22.6	6.9
	1157	7.9	2.4		1158	5.6	1.7
MO	1811	22.0	6.7	TU	1812	24.0	7.3
LU				MA			
9	0034	7.2	2.2	24	0041	4.9	1.5
	0649	20.7	6.3		0656	22.6	6.9
TU	1258	8.2	2.5	WE	1310	5.6	1.7
MA	1912	22.0	6.7	ME	1925	24.0	7.3
10	0135	6.9	2.1	25	0151	4.6	1.4
	0749	21.0	6.4		0806	23.3	7.1
WE	1357	7.9	2.4	TH	1419	5.2	1.6
ME	2010	22.3	6.8	JE	2032	24.6	7.5
11	0230	6.6	2.0	26	0254	3.9	1.2
	0842	21.7	6.6		0907	24.0	7.3
TH	1450	7.2	2.2	FR	1519	4.3	1.3
JE	2102	23.0	7.0	VE	2131	24.9	7.6
12	0319	5.6	1.7	27	0349	3.6	1.1
	0928	22.3	6.8		0959	24.6	7.5
FR	1537	5.9	1.8	SA	1613	3.6	1.1
VE	2147	24.0	7.3	SA	2223	25.3	7.7
13	0402	4.6	1.4	28	0438	3.0	0.9
	1009	23.6	7.2		1047	25.3	7.7
SA	1618	4.9	1.5	SU	1701	3.0	0.9
SA	2227	24.9	7.6	DI	2309	25.6	7.8
14	0441	3.6	1.1	29	0522	3.0	0.9
	1047	24.6	7.5		1130	25.6	7.8
SU	1657	3.6	1.1	MO	1745	2.6	0.8
DI	2306	25.6	7.8	LU	2353	25.3	7.7
15	0519	3.0	0.9	30	0604	3.3	1.0
	1124	25.6	7.8		1210	25.9	7.9
MO	1736	2.6	0.8	TU	1826	2.6	0.8
LU	2343	25.9	7.9	MA			

Figure A-1 Tide Table

Note. From Fisheries and Oceans Canada, *Tides, Currents and Water Levels*. Retrieved October 15, 2008, from http://www.waterlevels.gc.ca/2008_predictions/vol_1/wlev_ref/00065.pdf

TIDAL GRAPH WORKSHEET

PORT: _____ **DATE:** _____

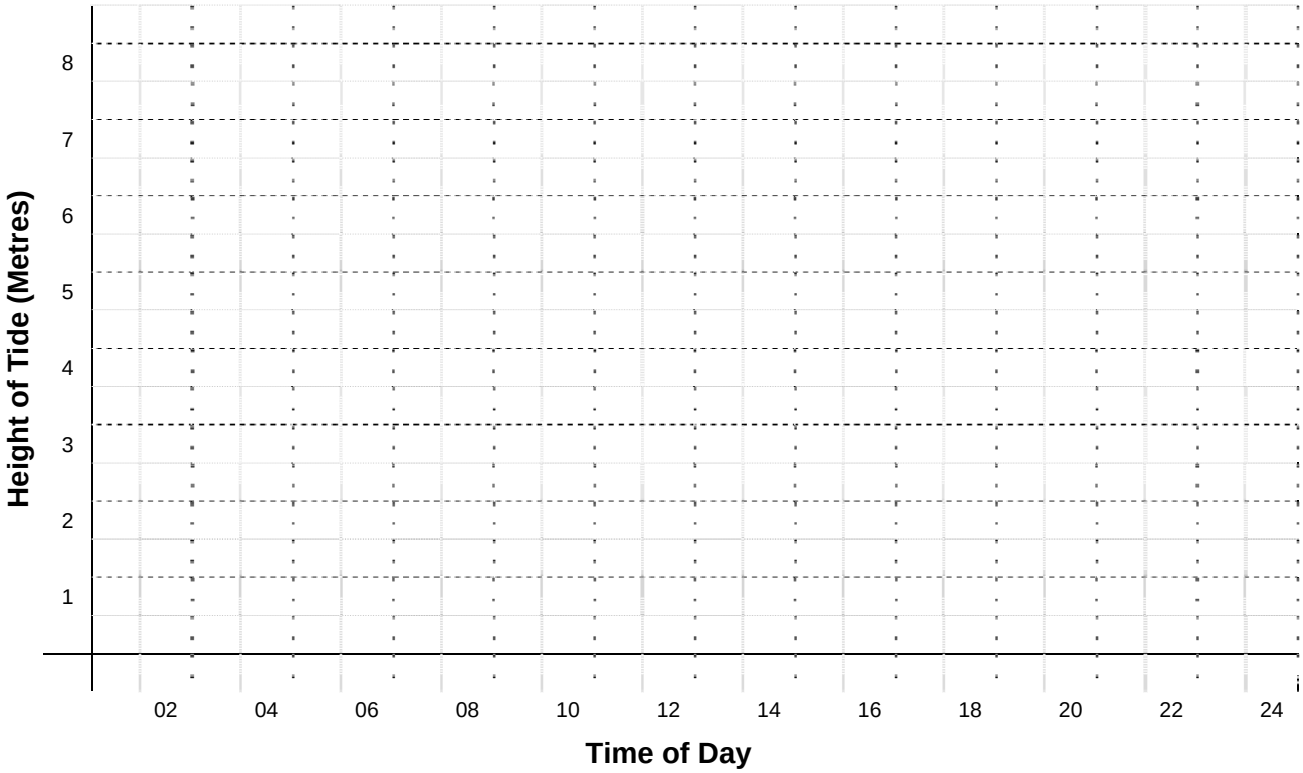
Tide	
Time	Height
Correction	Height
Corrected Time	Corrected Height

Tide	
Time	Height
Correction	Height
Corrected Time	Corrected Height

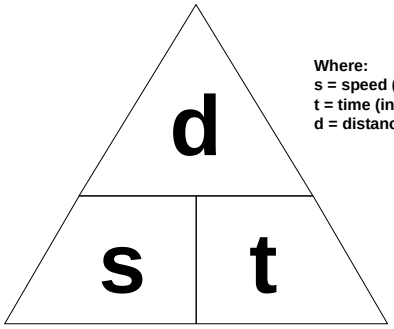
Tide	
Time	Height
Correction	Height
Corrected Time	Corrected Height

Tide	
Time	Height
Correction	Height
Corrected Time	Corrected Height

Tidal Graph



Speed, Time and Distance

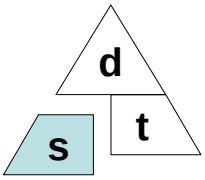


Where:
s = speed (in knots [kts]),
t = time (in hours [h]), and
d = distance (in nautical miles [NM]).

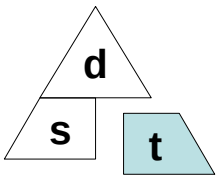
Speed = $\frac{\text{Distance}}{\text{Time}}$

Time = $\frac{\text{Distance}}{\text{Speed}}$

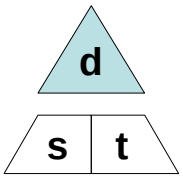
Distance = Speed X Time



Speed



Time

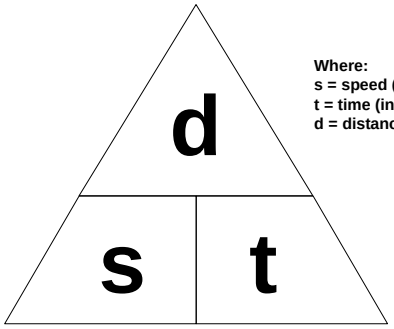


Distance

Exercises:

	Speed (kts)	Time (h)	Distance (NM)
1.	**5**	**2**	
2.	**10**		**40**
3.		**5**	**15**
4.		**9**	**4.5**
5.	**12**	**5**	
6.	**A powerboat needs to refuel before the marina closes at 2000 hours. The marina is 35 NM away and it is 1800 hours. If the top speed of the powerboat is 17 kts, can it make it in time?** **s =** **t =** **d =**		

Speed, Time and Distance (Answer Key)

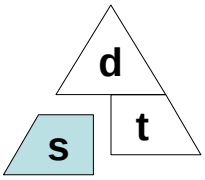


Where:
s = speed (in knots [kts]),
t = time (in hours [h]), and
d = distance (in nautical miles [NM]).

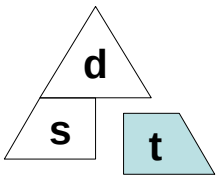
Speed = $\frac{\text{Distance}}{\text{Time}}$

Time = $\frac{\text{Distance}}{\text{Speed}}$

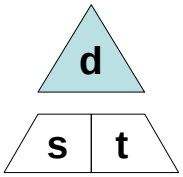
Distance = Speed X Time



Speed



Time



Distance

Exercises:

	Speed (kts)	Time (h)	Distance (NM)
1.	**5**	**2**	**10**
2.	**10**	**4**	**40**
3.	**3**	**5**	**15**
4.	**0.5**	**9**	**4.5**
5.	**12**	**5**	**60**
6.	**A powerboat needs to refuel before the marina closes at 2000 hours. The marina is 35 NM away and it is 1800 hours. If the top speed of the powerboat is 17 kts, can it make it in time?** **s = 17** **t = 2** **d = 34 - The powerboat will not make it as they will be 1 NM away at 2000 hours.**		

CANADIAN CADET ORGANIZATIONS

NAVIGATION MANUAL

INSTRUCTIONAL GUIDE

SECTION 2

EO X51.02 – IDENTIFY ASPECTS OF A CHART

Total Time:	60 min

PREPARATION

PRE-LESSON INSTRUCTIONS

This IG supports EO X51.02 (Identify Aspects of a Chart).

The timings for this EO are based on a 30 minute period so will need to be adjusted for Ship's Boat Operator.

Photocopy Annex A for each student.

Set up the classroom or training area so that students can sit in pairs at tables suitable for chartwork.

Distribute one copy of *Chart 3441* to each table.

PRE-LESSON ASSIGNMENT

Nil.

APPROACH

An interactive lecture was chosen for TPs 1–3 to orient the students to information found on marine charts and to generate interest in small craft navigation.

INTRODUCTION

REVIEW

Nil.

OBJECTIVES

By the end of this lesson the student shall have identified information contained in the chart title block and other chart information.

IMPORTANCE

It is important for students to explain chart information by identifying chart symbols, title block and other information and be able to apply this when planning to navigate. Thorough knowledge of this information will ensure a safe and effective navigation plan can be created.

Teaching Point 1	**Explain Mercator chart projection.**
Time: 5 min	Method: Interactive Lecture

MERCATOR CHART PROJECTION

Charts used on board small craft are normally Mercator projections. A Mercator projection is created by transferring the spherical surface of the Earth onto a cylinder. This can be visualized by shining a light through part of a transparent globe so that the outlines of land masses make a chart on a screen.

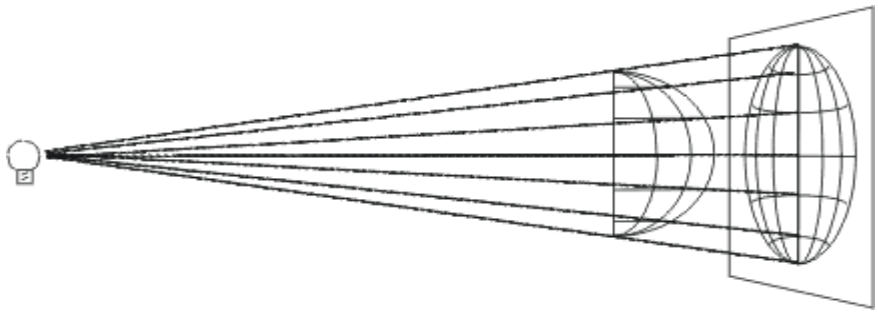


Figure 1 Mercator Chart Projection

Note. From "Nautical Know How Inc.", 2007, *BoatSafeKids.* Retrieved October 23, 2008, from http://boatsafe.com/kids/mercator.htm

Land masses and seas near the equator will be approximately the correct shape. However, as we get closer to the poles of the globe, the land masses and seas are stretched sideways in an east-west direction. In order to keep their proper shape, these areas are also stretched in the north-south direction by moving the parallels of latitude further apart as they get nearer to the poles.

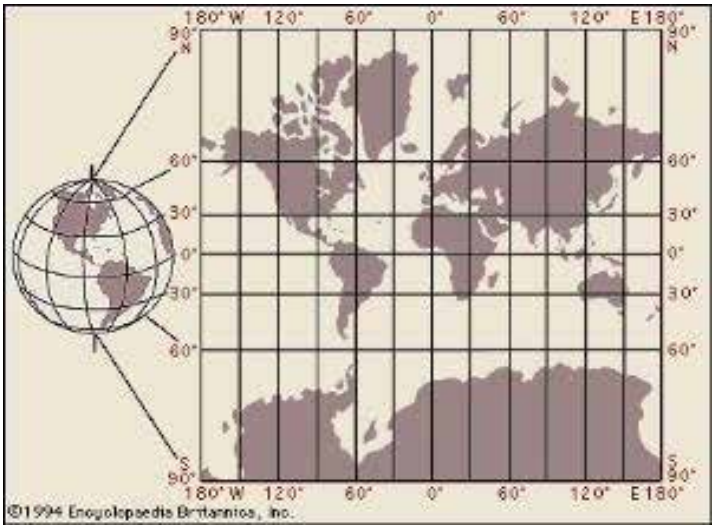


Figure 2 Mercator Projection Distortion

Note. From "Highbeam Research Inc.", 2008, *Highbeam Encyclopedia*. Retrieved October 23, 2008, from http://www.encyclopedia.com/doc/1E1-X-Mercat-map.html

The result of preserving the shape of areas closer to the poles is that the areas are exaggerated with increasing distance from the equator. Examples of this distortion are:

- Greenland on a Mercator chart looks bigger than the United States of America when in fact it has only the same area as Mexico.

- Alaska is presented as being similar or even slightly larger in size than Brazil, when Brazil's area is actually five times that of Alaska.

As a result of this distortion, modern atlases no longer use Mercator projection for world maps. Other methods of chart projection are used for areas that are distant from the equator because distortions at higher latitudes are significantly less.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS:

Q1. What projection is normally used for small boat charts?

Q2. Where is the distortion of the countries the greatest on a Mercator chart?

Q3. Why would the Mercator chart not be used while navigating in the world's arctic?

ANTICIPATED ANSWERS:

A1. Mercator.

A2. Near the poles.

A3. Due to the exaggeration of the land and sea areas closer to the poles.

Teaching Point 2	**Describe how to care for and maintain a chart.**
Time: 5 min	Method: Interactive Lecture

CARE AND MAINTENANCE OF A CHART

There are two main types of paper charts available:

- **Lithographic.** These charts are mass printed on one side of large-format, durable paper. These charts are limited in the number and brightness of colours used.

- **Print On Demand (POD).** These charts are printed by the Canadian Hydrographic Service (CHS) when the charts are ordered. These charts are easily recognized by the bright white paper they are printed on and they have a coloured CHS logo. These charts are not as durable as traditional lithographic charts.

Charts are essential to navigation. Paper charts are available from many different sources and can be expensive to replace. With proper care, paper charts can last for many seasons. The following tips can extend the life of paper charts:

- **Keep the chart dry.** POD charts are significantly less durable than lithographic charts. However with either type of chart, make every effort to keep it dry at all times.

- **Storage.** When storing charts, it may be necessary to either roll or fold them and place them in a dry location. Whether the charts are rolled or folded depends on how much storage space is available.

    - **Folded charts.** Mainly used on large ships as there is sufficient room on board to store all of the charts in drawers. The biggest drawback to folding charts is they quickly become illegible and can tear easily at the folds.

    - **Rolled charts.** If there is not sufficient room to store folded charts, then rolling them is the best solution. Rolling is considered better than folding as the charts remain flat and straight.

- **Marking on a chart.** When making marks on the chart, always use a 2H pencil. Draw with light pressure on the pencil to avoid damaging the surface of the paper.

- **Scrubbing charts.** At the end of each day, the chart must be erased of all tracks, marks and notes. This allows for easy set up for the next navigation plan. Always use gum or white vinyl erasers on the charts. Many erasers have a very abrasive texture which can scrub away important information and damage the surface of the paper.

Additional information on pencils and erasers is given in EO X51.04 (Locate a Position on a Chart).

CONFIRMATION OF TEACHING POINT 2

QUESTIONS:

Q1. What should be remembered when marking on a chart?

Q2. Why should only gum or white vinyl erasers be used on a chart?

Q3. What are two ways to store a chart?

ANTICIPATED ANSWERS:

A1. Use light pressure and a 2H pencil.

A2. Certain types of erasers have an abrasive texture which could damage the surface of the chart.

A3. Folded or rolled.

Teaching Point 3	**Describe and have the students find the chart title block and other information found on a chart.**
Time: 40 min	Method: Interactive Lecture

Have the students sit in pairs at tables with *Chart 3441* in front of them.

Have the students find the information as it is presented.

Emphasize the importance of knowing where to find the information on a chart rather than memorizing it.

The chart for this TP is *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*. The title block for this chart has been divided into two sections and placed on large land masses within the chart to avoid covering any navigation information.

Charts are oriented with true north at the top, east on the right-hand side, west on the left-hand side and south at the bottom.

CHART TITLE BLOCK INFORMATION

The following six items are illustrated in Figure 3.

The title block on a chart contains important information required for navigation in the area depicted.

Chart title. The name of the major navigational body of water in the area covered by the chart. The chart title is quoted along with the chart number when ordering charts.

Example: This chart is referred to as *Chart 3441 Haro Strait Boundary Pass and / et Satellite Channel*.

Projection. A statement of which type of chart projection was used to make the chart.

Example: *Chart 3441* uses Mercator projection.

Scale of the chart. The ratio of a unit of distance on the chart to the actual distance on the earth's surface.

Example: *Chart 3441* has a scale of 1 : 40 000; one inch on the chart equals 40 000 inches on the earth's surface.

There are two scales of charts that are mainly used in small craft navigation. These are:

- **Large-scale.** Cover a small area and show more detail of the earth's surface. These charts are best for navigating in coastal areas. Large-scale charts will have low scale ratios (eg, 1 : 5 000).

- **Small-scale.** Cover a large area of the earth's surface and show little detail. Small-scale charts will have high ratios (eg, 1 : 150 000).

Depth measurement. The unit of measurement for soundings and from which point they are taken.

Example: On *Chart 3441*, depths are measured in metres and are reduced to Chart Datum. (The reference for the Chart Datum is in Fulford Harbour located on Saltspring Island at the top of the chart).

Chart Datum was defined in EO X51.01 (Explain the Principles of Marine Navigation).

Elevation measurement. Can be either the height of both natural or man-made objects. The height of rocks and other features along the coastline are also defined.

Spot elevation. The height on a chart of the top of a hill or other natural feature.

Higher High Water, Large Tide (HHWLT). The average of the highest high waters, one from each of 19 years of predictions.

Clearances. The vertical distance between HHWLT and man-made objects such as overhead power cables and bridges.

Elevations on *Chart 3441* are given as:

- Spot elevations and clearances are in metres above HHWLT.
- Underlined figures on drying areas or in brackets against drying features are in metres above Chart Datum.

Examples on *Chart 3441*:

Spot elevation. Mount (Mt.) Newton has an elevation of 305 m. (Located north of the CHS logo in the title block).

Clearance. Christmas Point (Pt.) power cable has a charted clearance of 55 m. (Located in the inset found in the lower left corner of the chart).

Drying areas. The foreshore of Island View Beach has a drying height of 1.5 m at Chart Datum. (Located east of the title block on the Saanich Peninsula).

Drying features. Two charted rocks in Sannichton Bay have charted heights of 2.1 m and 3.4 m (Located east of the chart title).

- **Sources.** A nautical chart is no more accurate than the survey on which it is based. Charting agencies make every effort to keep charts updated and accurate. Charts with older survey dates should be used with caution. Early surveys were often made under circumstances that did not permit accuracy and detail. Few surveys have been so thorough as to make certain that all dangers have been found. Everyday forces of wind and waves can change shorelines, channel directions or create uncharted shoals.

Example: *Chart 3441* is based on surveys made by CHS up to 1999 and sources from the United States of America (USA).

On August 7 1992, the passenger liner *Queen Elizabeth 2* (QE2), grounded on uncharted and previously unsurveyed rocks located to the south of Cuttyhunk Island, Massachusetts, USA. The most recent survey of this area prior to the grounding was 1939 for some of the area and 1888 for the rest.

The outdated survey data contributed to the Master of the QE2 plotting his course through an area which he would have avoided had he known the dangers existed. Further information can be found at: http://www.maib.gov.uk/cms_resources/queen_elizabeth_2_pub_1993.pdf

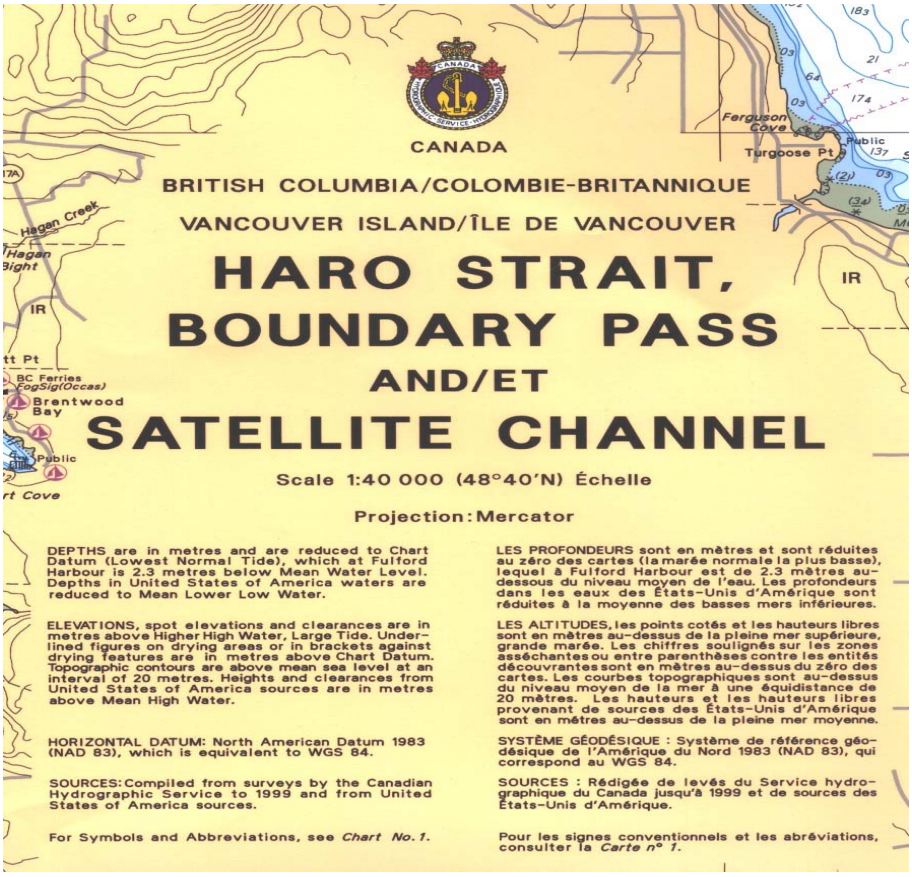


Figure 3 Chart Title Block Part One

Note. From *Chart 3441*, *Haro Strait, Boundary Pass and / et Satellite Channel*, 2005, Ottawa, ON: Canadian Hydrographic Service

- **Cautionary notes.** These notes outline specific navigational hazards to the area and should be read before using the chart to plan any navigational passage.

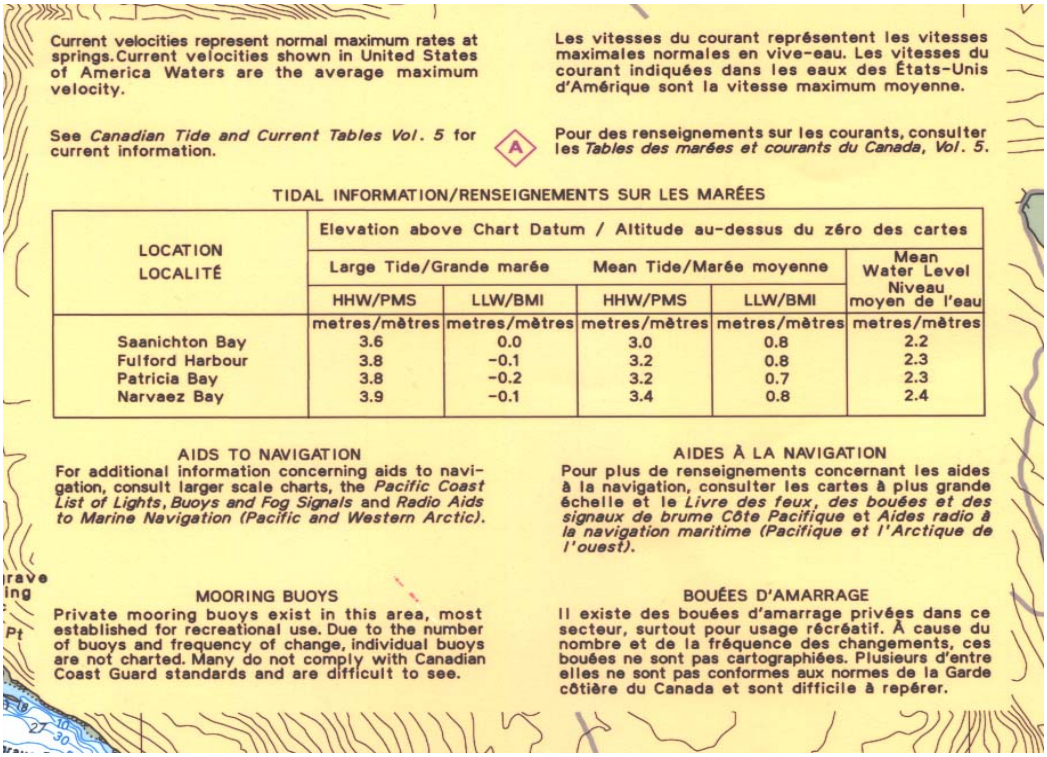
The cautionary notes found on *Chart 3441*:

- explain the meaning of special abbreviations used on the chart. Chart 3441 refers to Chart No. 1, which refers to *Symbols Abbreviations Terms (Chart 1)*;

- show special tidal and current information for the area (as illustrated in Figure 4);

- give information on aids to navigation found on the chart. *Chart 3441* refers to *Pacific Coast List of Lights, Buoys and Fog Signals* and *Radio Aids to Marine Navigation (Pacific and Western Arctic)* (as illustrated in Figure 4); and

- refer to anchorage areas or special moorings found in the area. This chart refers to private mooring buoys that do not comply with Canadian Coast Guard Regulations and may be difficult to see (as illustrated in Figure 4).



Current velocities represent normal maximum rates at springs. Current velocities shown in United States of America Waters are the average maximum velocity.

Les vitesses du courant représentent les vitesses maximales normales en vive-eau. Les vitesses du courant indiquées dans les eaux des États-Unis d'Amérique sont la vitesse maximum moyenne.

See *Canadian Tide and Current Tables Vol. 5* for current information.

Pour des renseignements sur les courants, consulter les *Tables des marées et courants du Canada, Vol. 5.*

TIDAL INFORMATION/RENSEIGNEMENTS SUR LES MARÉES

LOCATION LOCALITÉ	Elevation above Chart Datum / Altitude au-dessus du zéro des cartes				
	Large Tide/Grande marée		Mean Tide/Marée moyenne		Mean Water Level Niveau moyen de l'eau
	HHW/PMS	LLW/BMI	HHW/PMS	LLW/BMI	
	metres/mètres	metres/mètres	metres/mètres	metres/mètres	metres/mètres
Saanichton Bay	3.6	0.0	3.0	0.8	2.2
Fulford Harbour	3.8	−0.1	3.2	0.8	2.3
Patricia Bay	3.8	−0.2	3.2	0.7	2.3
Narvaez Bay	3.9	−0.1	3.4	0.8	2.4

AIDS TO NAVIGATION

For additional information concerning aids to navigation, consult larger scale charts, the *Pacific Coast List of Lights, Buoys and Fog Signals* and *Radio Aids to Marine Navigation (Pacific and Western Arctic).*

AIDES À LA NAVIGATION

Pour plus de renseignements concernant les aides à la navigation, consulter les cartes à plus grande échelle et le *Livre des feux, des bouées et des signaux de brume Côte Pacifique* et *Aides radio à la navigation maritime (Pacifique et l'Arctique de l'ouest).*

MOORING BUOYS

Private mooring buoys exist in this area, most established for recreational use. Due to the number of buoys and frequency of change, individual buoys are not charted. Many do not comply with Canadian Coast Guard standards and are difficult to see.

BOUÉES D'AMARRAGE

Il existe des bouées d'amarrage privées dans ce secteur, surtout pour usage récréatif. À cause du nombre et de la fréquence des changements, ces bouées ne sont pas cartographiées. Plusieurs d'entre elles ne sont pas conformes aux normes de la Garde côtière du Canada et sont difficile à repérer.

Figure 4 Title Block Part Two

Note. From Chart 3441, *Haro Strait, Boundary Pass and / et Satellite Channel*, 2005, Ottawa, ON: Canadian Hydrographic Service.

OTHER INFORMATION FOUND ON A CHART

It is important that all of the information printed on the chart is read prior to planning any navigation passages. Scan the chart for any information that has been printed on the margins, on large land areas or in different colours on the chart.

Information printed on *Chart 3441*, other than the information in the title block:

Number and edition of the chart. The chart number, edition information and the date the chart is corrected to are located in the margins of the chart.

Examples on *Chart 3441*:

- **Chart number.** Located in the upper left and lower right-hand corners of the chart (as illustrated in Figure 5).

- **Chart edition.** Previous editions of this chart are listed as well as the date of the newest edition available. In this case, the newest edition is dated July 1, 2005 (as illustrated in Figure 6).

- **Correction dates.** This chart is corrected to Notice to Mariners dated October 10, 2008 (as illustrated in Figure 6).

Figure 5 Chart Number and Title

Note. From Chart 3441, *Haro Strait, Boundary Pass and / et Satellite Channel*, 2005, Ottawa, ON: Canadian Hydrographic Service.

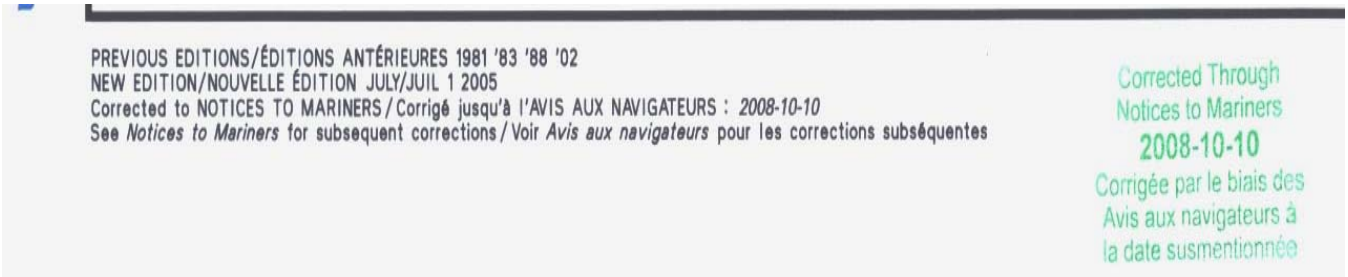


Figure 6 Chart Edition and Correction Date

Note. From Chart 3441, *Haro Strait, Boundary Pass and / et Satellite Channel*, 2005, Ottawa, ON: Canadian Hydrographic Service.

Important information and warnings. Important changes to charted information such as changes to traffic schemes and mooring areas may be printed in magenta-coloured ink. This ink is easily read under a red light (which is used on chart tables during night navigation). Important information found on *Chart 3441* is:

- **Vessel traffic system.** In July 2005, the vessel traffic system from Victoria to Vancouver was changed by the Canadian and United States Coast Guards. Information on the traffic system has been highlighted by symbols in Haro Strait (as illustrated in Figure 7) and further explained in magenta-coloured ink notes in the lower right corner of the chart (as illustrated in Figure 8).

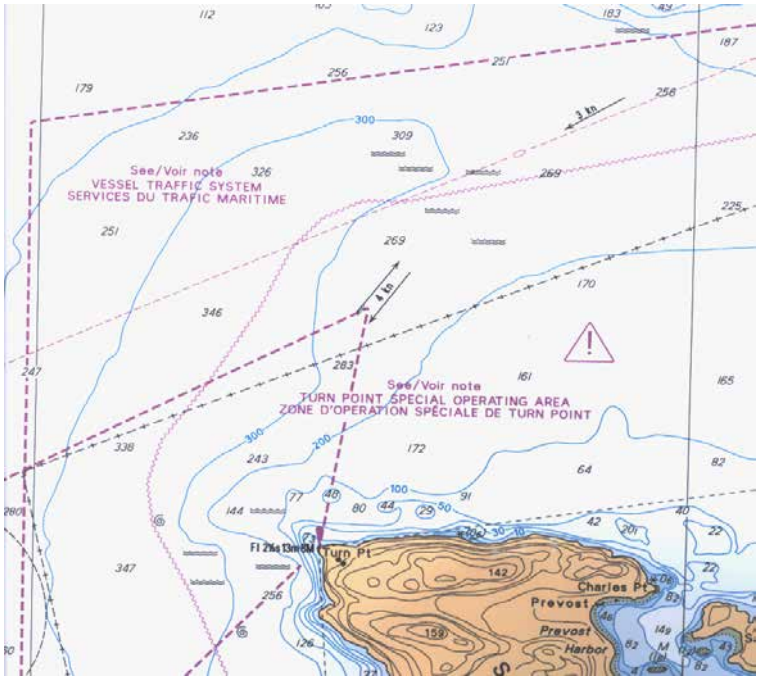
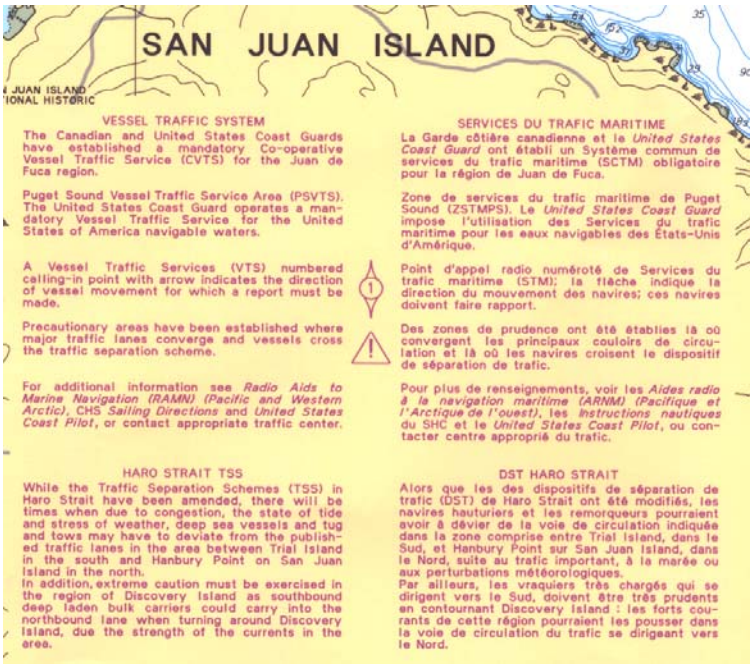


Figure 7 Special Notes–Turn Point Special Operating Area

Note. From *Chart 3441*, *Haro Strait, Boundary Pass and / et Satellite Channel*, 2005, Ottawa, ON: Canadian Hydrographic Service.



SAN JUAN ISLAND

VESSEL TRAFFIC SYSTEM

The Canadian and United States Coast Guards have established a mandatory Co-operative Vessel Traffic Service (CVTS) for the Juan de Fuca region.

Puget Sound Vessel Traffic Service Area (PSVTS). The United States Coast Guard operates a mandatory Vessel Traffic Service for the United States of America navigable waters.

A Vessel Traffic Services (VTS) numbered calling-in point with arrow indicates the direction of vessel movement for which a report must be made.

Precautionary areas have been established where major traffic lanes converge and vessels cross the traffic separation scheme.

For additional information see *Radio Aids to Marine Navigation (RAMN) (Pacific and Western Arctic)*, CHS *Sailing Directions* and *United States Coast Pilot*, or contact appropriate traffic center.

HARO STRAIT TSS

While the Traffic Separation Schemes (TSS) in Haro Strait have been amended, there will be times when due to congestion, the state of tide and stress of weather, deep sea vessels and tug and tows may have to deviate from the published traffic lanes in the area between Trial Island in the south and Hanbury Point on San Juan Island in the north.
In addition, extreme caution must be exercised in the region of Discovery Island as southbound deep laden bulk carriers could carry into the northbound lane when turning around Discovery Island, due the strength of the currents in the area.

SERVICES DU TRAFIC MARITIME

La Garde côtière canadienne et le *United States Coast Guard* ont établi un Système commun de services du trafic maritime (SCTM) obligatoire pour la région de Juan de Fuca.

Zone de services du trafic maritime de Puget Sound (ZSTMPS). Le *United States Coast Guard* impose l'utilisation des Services du trafic maritime pour les eaux navigables des États-Unis d'Amérique.

Point d'appel radio numéroté de Services du trafic maritime (STM); la flèche indique la direction du mouvement des navires; ces navires doivent faire rapport.

Des zones de prudence ont été établies là où convergent les principaux couloirs de circulation et là où les navires croisent le dispositif de séparation de trafic.

Pour plus de renseignements, voir les *Aides radio à la navigation maritime (ARNM) (Pacifique et l'Arctique de l'ouest)*, les *Instructions nautiques* du SHC et le *United States Coast Pilot*, ou contacter centre approprié du trafic.

DST HARO STRAIT

Alors que les des dispositifs de séparation de trafic (DST) de Haro Strait ont été modifiés, les navires hauturiers et les remorqueurs pourraient avoir à dévier de la voie de circulation indiquée dans la zone comprise entre Trial Island, dans le Sud, et Hanbury Point sur San Juan Island, dans le Nord, suite au trafic important, à la marée ou aux perturbations météorologiques.
Par ailleurs, les vraquiers très chargés qui se dirigent vers le Sud, doivent être très prudents en contournant Discovery Island : les forts courants de cette région pourraient les pousser dans la voie de circulation du trafic se dirigeant vers le Nord.

Figure 8 Explanation of Special Notes

Note. From *Chart 3441*, *Haro Strait, Boundary Pass and / et Satellite Channel*, 2005, Ottawa, ON: Canadian Hydrographic Service.

- **Navy mooring buoys.** Navy mooring buoys located in Patricia Bay are described with a note located on the Saanich Peninsula north of Patricia Bay (as illustrated in Figure 9).

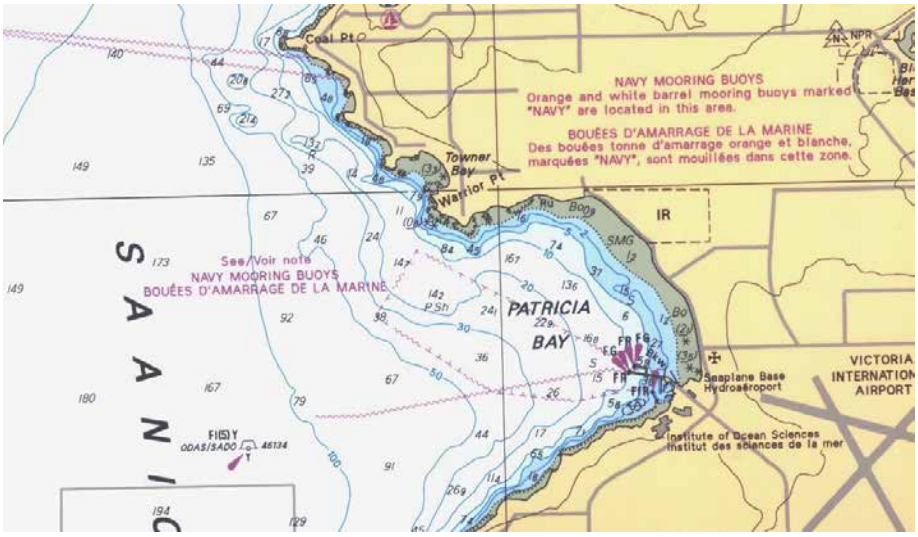


Figure 9 Patricia Bay Mooring Buoys

Note. From *Chart 3441*, *Haro Strait, Boundary Pass and / et Satellite Channel*, 2005, Ottawa, ON: Canadian Hydrographic Service.

- **Firing practice and exercise areas.** Areas reserved for military weapons practice and exercises will be outlined in light grey boxes (as illustrated in Figure 10). Further information on these areas is outlined in *Notice to Mariners: Annual Edition.* In this case, *Notice to Mariners number 35* of each year.

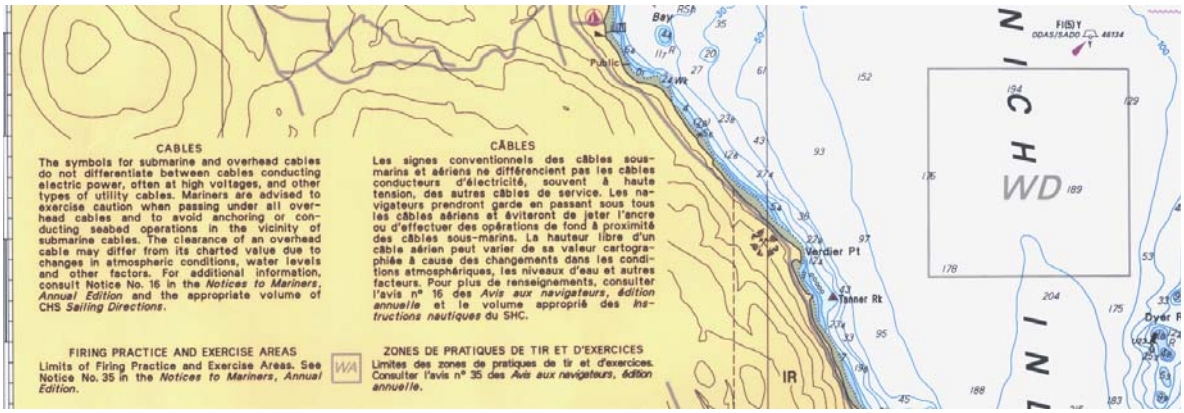


Figure 10 Weapons Practice Area

Note. From *Chart 3441*, *Haro Strait, Boundary Pass and / et Satellite Channel*, 2005, Ottawa, ON: Canadian Hydrographic Service.

Adjoining charts. Chart numbers for adjoining charts are placed around the margin. This will allow quick and easy chart changes as the navigation passage is executed. If the adjoining

chart covers navigation areas of other nations, such as the US, the proper chart number of that country will also be printed in magenta-coloured ink inside the territorial boundary of that country (as illustrated in Figure 11).

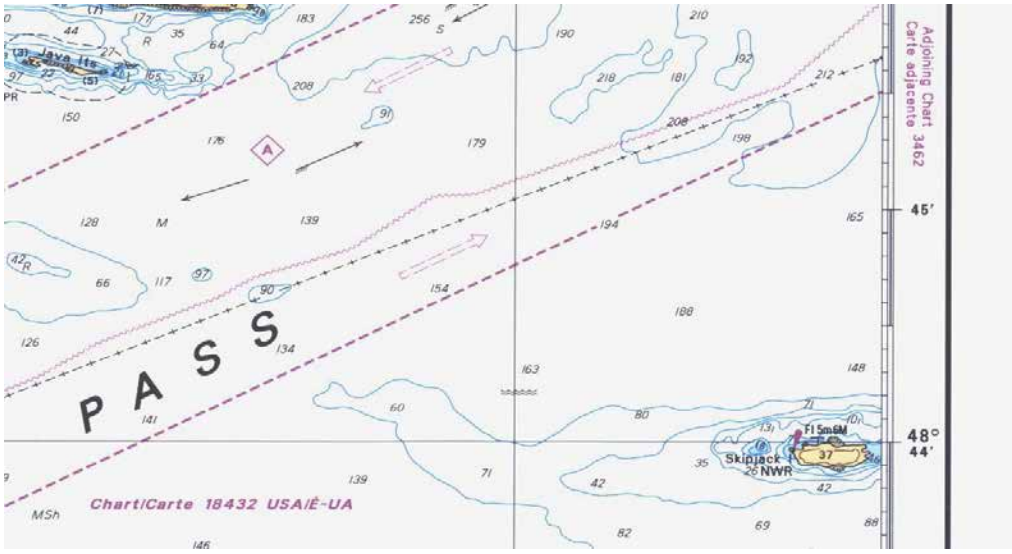


Figure 11 Adjoining Chart Numbers

Note. From *Chart 3441*, *Haro Strait, Boundary Pass and / et Satellite Channel*, 2005, Ottawa, ON: Canadian Hydrographic Service.

Large scale chart numbers. Are printed on the chart for areas where, in order to navigate safely, greater detail is required. Harbour charts, small passages and smaller waterways will have large-scale charts identified on the small-scale chart (as illustrated in Figure 12).

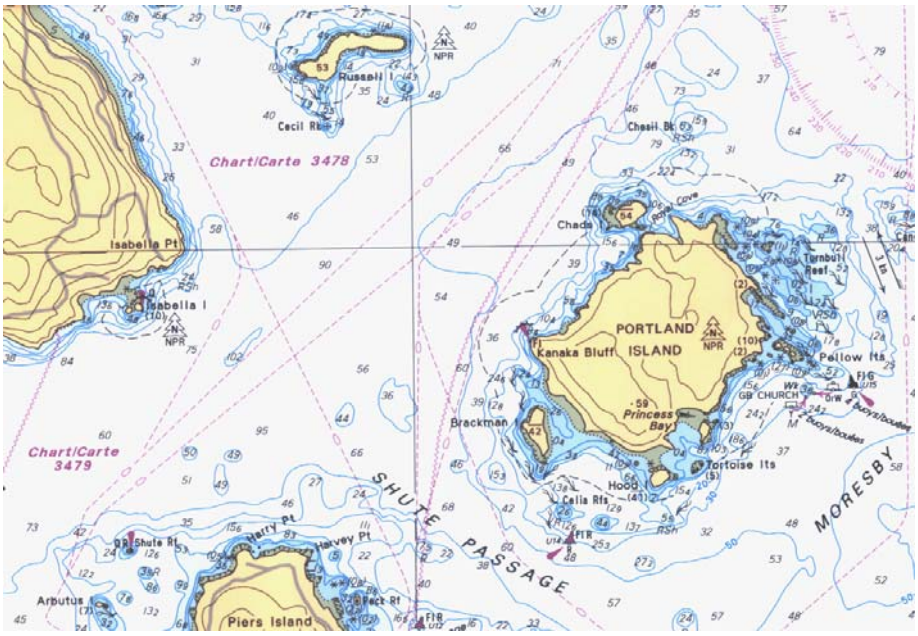


Figure 12 Large Scale Chart Numbers

Note. From *Chart 3441*, *Haro Strait, Boundary Pass and / et Satellite Channel*, 2005, Ottawa, ON: Canadian Hydrographic Service.

Tidal diamonds. The information which relates to this diamond is found elsewhere on the chart or may be referenced to another publication such as *Canadian Tide and Current Tables Vol. 5*. This publication will give the rates and direction of the currents in this area (as illustrated in Figure 13).

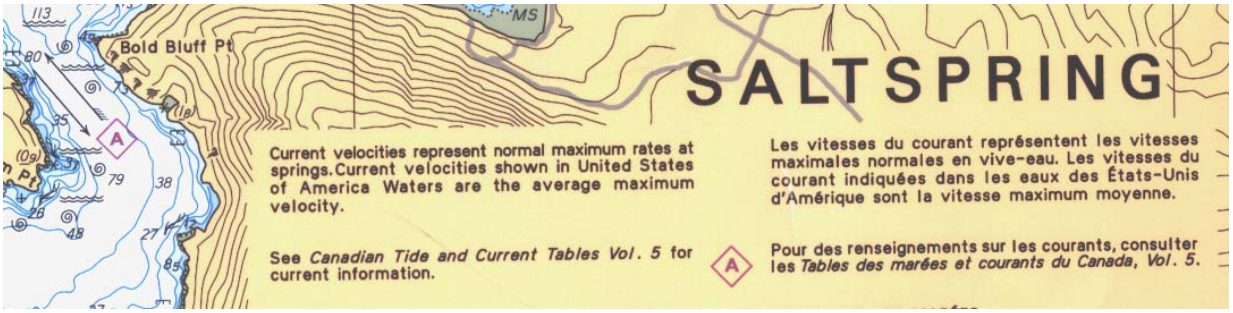


Figure 13 Tidal Diamond

Note. From *Chart 3441*, *Haro Strait, Boundary Pass and / et Satellite Channel*, 2005, Ottawa, ON: Canadian Hydrographic Service.

Inserts / continuations. Chart inserts are placed on the chart to show greater detail of a harbour or small area that would be too small to have its own chart. On *Chart 3441*, Continuation A is shown to give greater detail to Finlayson Arm. This area is too small to create its own separate chart.

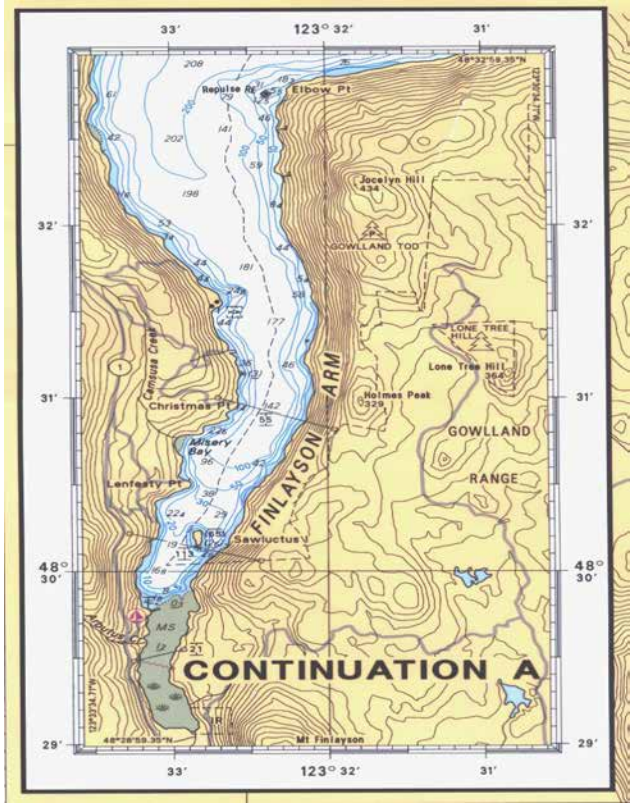


Figure 14 Continuation A

Note. From *Chart 3441*, *Haro Strait, Boundary Pass and / et Satellite Channel*, 2005, Ottawa, ON: Canadian Hydrographic Service.

Distance scales. Scales for measuring distances are provided in convenient locations on the chart. These scales can be used to measure distances in nautical miles (NM) or in metres (m) (as illustrated in Figure 15).

Measuring distances will be covered in greater detail in EO X51.04 (Locate a Position on a Chart).

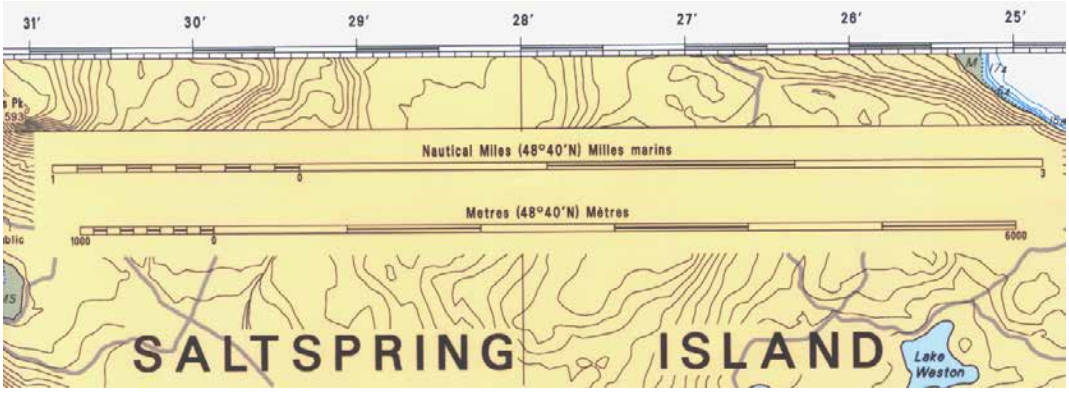


Figure 15 Distance Scales

Note. From *Chart 3441*, *Haro Strait, Boundary Pass and / et Satellite Channel*, 2005, Ottawa, ON: Canadian Hydrographic Service.

Compass rose. Every chart has at least one compass rose. Every compass rose has two circles. The outer circle is aligned to true north and the inner circle is aligned to magnetic north (as illustrated in Figure 16). When plotting bearings or courses on a chart, the outer (True) circle is used. The important information to remember about a compass rose is:

- True directions are printed around the outer circle of the compass rose.
- Magnetic directions are printed around the inner circle of the compass rose. The inner scale is oriented toward magnetic north.
- True north and magnetic north point to different directions.

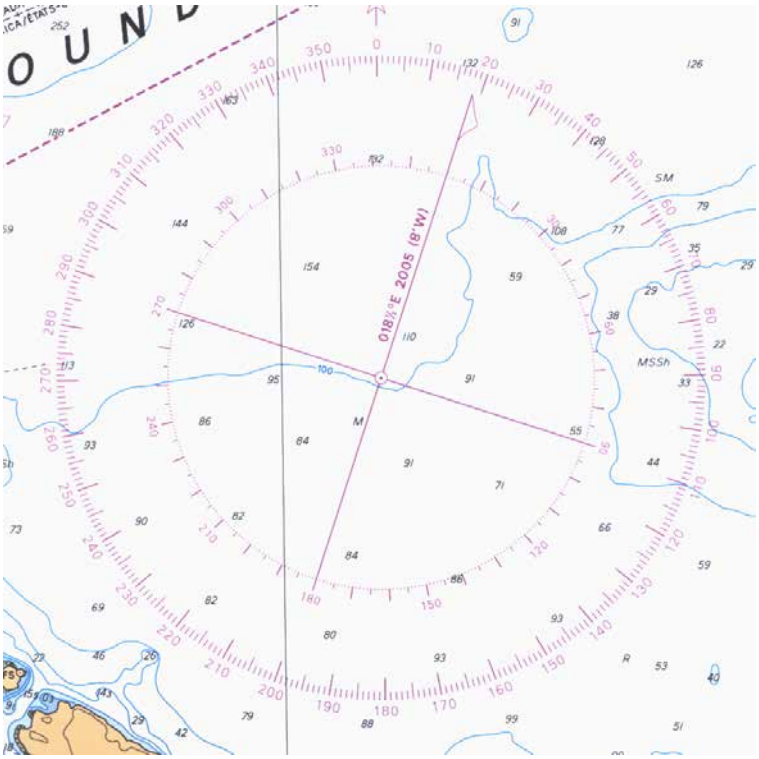


Figure 16 Compass Rose

Note. From *Chart 3441*, *Haro Strait, Boundary Pass and / et Satellite Channel*, 2005, Ottawa, ON: Canadian Hydrographic Service.

Distribute the Chart Information Worksheet located at Annex A.

The students have 10 minutes to complete the worksheet (students may work in pairs to complete). Once the worksheet is completed, have the students exchange their sheets for correction.

Review Chart Information Answer Sheet located at Annex B with the students.

CONFIRMATION OF TEACHING POINT 3

The students' completion of the Chart Information Worksheet will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The students' completion of the worksheets will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK / READING / PRACTICE

Nil.

METHOD OF EVALUATION

Nil.

CLOSING STATEMENT

Recognizing the information contained on the chart will enable you to safely and effectively create navigation plans for on-water activities.

INSTRUCTOR NOTES / REMARKS

Nil.

REFERENCES

ISBN 1-57409-052-6 Larkin, F. (1998). *Basic coastal navigation*. Dobbs Ferry, NY: Sheridan House Inc.

Chart Information Worksheet

Answer the following questions using *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*.

Q1. What is the scale? What does it mean?

A1. _____

_____

Q2. How are soundings measured on this chart?

A2. _____

_____

Q3. What is the date of the newest edition of this chart?

A3. _____

_____

Q4. Which Notice to Mariners outlines information on the Firing Practice and Exercise Areas that are shown on this chart?

A4. _____

_____

Q5. The revised Traffic Separation Scheme from Victoria to Vancouver came into effect on which date?

A5. _____

_____

Q6. Describe the Navy mooring buoys in Patricia Bay.

A6. _____

_____

Q7. Identify the large scale or adjoining chart numbers for the following areas:

a. Cowichan Bay: _____

b. Bazan Bay: _____

c. Spieden Channel: _____

d. Areas east of Jones Island: _____

e. Plumper Sound: _____

f. Areas north of Octopus Pt.: _____

Q8. What is the charted height of the following:

a. Highest point on Portland Island: _____

b. Tortoise Islets: _____

c. Christmas Pt. Power Cable: _____

d. Highest rock in Patricia Bay: _____

Q9. What area is shown in Continuation A?

A9. _____

_____

Q10. What units of measurement are used for the two distance scales on the chart?

A10. _____

_____

Q11. What is the latest survey used to make this chart?

A11. _____

_____

Q12. Who published this chart?

A12. _____

_____

Chart Information Answer Sheet.

Answer the following questions using Chart 3441 *Haro Strait, Boundary Pass and Satellite Channel*.

Q1. What is the scale? What does it mean?

A1. **The scale is 1 : 40 000. This means that every inch on the chart represents 40 000 inches on the earth's surface.**

Q2. How are soundings measured on this chart?

A2. **Soundings are measured in metres and are reduced to Chart Datum.**

Q3. What is the date of the newest edition of this chart?

A3. **July 1, 2005.**

Q4. Which Notice to Mariners outlines information on the Firing Practice and Exercise Areas that are shown on this chart?

A4. **Annual Notice to Mariners number 35.**

Q5. The revised Traffic Separation Scheme from Victoria to Vancouver came into effect on which date?

A5. **July 1, 2005.**

Q6. Describe the Navy mooring buoys in Patricia Bay.

A6. **They are orange and white barrel mooring buoys.**

Q7. Identify the large scale or adjoining chart numbers for the following areas:

a. Cowichan Bay: **Chart 3478.**

b. Bazan Bay: **Chart 3479.**

c. Spieden Channel: **Chart 18433 USA.**

d. Areas east of Jones Island: **Chart 18421 USA.**

e. Plumper Sound: **Chart 3477.**

f. Areas north of Octopus Pt.: **Chart 3442.**

Q8. What is the charted height of the following:

a. Highest point on Portland Island: **59 m.**

b. Tortoise Islets: **5 m.**

c. Christmas Pt. Power Cable: **55 m.**

d. Highest rock in Patricia Bay: **3.5 m.**

Q9. What area is shown in Continuation A?

A9. **Finlayson Arm (Southern Portion).**

Q10. What units of measurement are used for the two distance scales on the chart?

A10. **Nautical miles and metres.**

Q11. What is the latest survey used to make this chart?

A11. **1999.**

Q12. Who published this chart?

A12. **Canadian Hydrographic Service.**

CANADIAN CADET ORGANIZATIONS

NAVIGATION MANUAL

INSTRUCTIONAL GUIDE

SECTION 3

EO X51.03 – IDENTIFY CHART SYMBOLS

Total Time:	60 min

PREPARATION

PRE-LESSON INSTRUCTIONS

This IG supports EO X51.03 (Identify Chart Symbols).

Photocopy Annexes A, C, and D for each student.

Set up the classroom or training area so that students can sit in pairs at tables.

Distribute one copy of *Symbols Abbreviations Terms (Chart 1)* to each table.

PRE-LESSON ASSIGNMENT

Nil.

APPROACH

A practical activity was chosen for this TP as it is an interactive way to introduce students to identifying chart symbols. This activity contributes to the development of navigation skills in a fun and challenging setting.

INTRODUCTION

REVIEW

Nil.

OBJECTIVES

By the end of this lesson the student shall have identified chart symbols.

IMPORTANCE

It is important for students to explain chart information by identifying chart symbols and be able to apply this when planning to navigate. Thorough knowledge of this information will ensure a safe and effective navigation plan can be created.

The following information should be used to instruct students prior to the activity.

SYMBOLS ABBREVIATIONS TERMS* (*CHART 1)

An understanding of the symbols and terms found on charts is essential to using charts effectively. The CHS publication, *Symbols Abbreviations Terms (Chart 1)*, contains all of the standard symbols and abbreviations used on charts.

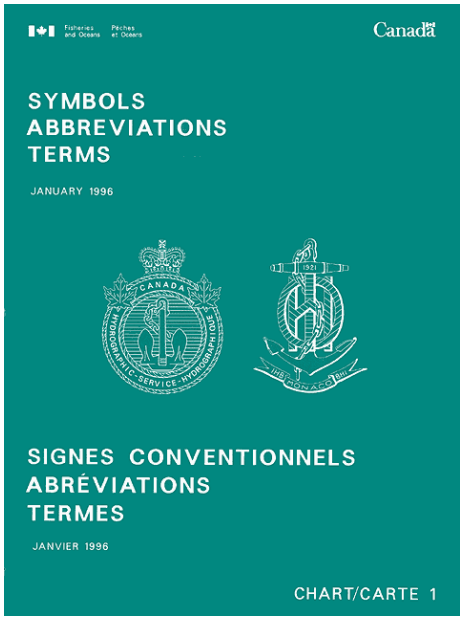


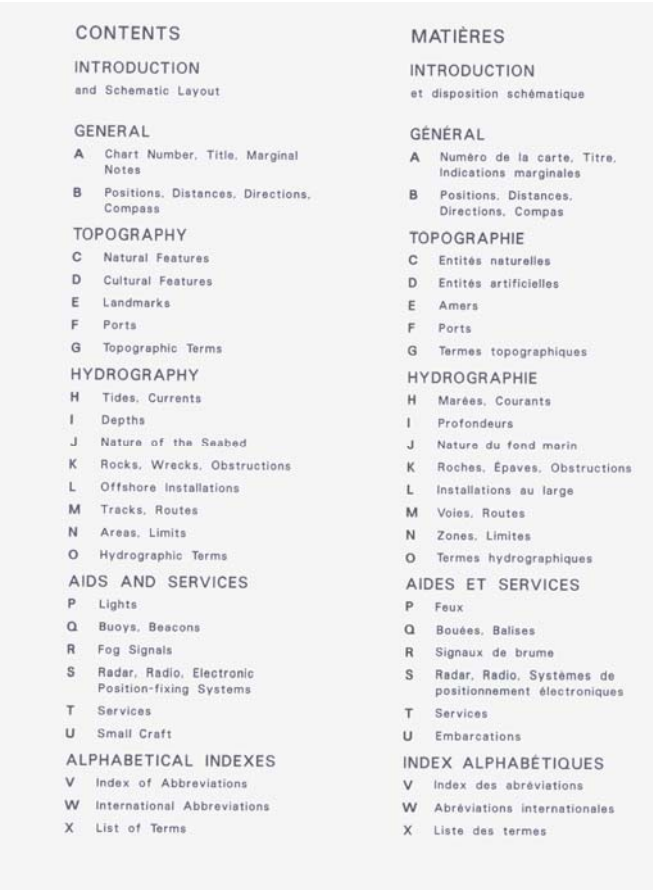
Figure 1 *Symbols Abbreviations Terms (Chart 1)*

Chart 1 explains all the symbols, abbreviations and terms used on charts. The publication is broken into 26 sections which are identified by a letter (as illustrated in Figure 2). The sections that will be discussed in this TP are:

- Section C–Natural features,
- Section E–Landmarks,
- Section F–Ports,
- Section H–Tides, currents,

- Section K–Rocks, wrecks, obstructions,
- Section Q–Buoys, beacons,
- Section T–Services, and
- Section U–Small craft.

It is impossible for students to memorize all of the symbols covered in each section of the publication. Only the symbols that a student will use when navigating small craft will be covered in detail during this TP.



CONTENTS

INTRODUCTION
and Schematic Layout

GENERAL
A Chart Number, Title, Marginal Notes
B Positions, Distances, Directions, Compass

TOPOGRAPHY
C Natural Features
D Cultural Features
E Landmarks
F Ports
G Topographic Terms

HYDROGRAPHY
H Tides, Currents
I Depths
J Nature of the Seabed
K Rocks, Wrecks, Obstructions
L Offshore Installations
M Tracks, Routes
N Areas, Limits
O Hydrographic Terms

AIDS AND SERVICES
P Lights
Q Buoys, Beacons
R Fog Signals
S Radar, Radio, Electronic Position-fixing Systems
T Services
U Small Craft

ALPHABETICAL INDEXES
V Index of Abbreviations
W International Abbreviations
X List of Terms

MATIÈRES

INTRODUCTION
et disposition schématique

GÉNÉRAL
A Numéro de la carte, Titre, Indications marginales
B Positions, Distances, Directions, Compas

TOPOGRAPHIE
C Entités naturelles
D Entités artificielles
E Amers
F Ports
G Termes topographiques

HYDROGRAPHIE
H Marées, Courants
I Profondeurs
J Nature du fond marin
K Roches, Épaves, Obstructions
L Installations au large
M Voies, Routes
N Zones, Limites
O Termes hydrographiques

AIDES ET SERVICES
P Feux
Q Bouées, Balises
R Signaux de brume
S Radar, Radio, Systèmes de positionnement électroniques
T Services
U Embarcations

INDEX ALPHABÉTIQUES
V Index des abréviations
W Abréviations internationales
X Liste des termes

Figure 2 *Chart 1* Index

When using *Chart 1*, students may find the quick reference table on the back cover of the publication a very useful tool. Examples of the more frequently used symbols are displayed by each section letter (as illustrated in Figure 3).

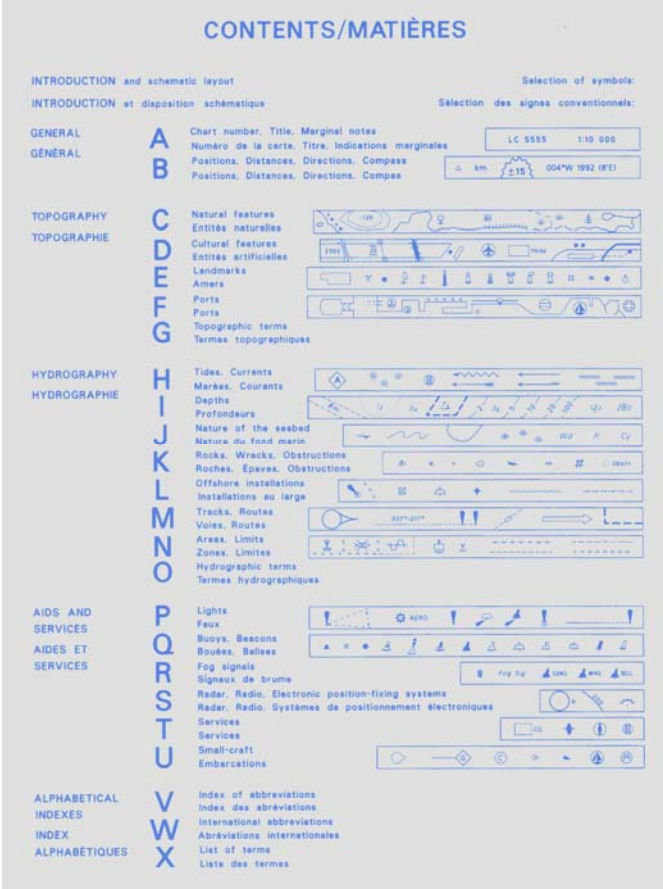


Figure 3 Back Cover of *Chart 1*

Distribute Annex A to each student. The students are to identify which section of Chart 1 contain the symbols shown.

Have the students compare answers with those located at Annex B.

ACTIVITY

Time: 40 min

1. Divide the students into pairs.
2. Distribute the Chart Symbols Worksheets 1–3 located at Annex C to each student.
3. While working in pairs, give the students 30 minutes to identify the given symbols by searching *Symbols Abbreviation Terms (Chart 1)*.
4. Have the students record all answers on Chart Symbols Answer Sheet located at Annex D.
5. Review answers with students using the answer key located at Annex E.

The answer sheet found at Annex E contains the name of the symbol and where in *Symbols Abbreviations Terms (Chart 1)* the symbol is found. The proper section is identified by section and symbol number in brackets.

SAFETY

Nil.

END OF LESSON CONFIRMATION

The students' completion of the worksheets will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK / READING / PRACTICE

Nil.

METHOD OF EVALUATION

Nil.

CLOSING STATEMENT

Recognizing chart symbols will enable you to safely and effectively create navigation plans for on-water activities.

INSTRUCTOR NOTES / REMARKS

Nil.

REFERENCES

Minister of Fisheries and Oceans. (2004). *Symbols abbreviations terms (Chart 1)*. Ottawa, ON: Canadian Hydrographic Service.

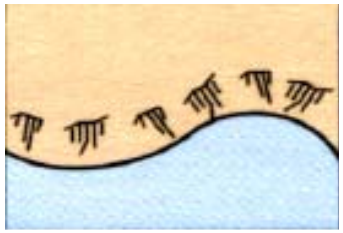
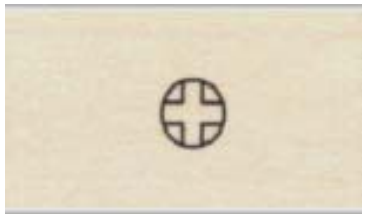
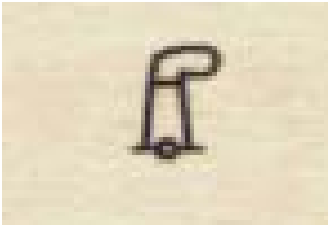
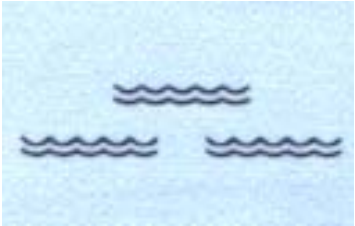
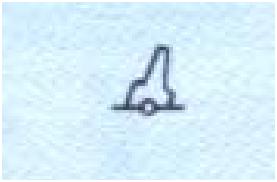
1. 	3. 	5. 	7. 
2. 	4. 	6. 	8. 

Figure A-1 Symbols Abbreviations Terms (Chart 1) Worksheet

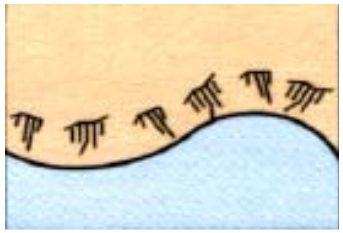
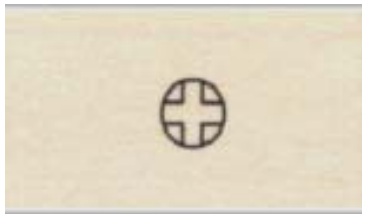
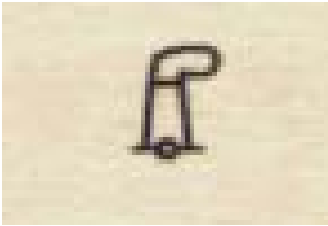
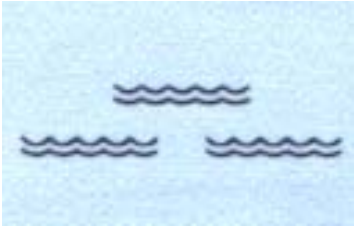
1. 	3. 	5. 	7. 
Section C	Section F	Section K	Section T
2. 	4. 	6. 	8. 
Section E	Section H	Section Q	Section U

Figure B-1 Symbols Abbreviations Terms (Chart 1) Worksheet–Answers

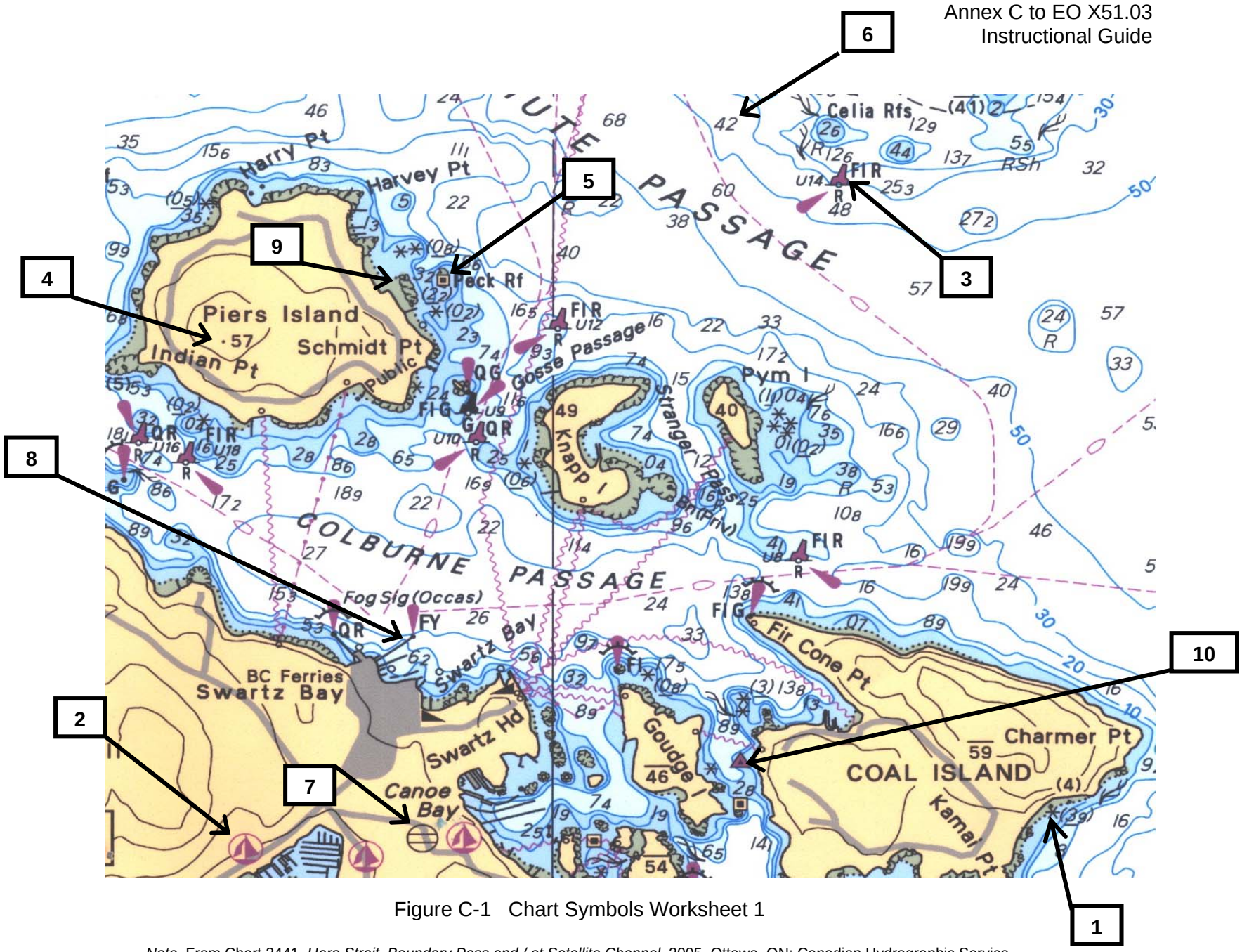


Figure C-1 Chart Symbols Worksheet 1

Note. From Chart 3441, *Haro Strait, Boundary Pass and / et Satellite Channel*, 2005, Ottawa, ON: Canadian Hydrographic Service.

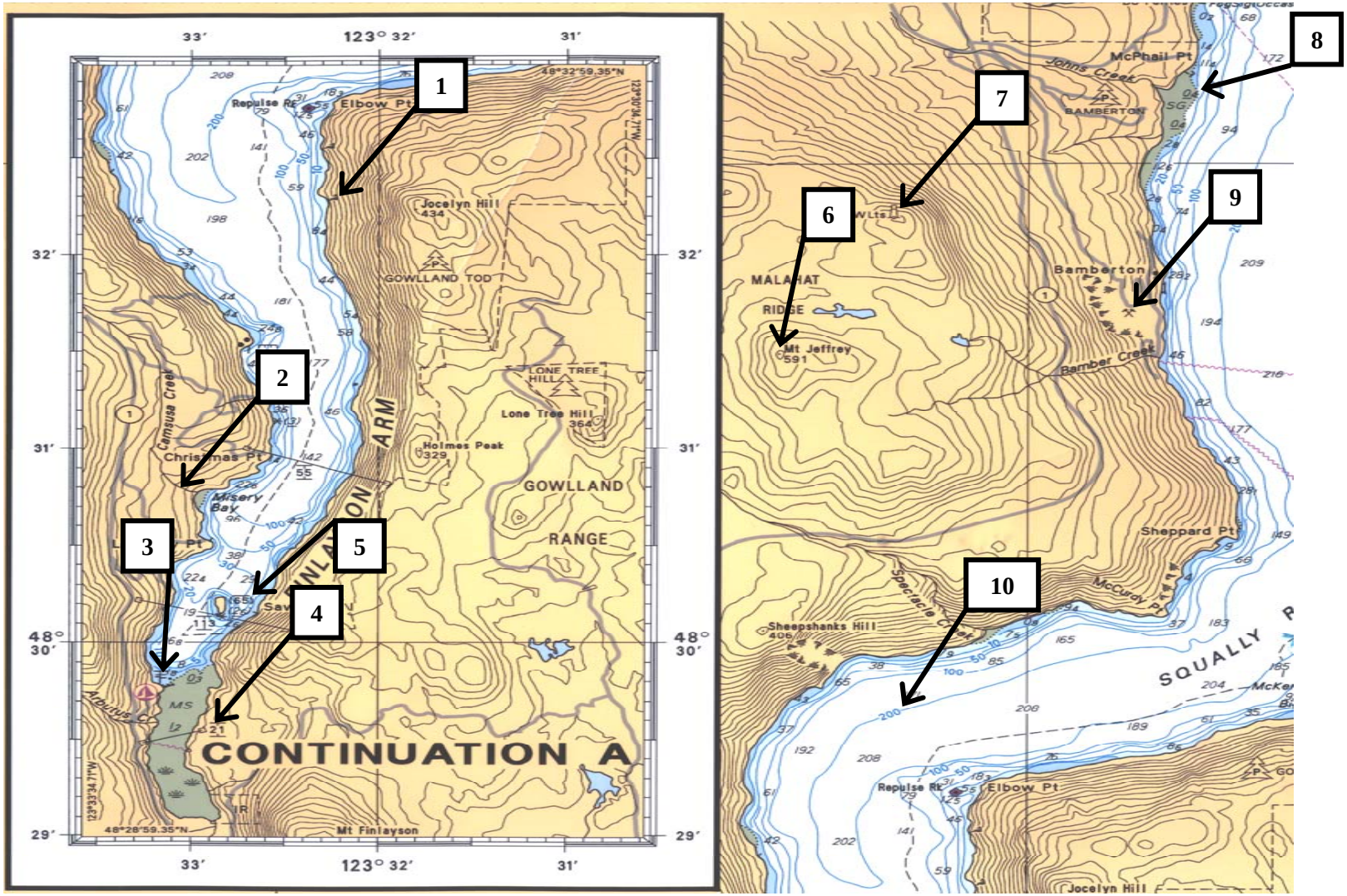


Figure C-2 Chart Symbols Worksheet 2

Note. From Chart 3441, *Haro Strait, Boundary Pass and / et Satellite Channel*, 2005, Ottawa, ON: Canadian Hydrographic Service.

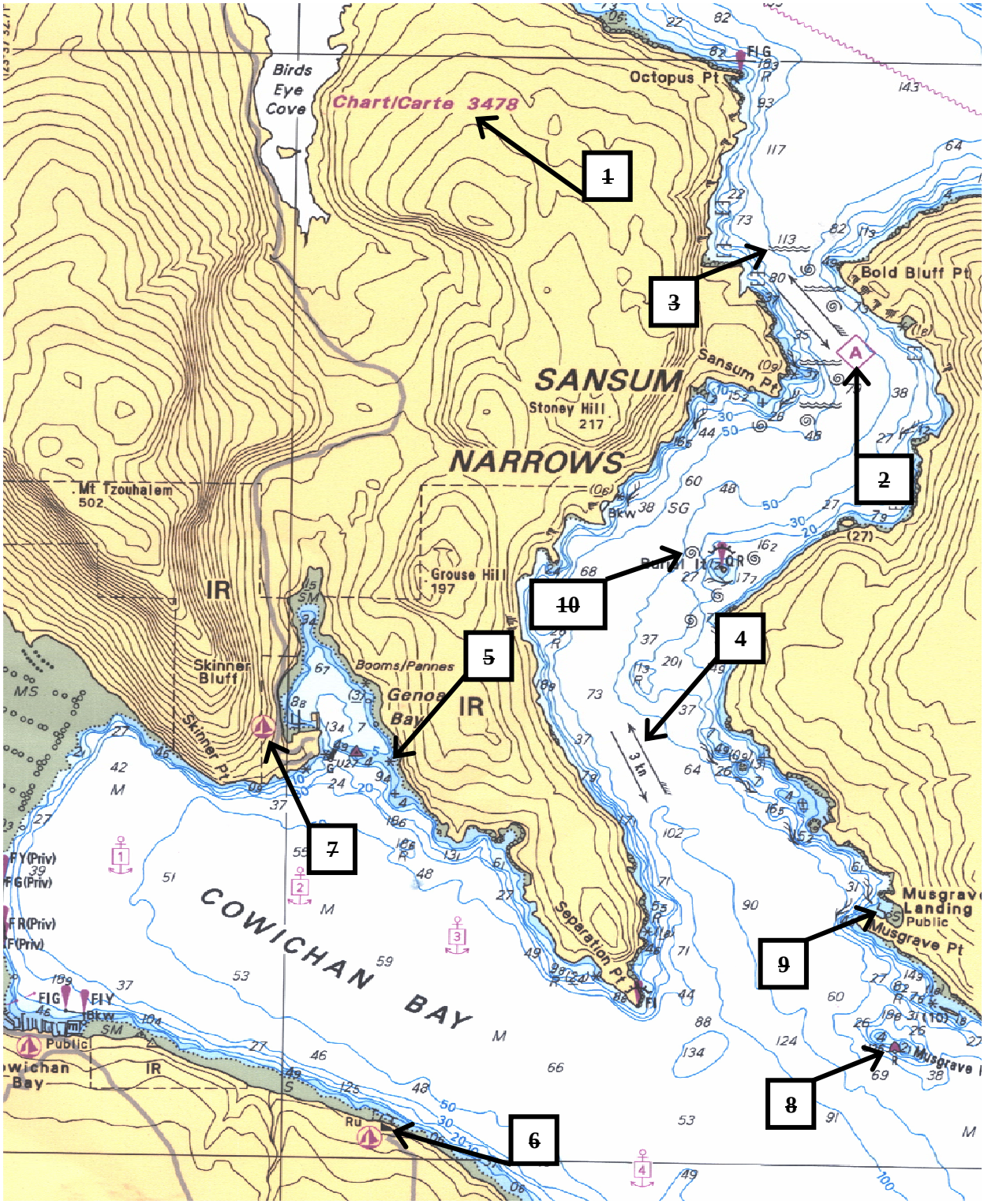


Figure C-3 Chart Symbols Worksheet 3

Note. From Chart 3441, *Haro Strait, Boundary Pass and / et Satellite Channel*, 2005, Ottawa, ON: Canadian Hydrographic Service.

Name: _____ **Division:** _____

Worksheet 1	Worksheet 2	Worksheet 3
1.	1.	1.
2.	2.	2.
3.	3.	3.
4.	4.	4.
5.	5.	5.
6.	6.	6.
7.	7.	7.
8.	8.	8.
9.	9.	9.
10.	10.	10.

Figure D-1 Chart Symbols Answer Sheet

Worksheet 1	Worksheet 2	Worksheet 3
1. Rock that covers and uncovers to 2.2 m (K11)	1. Steep / hilly coast (C3)	1. Large-scale chart reference. (A18)
2. Marina (U1.1)	2. River, stream or creek (E20)	2. Tidal Diamond. (H46)
3. Starboard Hand Buoy (Qg)	3. Jetty (F14)	3. Overfalls, tide rips, races. (H44)
4. Spot elevation 57m (C13)	4. Vertical clearance (D20)	4. Tide direction arrows for flood and ebb currents. (H40/41)
5. Port hand day beacon (Qt)	5. Elevation of top of trees. (C14)	5. Rock that covers and uncovers. No height given. (K11)
6. Sounding (I10)	6. Spot elevation. Mt. Jeffery 591m (C13)	6. Boat ramp / launch (U5)
7. Custom house (F61)	7. Tower (E20)	7. Marina (U1.1)
8. Jetty (F14)	8. Drying area (foreshore) to 0.4m (Ji)	8. Starboard Hand Buoy (Qg)
9. Rock that covers and uncovers to 2.2 m (K11)	9. Quarry (E35.1)	9. Jetty (F14)
10. Starboard hand day mark (Qt)	10. Depth contour (I30)	10. Eddies, whirlpools (H45)

Figure E-1 Chart Symbols Answer Key

CANADIAN CADET ORGANIZATIONS

NAVIGATION MANUAL

INSTRUCTIONAL GUIDE

SECTION 4

EO X51.04 – LOCATE A POSITION ON A CHART

Total Time:	360 min

PREPARATION

PRE-LESSON INSTRUCTIONS

This IG supports EO X51.04 (Locate a Position on a Chart).

Distribute one set of navigation instruments, *Symbols Abbreviations Terms (Chart 1)* and *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel* to each pair of students.

If desired, an alternative chart, such as one of the local area, may be used. If so, modify the lesson to include the information in the given examples to reflect that chart.

Photocopy Annexes A–D and F for each student.

Ship's Boat Operator, conduct all teaching points for a total of 360 min.

Phase 4, the following periods are mandatory and a suggested time allocation is as follows:

1. TP 1 – 60 min,
2. TP 2, 3, 4 and 5 (30 min each) – 120 min, and
3. TP 6 – 60 min.

Sea Environmental Training Course (SETC):

1. TP1 – via Distributed Learning,
2. TP 2, 3 – 60 min,
3. TP 4 – 25 min,
4. TP 5 – 25 min, and
5. TP 6 – 40 min.

PRE-LESSON ASSIGNMENT

Nil.

APPROACH

A demonstration and performance was chosen for TPs 1, 4, 5, and 6 as it allows the instructor to explain and demonstrate the skills the student is expected to acquire while providing an opportunity for the student to practice the skills under supervision.

An interactive lecture was chosen for TP 2 to introduce latitude and longitude to the students.

A practical activity was chosen for TP 3 as it is an interactive way to allow students to experience determining the latitude and longitude of points and locating positions on a chart using different methods. This activity contributes to the development of navigation skills in a fun and challenging way.

INTRODUCTION

REVIEW

Nil.

OBJECTIVES

By the end of this lesson the student shall be expected to locate a position on a chart and complete a fixing paper to an accuracy of 60 percent.

IMPORTANCE

It is important for students to know how to navigate as it introduces them to skills necessary for future training opportunities. Knowledge of this information will ensure that students are able to create safe and effective navigation plans for on water activities.

Teaching Point 1 **Demonstrate and have the students practice using navigation instruments.**

Time: See Pre-Lesson Instructions

Method: Demonstration and Performance

For this TP it is recommended that instruction take the following format:

1. Explain and demonstrate the use of each navigation instrument.
2. Explain and demonstrate each step required to use each instrument.
3. Monitor the students' performance as they practice with each navigation instrument.

USE OF NAVIGATION INSTRUMENTS

The purpose of navigation is to find the present position and to determine the necessary speed, direction etc to arrive at a port or point of destination. The proper use of navigation instruments will greatly effect the accuracy of the navigation and will therefore impact the safe and timely execution of any planned passage.

A navigator's instrument kit will contain, but is not limited to, the following:

- **Pencils.** The recommended pencils for navigation are HB wooden pencils. These pencils allow clean lines on the chart and will not leave wide, smudgy lines which are difficult to erase. Mechanical pencils (0.5 mm and 0.7 mm) are not recommended as the lead will become very sharp during use and may damage the surface of the chart, leaving permanent lines.

- **Erasers.** Tests done by Canadian Hydrographic Service (CHS) indicate that indian gum erasers work the best on either type of chart. Never use the red erasers which are attached to the pencil. These erasers will leave red smears on the chart and their abrasive material may scrub any information (lines, soundings, etc.) from the surface of the chart.

- **Parallel ruler.** Used for transferring a line across a chart while maintaining its direction. There are two main types of parallel rulers used:

Students should be given an opportunity to use both types of rulers (if available).

  - **Hinged parallel ruler.** Two straight edges hinged so that they maintain the same angle. By alternating the moving edge, and securely holding down the non-moving edge, the rulers move about the chart while maintaining the same angle (as illustrated in Figure 1).

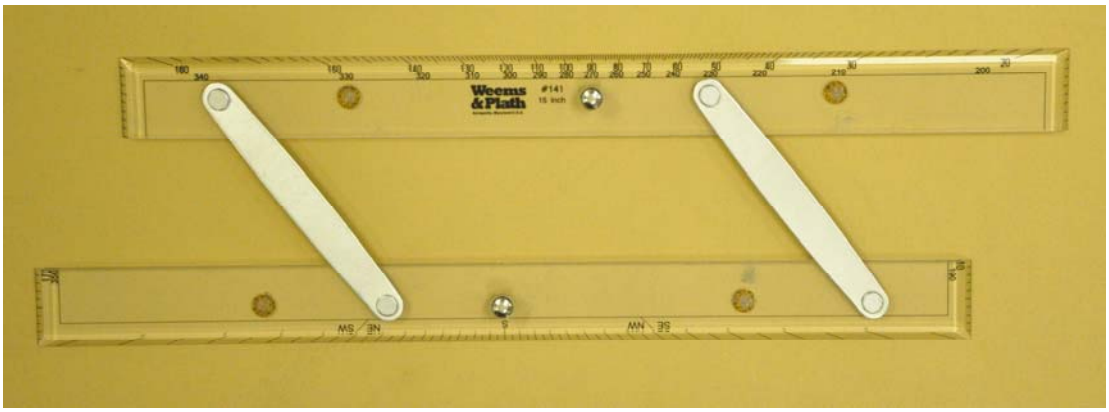


Figure 1 Hinged Parallel Ruler

Instructions and an exercise for the students on how to use a hinged parallel ruler are located at Annex A.

- **Rolling parallel ruler**. Designed to roll without sliding laterally and easy to use with little practice. Rolling rulers do not work well near the edge or over folds in charts as they may catch on the fold or edge. (Illustrated in Figure 2).

Figure 2 Rolling Parallel Ruler

Note. From Chartroom-online.com, 2008, *The Navigators Best Friend*, Retrieved November 6, 2008, from www.chartroom-online.com/store/products/equipment/RollingRule.html

Instructions and an exercise for the students on how to use a rolling parallel ruler are located at Annex B.

- **Dividers.** Dividers are used to measure the distance between two points, and also to help align parallel rulers. There are several styles of dividers available . A good set of dividers will have an adjusting screw to maintain the tension on the divider's arms.

Figure 3 Dividers

Note. From Binnacle.com, 2008, *Your Online Marine Store*, Retrieved November 13, 2008, from http://ca.binnacle.com/Product_info.php

Additional navigation instruments that could be included are:

- **Drafting compass.** A drafting compass can be used for scribing arcs, which indicate distances, on a chart. The best compass for navigation is one with a thumb screw between the legs to keep them in a set position.

Figure 4 Drafting Compass

Note. From Staedtler.com, 2008, Retrieved November 13, 2008, from www.staedtler.com/technical_drawing.

- **Speed-Time-Distance calculator.** A simple slide rule for calculating the speed, distance or time if the other two quantities are known.

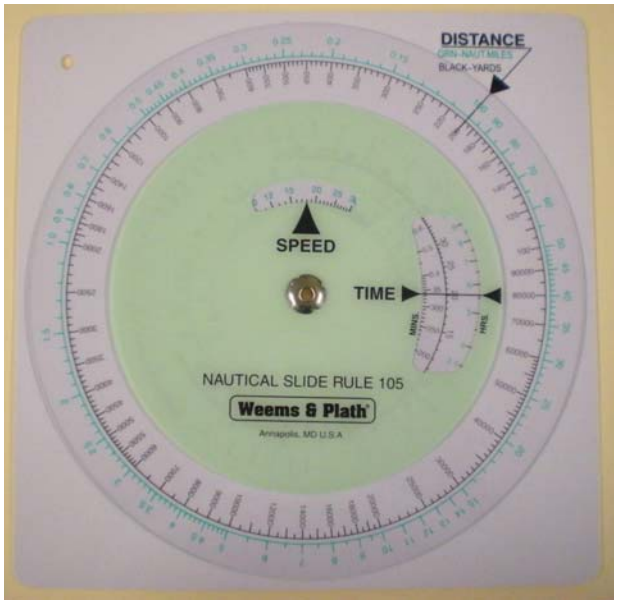


Figure 5 Weems & Plath Speed-Time-Distance Calculator

Refer to X51.01, TP 5 for instructions on how to perform speed-time-distance calculations. If time permits, have the cadets complete the worksheet.

Instructions on how to use the speed-time-distance calculator are located at Annex C.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS:

Q1. What type of pencil is recommended for navigation?

Q2. What are the two types of parallel rulers?

Q3. What instrument is used to measure distance between two objects?

ANTICIPATED ANSWERS:

A1. HB wooden pencils.

A2. Hinged or rolling.

A3. Dividers.

Teaching Point 2 **Describe latitude and longitude.**

Time: See Pre-Lesson Instructions

Method: Interactive Lecture

DESCRIBE LATITUDE AND LONGITUDE

To know precisely a location on the surface of the earth, a simple system of reference points, based on a set of lattice lines covering the globe was invented.

This system of lattice lines can be described as:

Parallels of latitude. These lines run parallel to the equator and are measured from 000 degrees at the equator to 90 degrees north or south at the poles. Since these lines are parallel, they are used to measure distance on a chart.

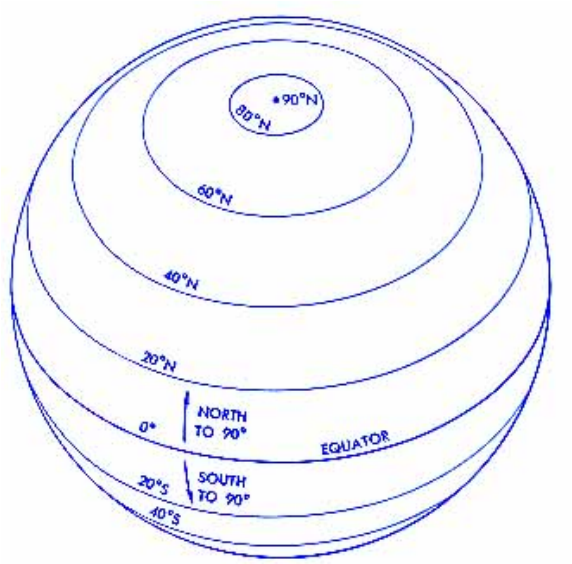


Figure 6 Parallels of Latitude

Note. From "*Latitude and Longitude: The Geographic Grid (Introduction*)" by Dr. Rodrigue, 2000, Retrieved November 13, 2008, from http://homepages.ius.edu/PGALVIN/lat_long/Geographic%20Grid.htm

Memory Aid: "Lat. is flat."

Meridians of longitude. Lines that run perpendicular to the equator and converge or meet at the poles (as illustrated in Figure 7). These lines are measured 180 degrees east or west from the Prime Meridian (000 degrees), which runs through Greenwich, England. These lines meet at a point called the International Date Line (180 degrees) on the other side of the globe from the Prime Meridian. Since the meridians of longitude converge at the poles, they cannot be used for measuring distance on a chart.

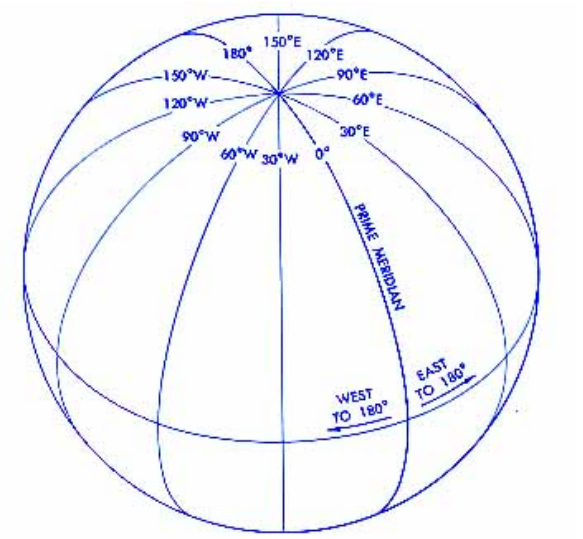


Figure 7 Meridians of Longitude

Note. From "*Latitude and Longitude: The Geographic Grid (Introduction*)" by Dr. Rodrigue, 2000, Retrieved November 13, 2008, from http://homepages.ius.edu/PGALVIN/lat_long/Geographic%20Grid.htm

Any point on the earth's surface can be found by referencing the corresponding latitude and longitude. On charts, the latitude scales are found on the left and right sides while the longitude scales are found on the top and bottom.

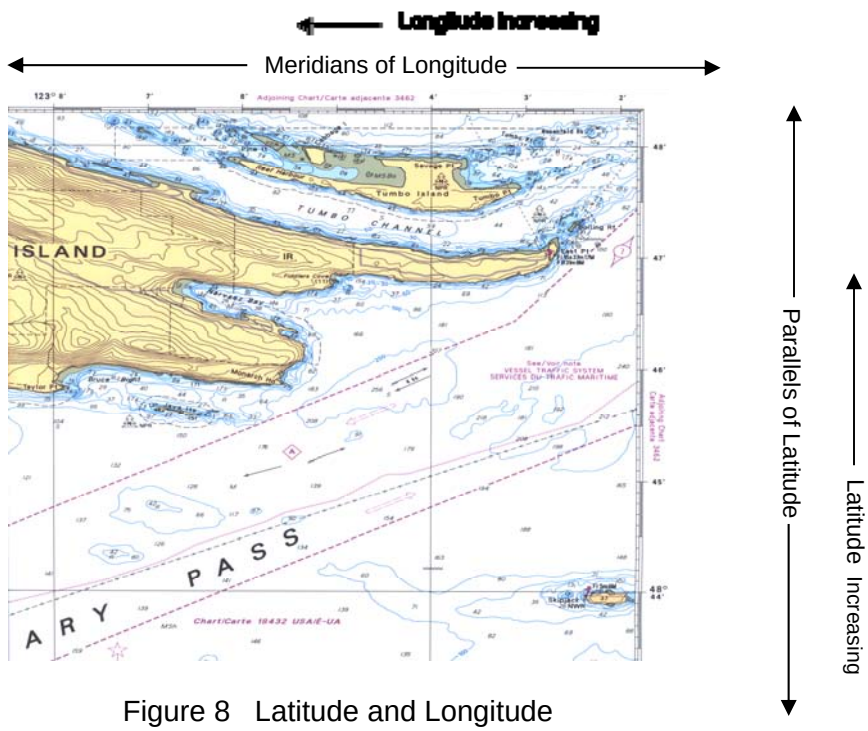


Figure 8 Latitude and Longitude

Note. From *Chart 3441, Haro Strait, Boundary pass and / et Satellite Channel*, 2005, ON: Canadian Hydrographic Service, Ottawa.

Chart 3441 depicts an area of British Columbia. Since this is in North America, the numbers on the latitude scale increase from the bottom of the chart to the top or as you move north. The numbers on the longitude scale increase from right to left as you move west (as illustrated in Figure 8).

Latitude and longitude are measured in degrees, minutes and seconds. A degree is divided into 60 minutes and each minute can be divided into 60 seconds. However, when referring to positions on a chart, it is more common to use degrees, minutes and tenths of a minute.

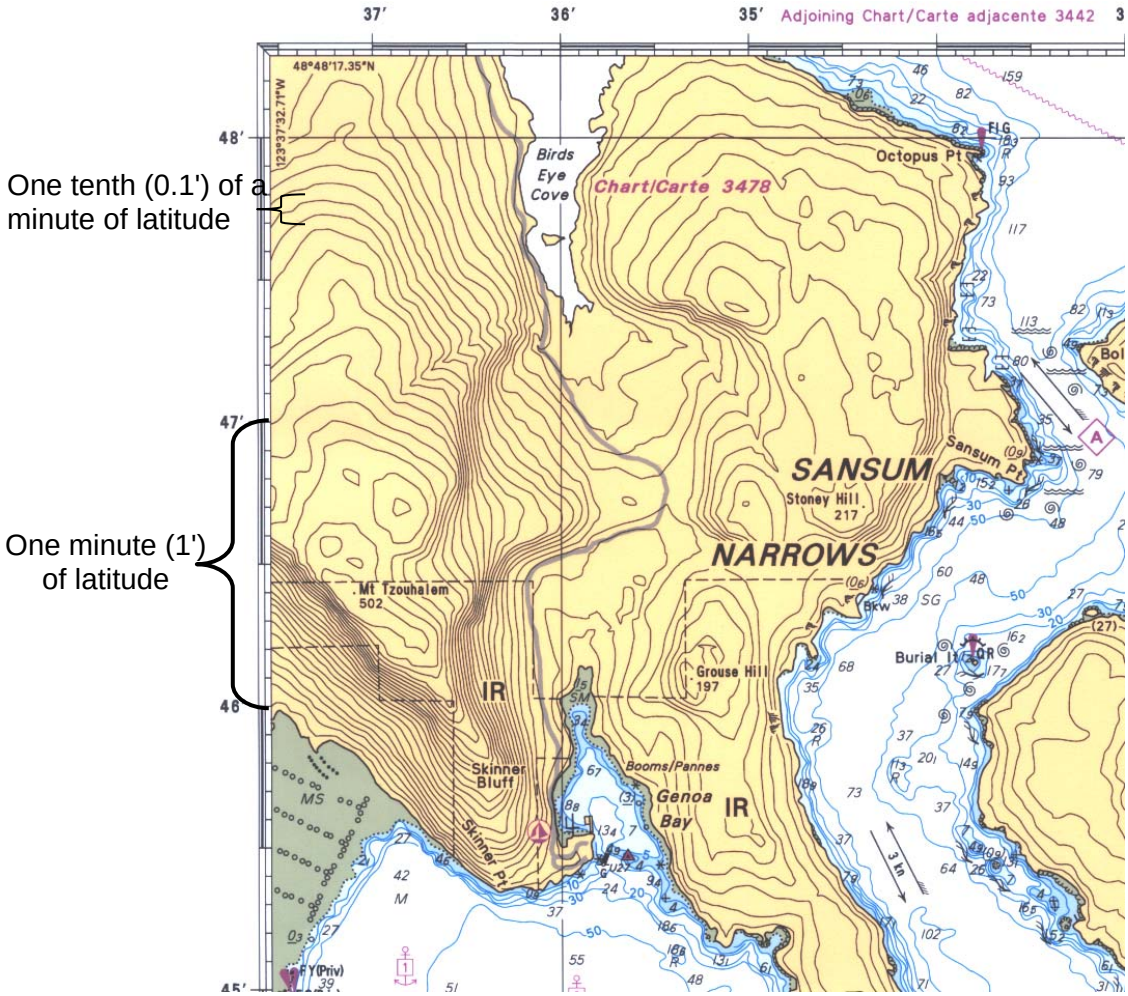


Figure 9 Minutes and Tenths of Minutes

Note. From *Chart 3441*, *Haro Strait, Boundary pass and / et Satellite Channel*, 2005, Ottawa, ON: Canadian Hydrographic Service.

When writing the latitude and longitude of a position, latitude is always written above longitude or written first when written on the same line.

Example: The position of Senanus I. light can be written as:

1. 48° 35.55' N 123° 29.20' W or

2. 48° 35.55' N
   123° 29.20' W

Degrees of longitude are always written in three digits (eg 090°E). If the longitude is less than 100 degrees, then a 0 is placed in front to differentiate between latitude and longitude.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS:

Q1. Which lines are parallel to the equator and are measured from the equator to the poles?

Q2. What is the proper name for 000 degrees longitude?

Q3. What is the most common way of writing latitude or longitude?

ANTICIPATED ANSWERS:

A1. Parallels of latitude.

A2. The Prime Meridian.

A3. In degrees, minutes and tenths of minutes.

Teaching Point 3	**Conduct an activity where the students will determine the latitude and longitude of a given point on a chart.**
Time: See Pre-Lesson Instructions	Method: Practical Activity

The following information should be presented to the students prior to the activity.

With *Chart 3441*, determine the latitude and longitude of Separation Pt. light.

Two methods of finding the latitudes and longitudes are given. The students may use either method.

Determining Latitude (Method One)

The technique for using a parallel ruler to find the latitude is as follows:

1. Align the edge of the parallel ruler along the nearest parallel of latitude on the chart. In this example, the ruler must be placed so that its left end intersects the latitude scale on the left side of the chart.

2. Roll the ruler to the light's symbol so that the black dot of the symbol falls along the edge of the ruler. Using the ruler as a guide, draw a light line on the latitude scale where the ruler intersects the scale.

3. Read and record the latitude of the object (in this case the latitude is 48° 44.58' N).

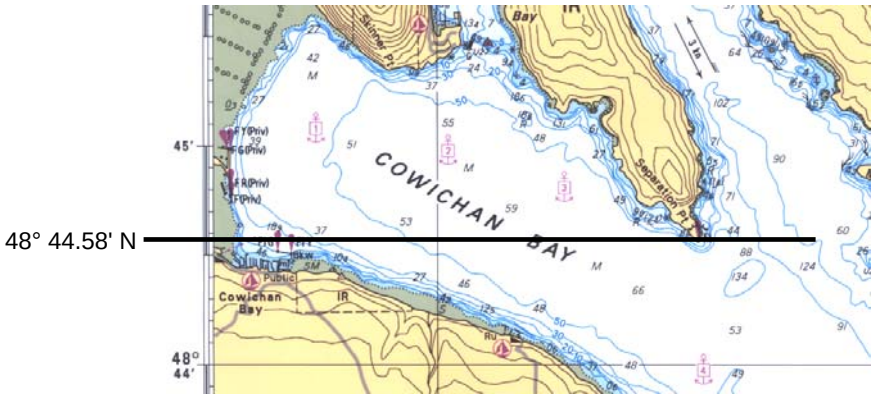


Figure 10 Measuring Latitude

Determining Latitude (Method Two)

The technique of determining latitude using a set of dividers is as follows:

1. Align the edge of the parallel ruler with a meridian of longitude nearest Separation Pt.

2. Roll the ruler to the symbol so that the black dot at the bottom falls along the edge of the ruler.

3. Using the edge of the ruler as a guide, measure the distance from the symbol to the nearest parallel of latitude (in this case it is 48° 44' N).

4. Move the dividers to the latitude scale on the left side of the chart. Place one point on the same parallel (48° 44' N) and measure up the scale (as Separation Pt. is north of this parallel).

5. Read and record the latitude of the light (48° 44.58' N).

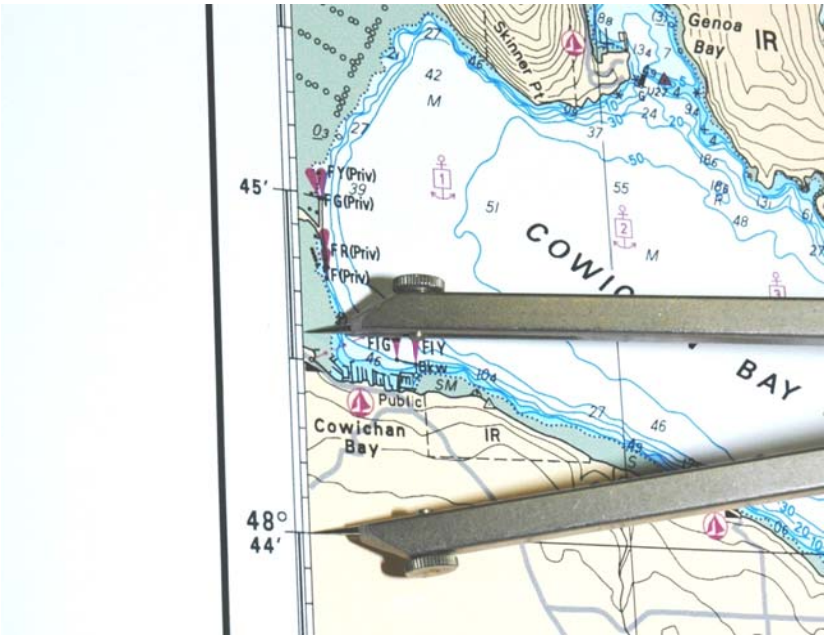


Figure 11 Determining Latitude Step 4

Determining Longitude (Method One)

The technique of determining the longitude of a point using a parallel ruler is as follows:

1. Place the edge of the parallel ruler along a meridian of longitude or along the longitude scale on the left side of the chart.

2. Roll the ruler to the light symbol so that the black dot of the symbol falls along the edge of the ruler. Using the ruler as a guide, draw a light line on the longitude scale at the top of the chart where the ruler intersects it.

3. Read and record the longitude of the object (in this case the longitude is 123° 34.20' W).

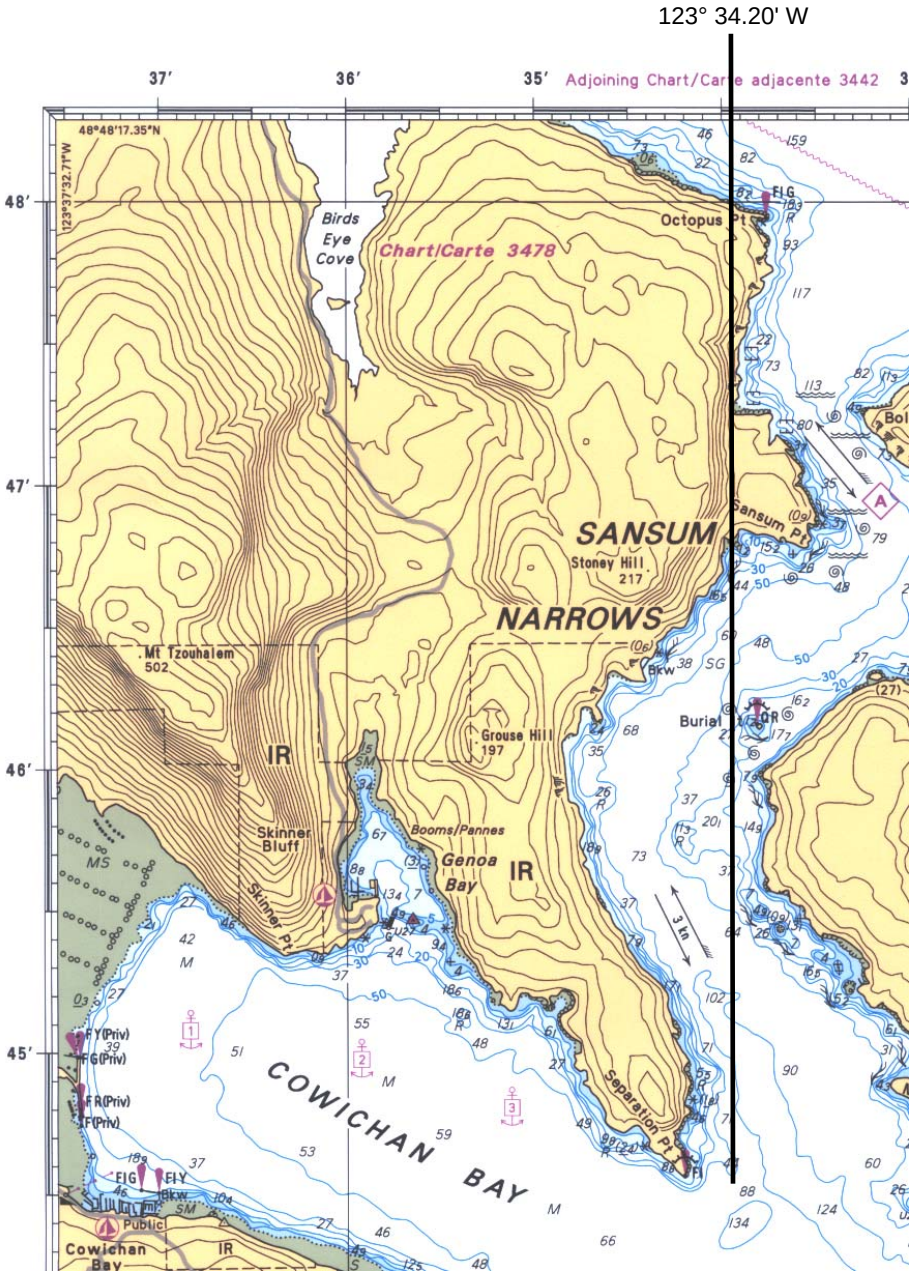


Figure 12 Determining Longitude

Determining Longitude (Method Two)

The technique of determining longitude using a set of dividers for the same point is as follows:

1. Align the edge of the parallel ruler with the parallel of latitude nearest Separation Pt.

2. Roll the ruler to the symbol so that the black dot at the bottom falls along the edge of the ruler.

3. Using the edge of the ruler as a guide, measure the distance from the symbol to the nearest meridian of longitude (in this case it is 123° 36' W).

4. Move the dividers to the longitude scale on the top of the chart. Place one point on the same meridian (123° 36' W) and measure along the scale to the right (as Separation Pt. is east of this meridian).

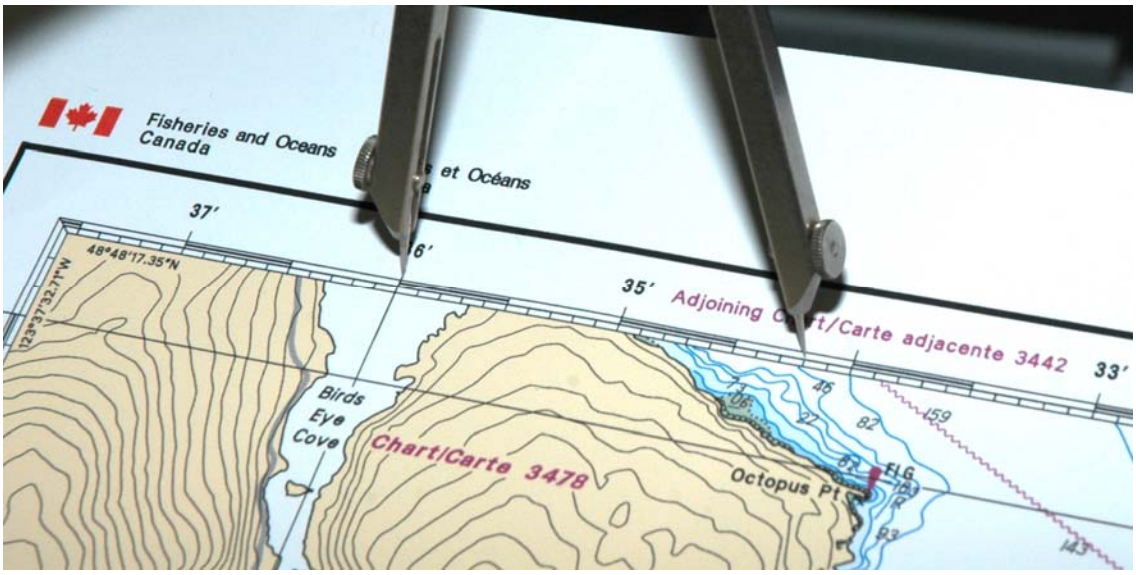


Figure 13 Determining Longitude Step 4

5. Read and record the longitude of the light (123° 34.20' N).

ACTIVITY

1. Distribute the position worksheet to each student.

2. Have the students find the latitude and longitude of each point listed on the worksheet. Time allocated is 15 minutes.

3. Once the worksheet is complete, correct the students' answers using the answer key located at Annex E.

CONFIRMATION OF TEACHING POINT 3

The students' completion of the worksheet will serve as the confirmation of this TP.

Teaching Point 4	**Demonstrate and have the students measure distances on a chart.**
Time: See Pre-Lesson Instructions	Method: Demonstration and Performance

The following information should be presented to the students prior to demonstrating the techniques for measuring distances.

MEASURE DISTANCE ON A CHART

In marine navigation the term “mile” does not refer to the land or statute mile, it refers to the nautical mile.

A nautical mile (NM) measures 1853 m or 2000 yards or 10 cables.

A statute mile (mi) measures 1609.3 m or 1760 yards.

When measuring distance on Mercator charts, always measure from the latitude scale. The longitude scale cannot be used as the meridians of longitude converge at the poles. Therefore they are not truly parallel.

Meridians of longitude only project distance accurately at one location on the globe—the equator.

As mentioned in TP 2, the latitude scale is divided into degrees, minutes and seconds. However, when measuring distances on a chart, it is more common to use minutes and tenths of a minute.

Latitude can be divided into:

- One degree of latitude equals 60 minutes.
- One minute of latitude equals 1 NM.
- One minute can be further divided into tenths (as illustrated in Figure 9).

One NM is 2000 yards long. Therefore 1/10th of a NM is equal to 200 yards or one cable. In navigation, it is common for distance to be referred to in cables up to 1 NM.

Technique for Measuring a Short Distance on a Chart

Distance is measured on charts using dividers. A good rule of thumb for using dividers is to keep the angle between the legs less than 60 degrees. If the dividers are opened more than 60 degrees, the accuracy of the measurement is lessened.

Follow these steps for measuring short distances on a chart:

1. Set one point of the dividers at the first point and the other at the second point. Ensure the dividers are not opened more than 60 degrees.

2. Being careful not to disturb the position of the dividers, move them to the latitude scale on either side of the chart.

3. Place one point on a whole minute of latitude and let the other point fall along the scale line.

4. Read the distance in nautical miles and tenths of miles.

Example of measuring a short distance:

Demonstrate and have the students perform each of the following steps.

Arachne Rf. is located south of Moresby Island in Prevost Passage.

Pt. Fairfax is located on the south end on Moresby Island.

To measure the distance between Arachne Rf. light and Pt. Fairfax light:

1. Place one point on the symbol for Arachne Rf. light.

2. Open the dividers until the second point is on the symbol for Pt. Fairfax light.

Figure 14 Measuring the Distance Between Arachne Rf. and Pt. Fairfax Step 2

3. Being careful not to disturb the position of the dividers, move them to the latitude scale on the right side of the chart.

4. Place one point on the line marking 48° 40' N.

5. Place the second point on the scale above this line and count the number of marks between the points in this example the distance is 0.86 NM.

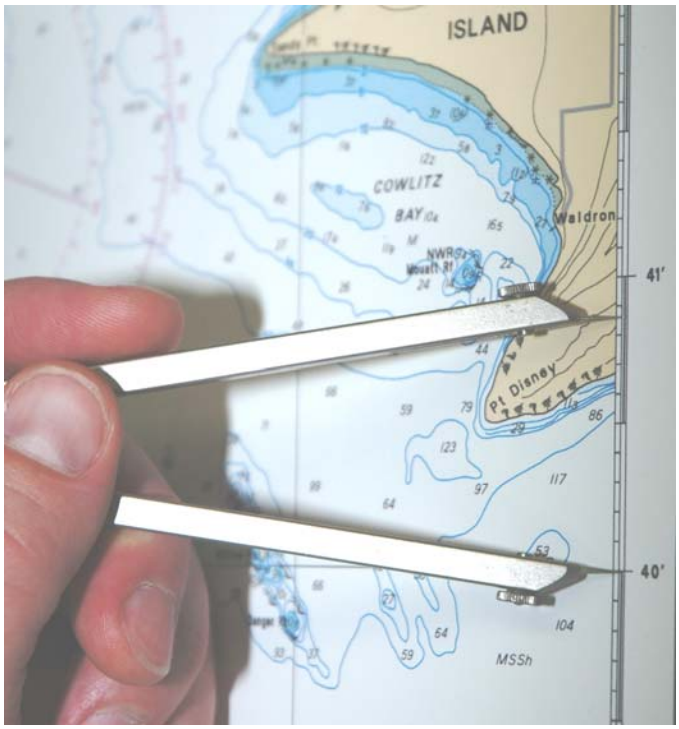


Figure 15 Measuring the Distance Between Arachne Rf. and Pt. Fairfax Step 5

When measuring from symbols for lights, the points of the dividers are placed on the black dot at the bottom of the symbol.

Technique for Measuring a Longer Distance on a Chart

A long distance is defined as a distance that cannot be measured within the width of a pair of dividers opened to no more than 60 degrees.

Follow these steps for measuring long distances on a chart:

1. Preset your dividers to a whole mile or a multiple-mile increment.

2. Align one edge of the parallel ruler between the two points.

A parallel ruler is used to align the two points to assist the students with walking the dividers along a straight line. With practice, the ruler will no longer be required.

3. Place one point of the dividers at the first point and lay the other along the parallel ruler toward the second point.

4. Being careful not to disturb the position of the dividers, swing or walk them along the ruler to the second point.

5. Count the number of times the dividers swing or walk along the ruler without passing the second point.

If the second point has not been reached but is within the distance the dividers have been set measure the remaining distance as follows:

6. Without removing the point of the dividers on the chart, compress the other arm of the dividers carefully and place its point on the destination.

7. Being careful not to disturb the opening, move your dividers to the latitude scale and measure the distance. Add the number of swings from Step 5 and the distance in Step 6 to get the total distance.

Example of measuring a long distance:

Demonstrate and have the students perform each of the following steps.

Sandy Pt. is located on Waldron Island on the west side of the chart.

Gowlland Pt. is located on the south end of North Pender Island.

To measure the distance between Sandy Pt. and Gowlland Pt. light:

1. Measure 1 NM from the latitude scale with the dividers.

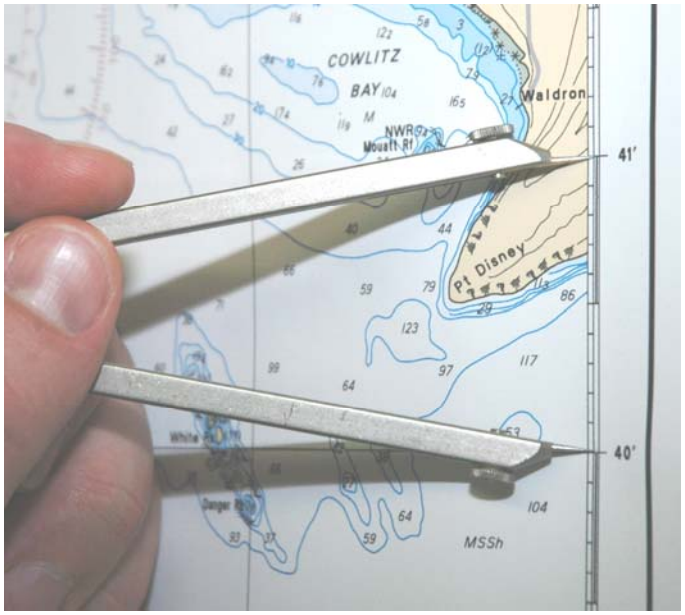


Figure 16 Measuring the Distance Between Gowlland Pt. and Sandy Pt. Step 1

2. Align the parallel ruler between Sandy Pt. and Gowlland Pt. light.

3. Place one point of the dividers on the outer edge of Sandy Pt.

4. Lay the dividers along the edge of the parallel ruler.

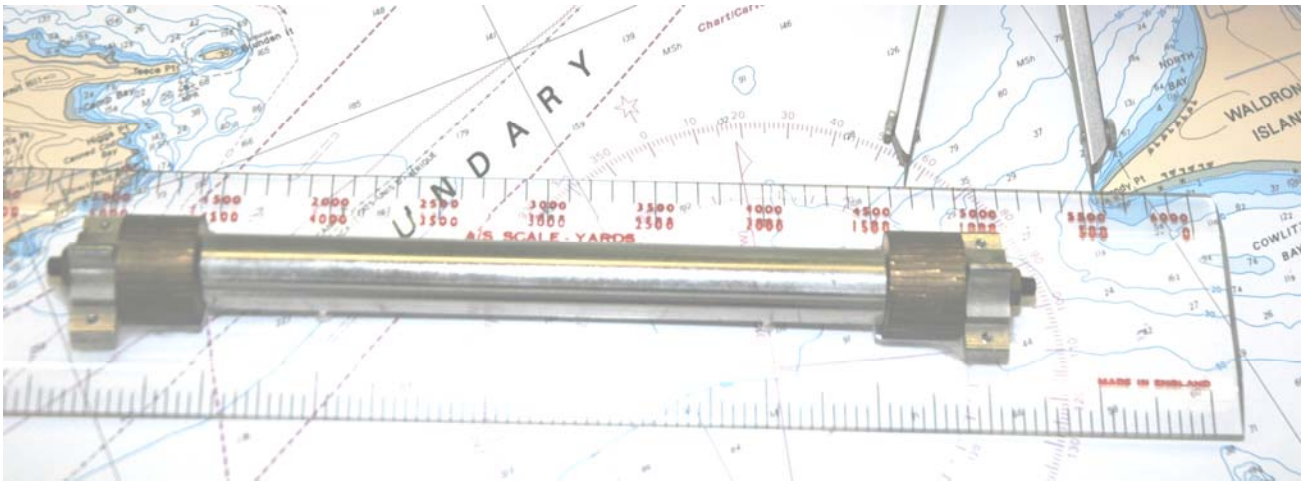


Figure 17 Measuring the Distance Between Gowlland Pt. and Sandy Pt. Steps 3 and 4

5. Being careful not to disturb the position of the dividers, swing or walk them along the ruler toward Gowlland Pt.

6. Count the number of swings made with the dividers.

7. From Sandy Pt. to Gowlland Pt. it takes five swings. Since the dividers were set to 1 NM in Step 1, the distance is 5 NM.

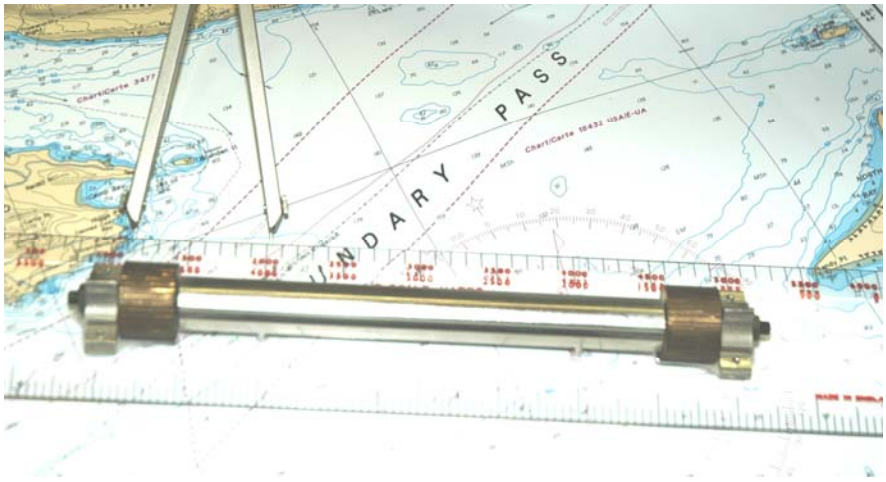


Figure 18 Measuring the Distance Between Gowlland Pt. and Sandy Pt. Step 5

Have the students practice measuring distances between the following points:

1. Kellet Bluff Lt. to Wymond Pt. = 2.7 NM
2. Separation Pt. to Burial It. Light = 1.6 NM
3. Patricia Bay Jetty to Mill Bay Jetty = 3.95 NM
4. Thieves Bay light to Kellett Bluff light = 11.88 NM

CONFIRMATION OF TEACHING POINT 4

QUESTIONS:

Q1. What is the maximum opening used on dividers when measuring distances?

Q2. What does the term mile refer to in navigation?

Q3. How long is a nautical mile in yards?

ANTICIPATED ANSWERS:

A1. 60 degrees.

A2. The nautical mile.

A3. 2000.

Teaching Point 5 **Demonstrate and have the students plot a position on a chart using an electronic position.**

Time: See Pre-Lesson Instructions

Method: Demonstration and Performance

To better understand the principles outlined, it is important to know the following term:

Heading. The direction in which the bow of the small craft is pointing. Headings are expressed in degrees (°)—000 through 360.

Electronic Position

Global Positioning Systems (GPS) have taken over much of the traditional work in finding a small craft's position. A GPS receiver will indicate the latitude and longitude of a position as long as it is locked on to a minimum of three satellite signals.

Further information on GPS and the receivers is outlined in EO X51.05 (Locate a Position Using a GPS Receiver)

Electronic positions should be verified periodically with visual three bearing fixes. Any electronic system can, at times, give false information. However once verified, finding the small craft's position is as simple as plotting the latitude and longitude as displayed on the receiver.

Demonstrate and have the students plot the following on *Chart 3441*:

48° 37.6' N
123° 05' W

Two methods of plotting the latitudes and longitudes are given. The students may use either method.

Plotting an Electronic Position (Method One)

The technique for using only the parallel ruler to plot the latitude for this position is as follows:

1. Align the edge of the parallel ruler along the nearest parallel of latitude. In this example use 48° 36' N. The ruler must be placed so that its right end intersects the latitude scale on the right side of the chart.

Figure 19 Plotting a Position Step 1

2. Roll the ruler up until the given latitude falls along the upper edge of the ruler. Draw a very light line on the chart in the approximate area of the position, estimate the approximate longitude the position.

The line drawn must be barely dark enough to see. This line will be erased once the position is found.

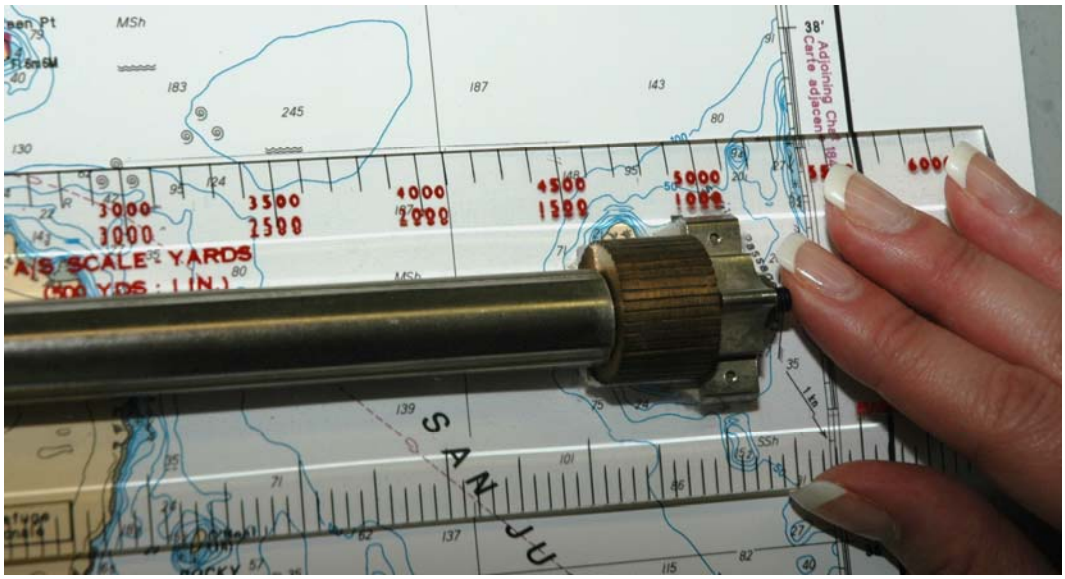


Figure 20 Plotting a Position Step 2

3. Align the edge of the parallel ruler along the nearest meridian of longitude. In this example use 123° 04' W. The ruler must be placed so that the bottom end intersects the longitude scale at the bottom of the chart.

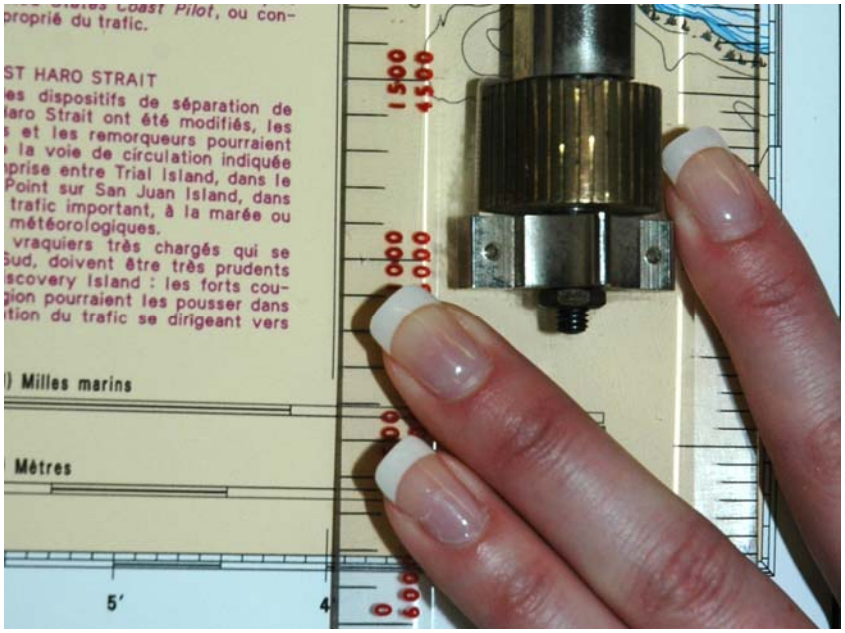


Figure 21 Plotting a Position Step 3

4. Roll the ruler across until the given longitude falls along the edge of the ruler (in this example the ruler will be rolled to the left as the given position is west of the meridian). The required position is where the edge of the ruler intersects the line drawn in Step 2.

Figure 22 Plotting a Position Step 4

5. Identify the position with the proper symbol.

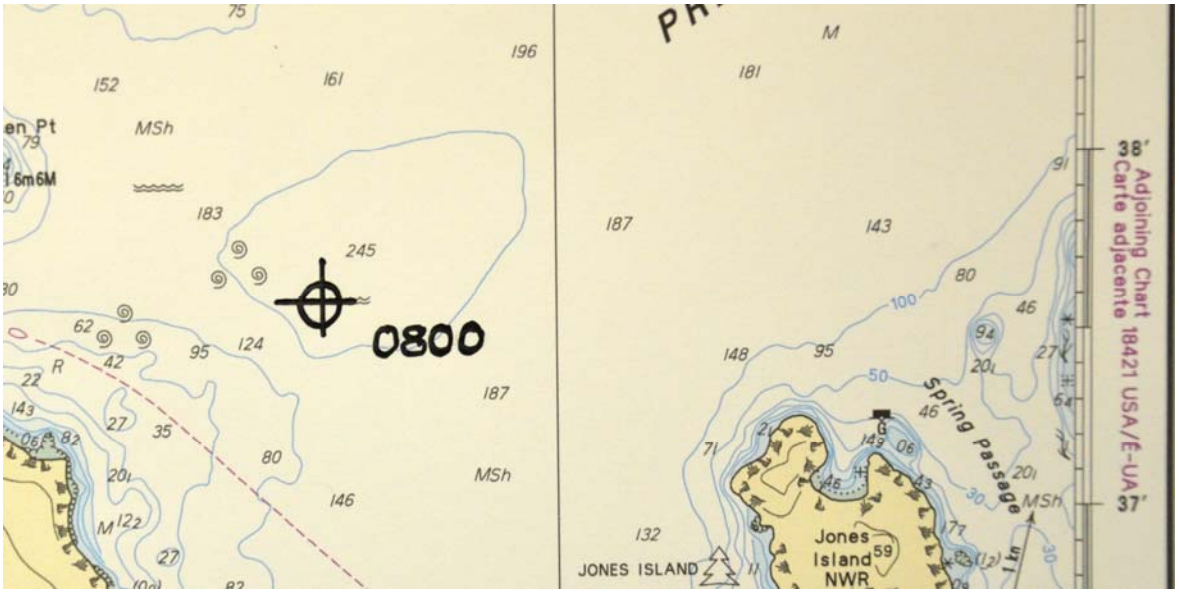


Figure 23 Plotting a Position Step 5

The proper symbol for an electronic position is: 

Time

The position given, when plotted, should be on the symbol for rip tides, overfalls or races in San Juan Channel.

Plotting an Electronic Position (Method Two)

The technique of determining latitude using a parallel ruler and dividers for a given point is as follows:

1. Place one point of the dividers on the nearest parallel of latitude (48° 36' N).

2. Open the dividers until the other point is at the given latitude.

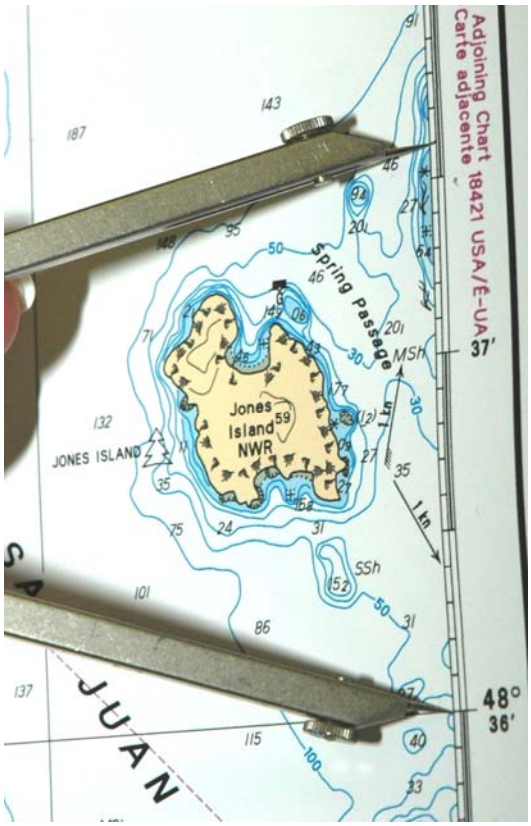


Figure 24 Plotting a Position (Method Two) Step 2

3. Align the parallel ruler on the meridian nearest the given longitude (123° 04' W).

4. Roll the ruler to the given longitude (123° 05' W).

5. Move the dividers along parallel 48° 36' N until they touch the parallel ruler. Be careful not to change the distance between the two points.

6. The upper point of the dividers is in the given position.

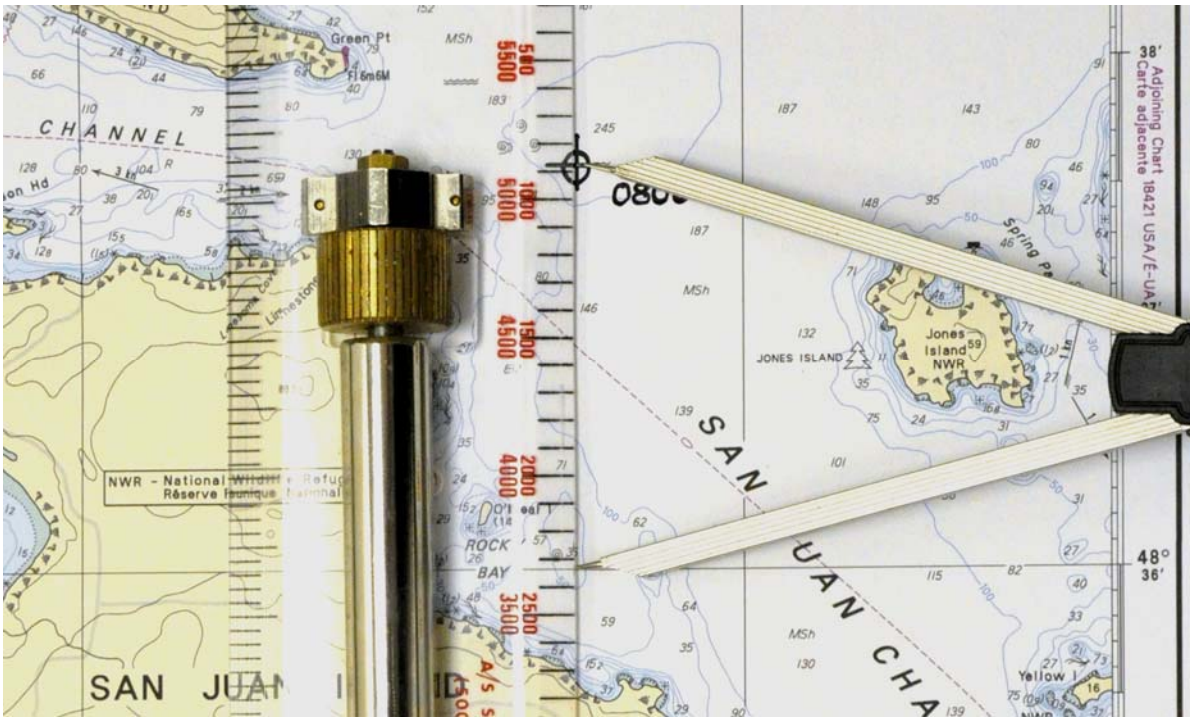


Figure 25 Plotting a Position (Method Two) Step 6

7. Identify the position with the proper symbol (as illustrated in Figure 24).

	Distribute Annex F to each student. The students are to identify the symbol for each position given. Correct with the answer key located at Annex G.

NAVIGATIONAL TRACK

A navigational track is a line that shows a projected course from a given position. It is commonly referred to as a track (TR). To plot a track on a chart, follow these steps:

	Use the plotted position from earlier to continue demonstrating how to plot a navigational track.

Plotting

1. Plot the position on a chart (use the plotted position from earlier).

2. Align one edge of the parallel ruler with the centre of the compass rose and the number of degrees being steered (course) on the outer circle.
3. Roll or walk the ruler until the edge aligns with the plotted position.

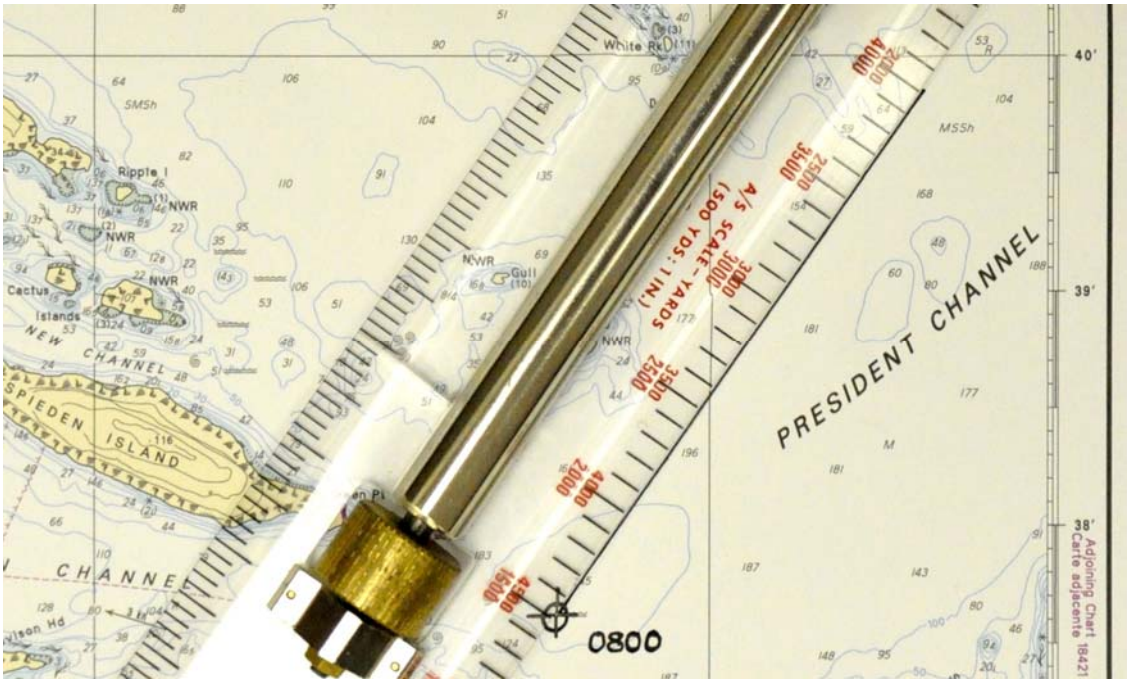


Figure 26 Plotting a Track Steps 3 and 4

4. Draw a line away from the fix along the ruler in the direction of the course.
5. Draw an arrow on the line showing the direction of the course.

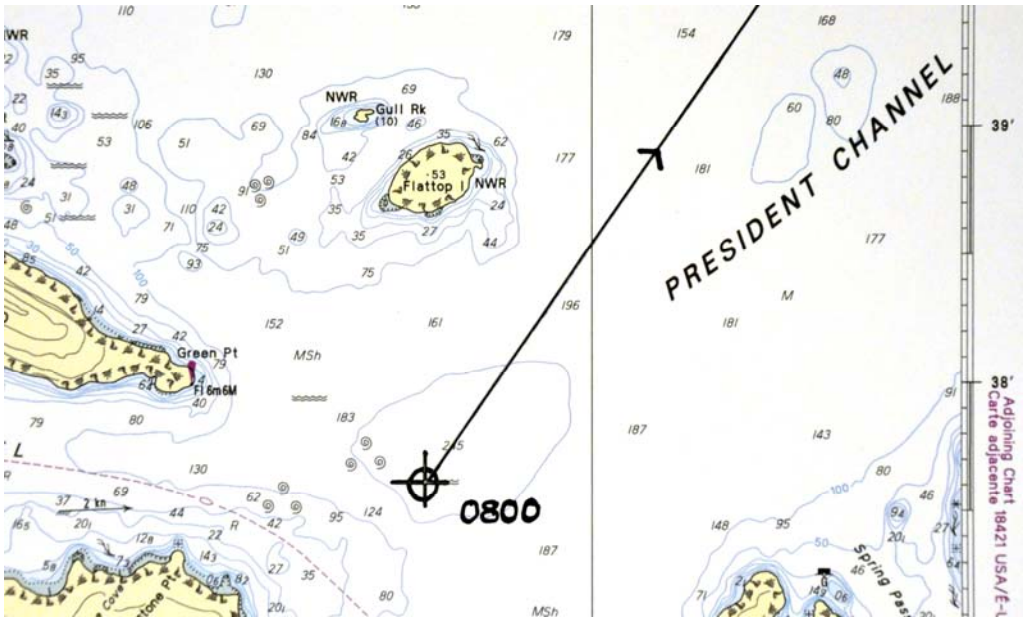


Figure 27 Plotting a Track Step 5

Labelling

When a track is drawn on a chart, it must be labelled for future reference. They are always drawn showing a True heading. To label the course, place the course above the track, make sure that it is parallel to the track, above the arrow indicating the direction of travel, and both large enough to seen and far enough from the track to allow for future fixes. Label the course using three digits (eg, 084) (as illustrated in Figure 28).

Label the speed below the track and in line with the arrow indicating the direction. Place the speed in a speed box oriented from east to west (as illustrated Figure 28).

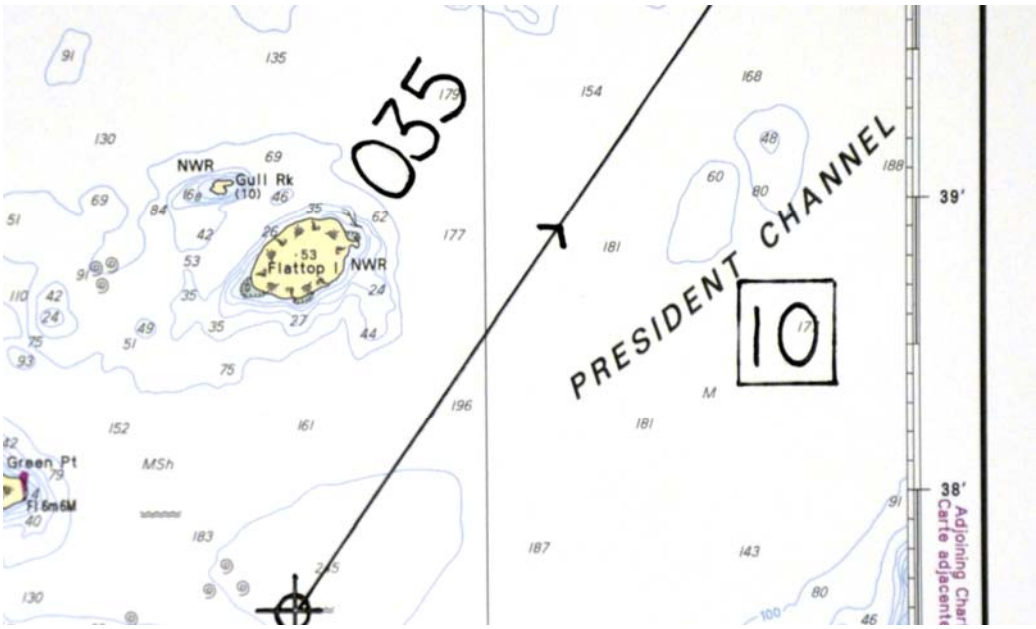


Figure 28 Labelling a Track

DEAD RECKONING

Dead reckoning (DR) is the continuous plotting of a course and position based on known facts. The facts used when making calculations for a DR include;

- time,
- speed,
- distance, and
- course steered.

Some reasons to maintain a plot of the dead reckoned positions are:

- to make a very rapid assessment of safe water ahead, and when and where to alter,
- to make a very rapid determination of your approximate position in the event of an emergency;
- to have knowledge of approximate position in order to render assistance to another vessel in an emergency;
- to be able to plot the safest and shortest course to a desired destination; and
- to be able to make important decisions as to the proper action in the event of adverse conditions, such as:

    - fog,
    - wind,
    - storm, and
    - equipment failure.

The calculations for plotting a DR are derived through standard speed-time-distance calculations.

A DR is normally made at 6-minute intervals to make calculations simple. A 6-minute interval is equal to 1/10 of an hour; therefore, the distance travelled is 1/10 of your speed.

It is good practice to plot two DRs, one at 6 minutes and one at 12 minutes because it gives a better view into the future safety of the vessel, especially in close navigable waters.

A DR position is indicated by placing a small line across the course and the time alongside. A small cross may be used to originate the DR if a fix or estimated position is not available.

Plotting

Use the plotted information from TP 2 to continue demonstrating how to plot a DR position.

To plot a DR on a chart, follow these steps:

1. Determine distance traveled in 6 minutes.

For this example use a speed of 10 knots (kts) and time of 6 minutes (1/10 hour), equalling a distance of 1 NM or 10 cables (cbl).

2. Measure 1 NM of distance on the latitude scale.

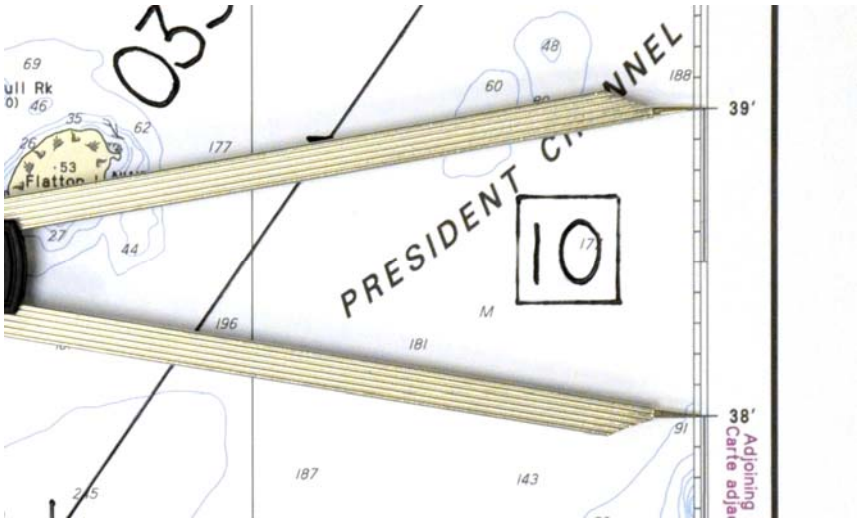


Figure 29 Plotting a DR Step 2

3. Mark the DR position 1 NM (6 mins) from the plotted position and then a second DR position 1 NM (6 mins) from the first DR.

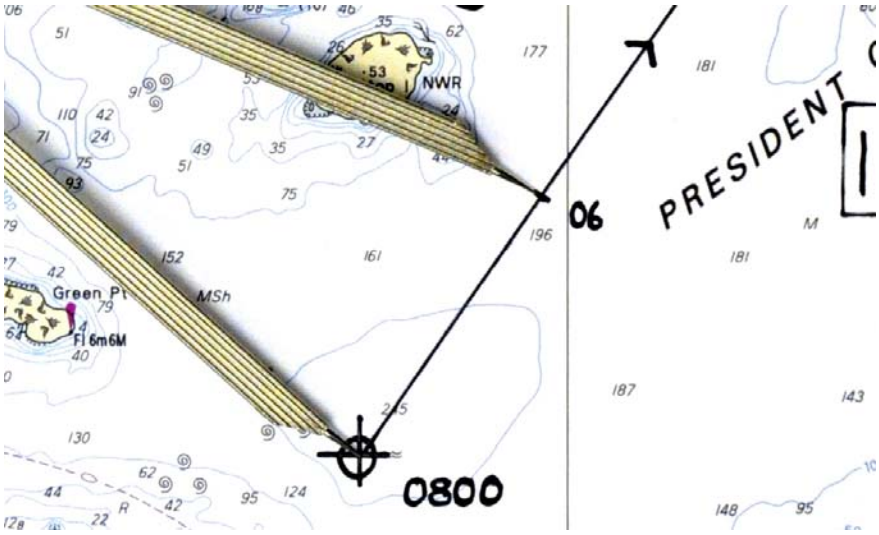


Figure 30 Plotting a DR Step 3

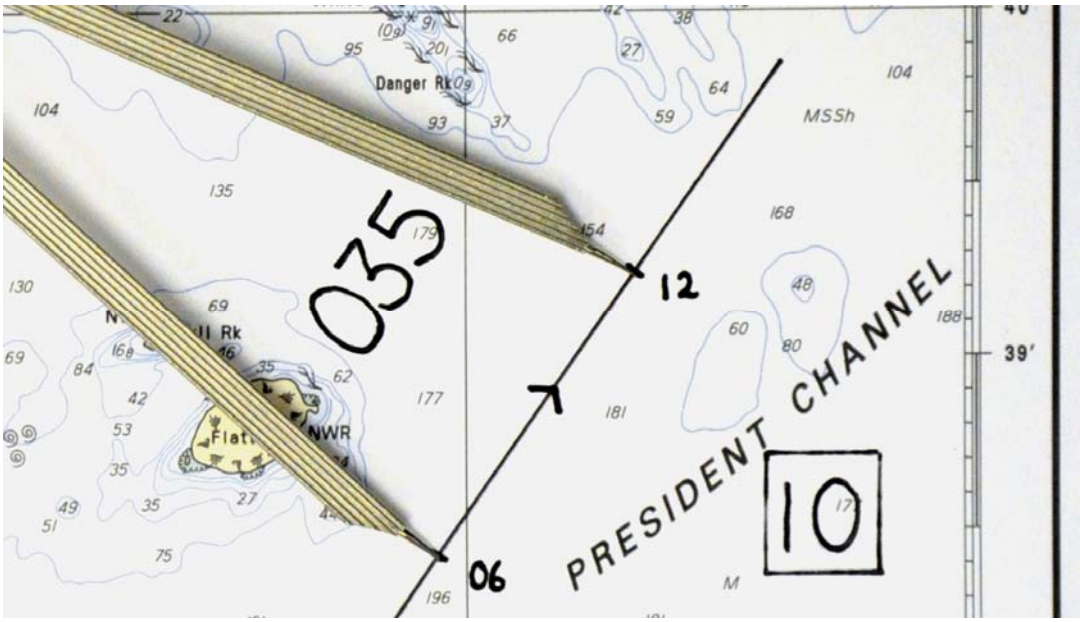


Figure 31 Plotting a DR Step 3

Labelling

Each DR drawn on a chart must be labelled for future reference. A DR is labelled with a two digit time (as illustrated in Figure 32).

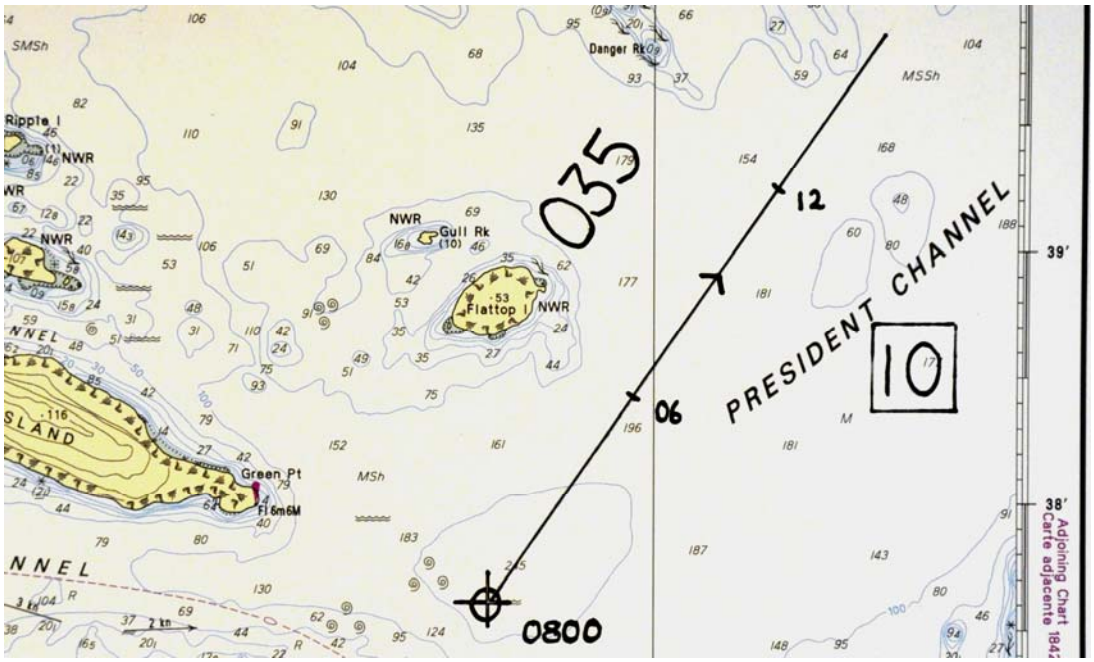


Figure 32 Labelling a DR

CONFIRMATION OF TEACHING POINT 5

The students' plotting a navigational track and two DRs, along with their completion of the Latitude and Longitude Worksheet will serve as the confirmation of this TP.

Teaching Point 6	**Demonstrate and have the students plot a position on a chart using three-bearing fix.**
Time: See Pre-Lesson Instructions	Method: Demonstration and Performance

Three-Bearing Fix

To better understand the principles outlined, it is important to know the following terms:

Bearing. A line of position sighted from a small craft to another object. Only true bearings can be plotted on charts.

Lines of Position (LOPs). Lines that are plotted on a chart for the bearings taken of objects.

A fix. The intersection of two or more LOPs. While a fix can be made with two LOPs, it is considered more accurate to use three LOPs in every fix. An ideal three-bearing fix should have 60-degree angles between the LOPs with no less than 20- degrees.

True bearings are obtained from a gyrocompass. Small craft are not normally fitted with a gyrocompass due to their weight and size.

If taking bearings from a small craft, a handheld magnetic compass may be used to obtain the bearings. However, these bearings must be converted to true bearings before plotting them on a chart.

Throughout this TP, all bearings given in examples and exercises are to be considered true bearings.

Line of Position

Bearings that are plotted on a chart are referred to as LOPs and when they true bearings they are measured on the outer ring of the compass rose with a parallel ruler. To plot an LOP on a chart, follow these steps:

1. Align one edge of the parallel ruler with the centre of the compass rose and the number of degrees on the outer circle. In this case East Pt Light bears 010.

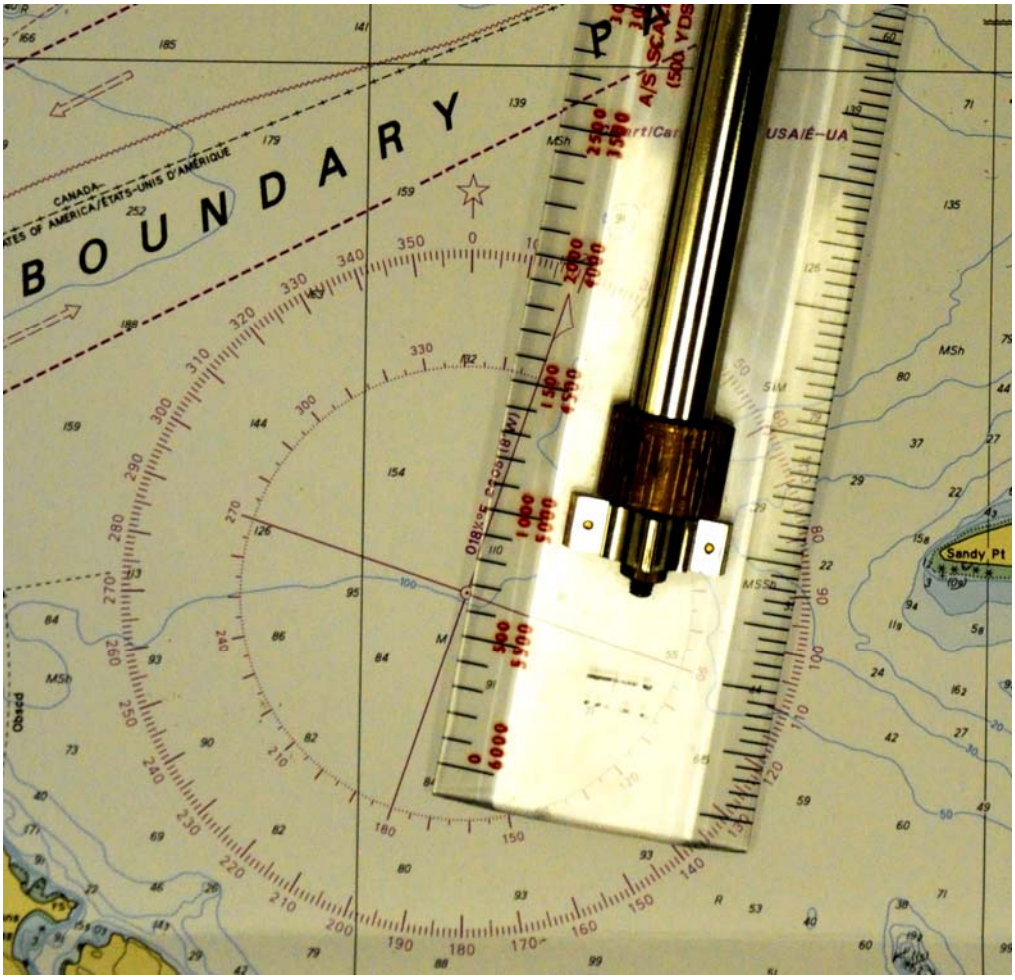


Figure 33 Line of Position Step 1

Instructions on how to use a rolling parallel ruler are outlined in Annex B.

2. Roll or walk the ruler until the edge used aligns with the object the bearing was taken from.

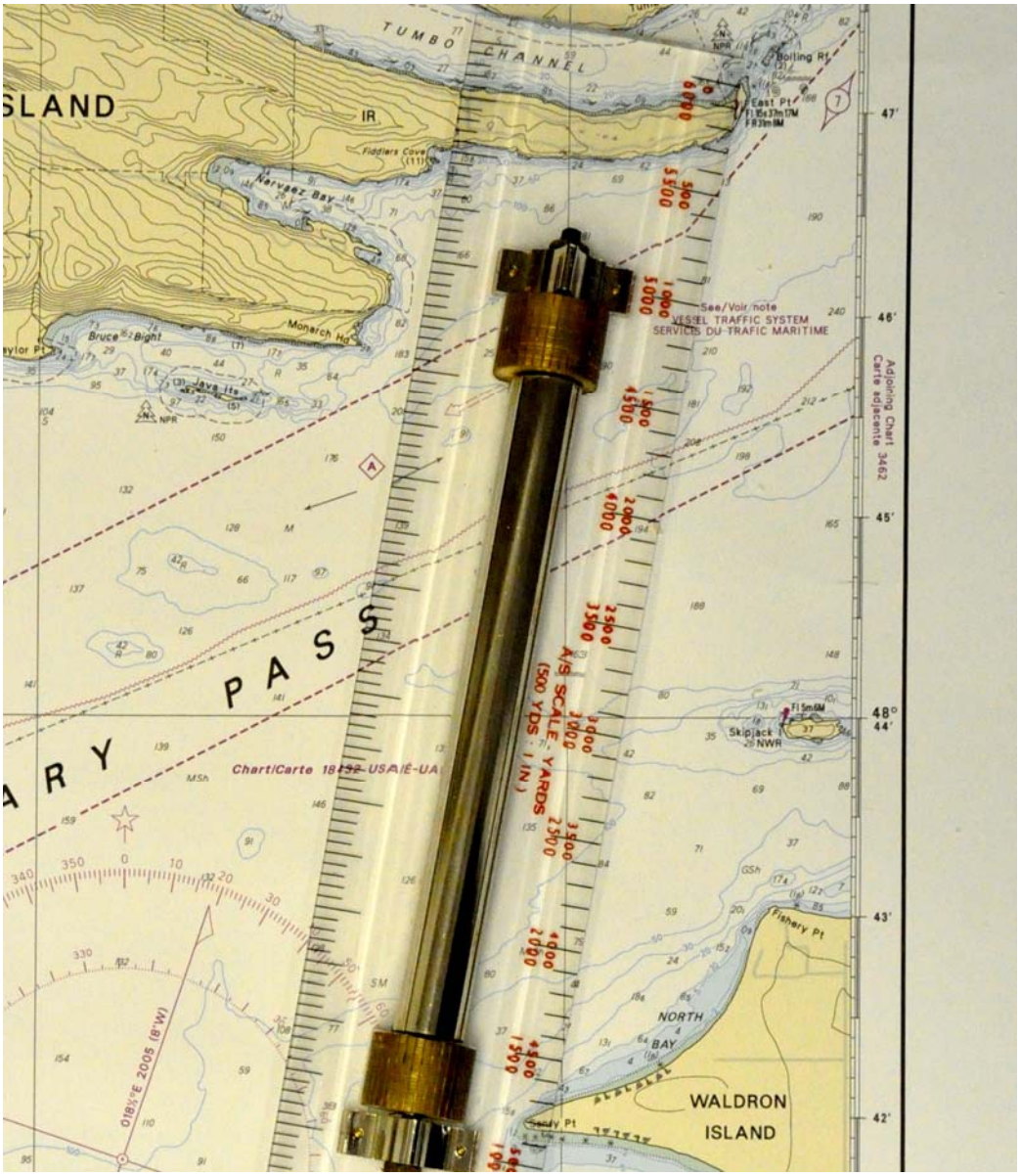


Figure 34 Line of Position Step 2

3. Draw a line along the ruler.

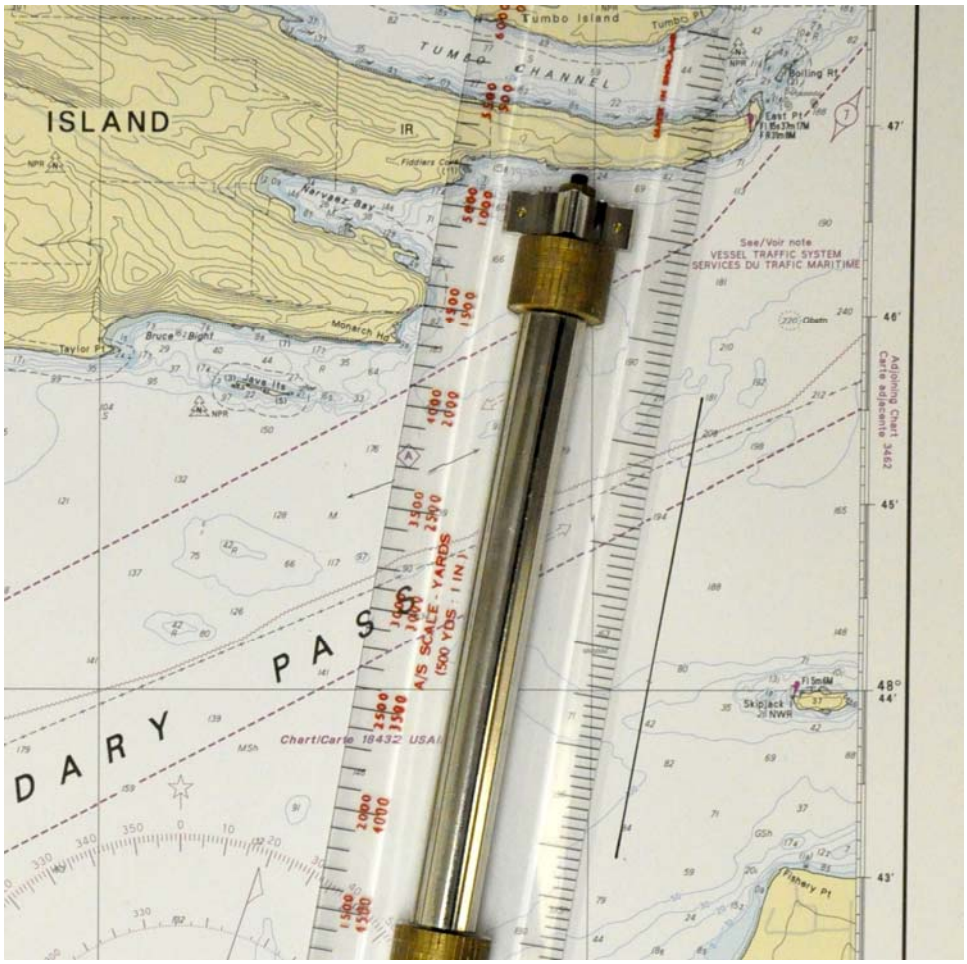


Figure 35 Line of Position Step 3

Three Bearing Fix

In order to plot a three bearing fix, three LOPs must cross at a specific point.

Have the students will follow along as the bearings are plotted.

Example: Plot the following fix on *Chart 3441*:

	East Pt. light	010
0800	Skipjack I. light	085
	Monarch Hd DM.	333
	Course	275
	Speed	10 kts

1. Align the parallel ruler with the centre of the compass rose and 010 on the outer ring of the compass rose.

2. Roll the ruler along the chart until the edge aligns with the black dot on East Pt. light.

3. Draw a line from the light along the ruler.

4. Repeat Steps 1–3 for the other two bearings. After the first LOP is plotted, the remaining LOPs are only drawn across the first LOP plotted.

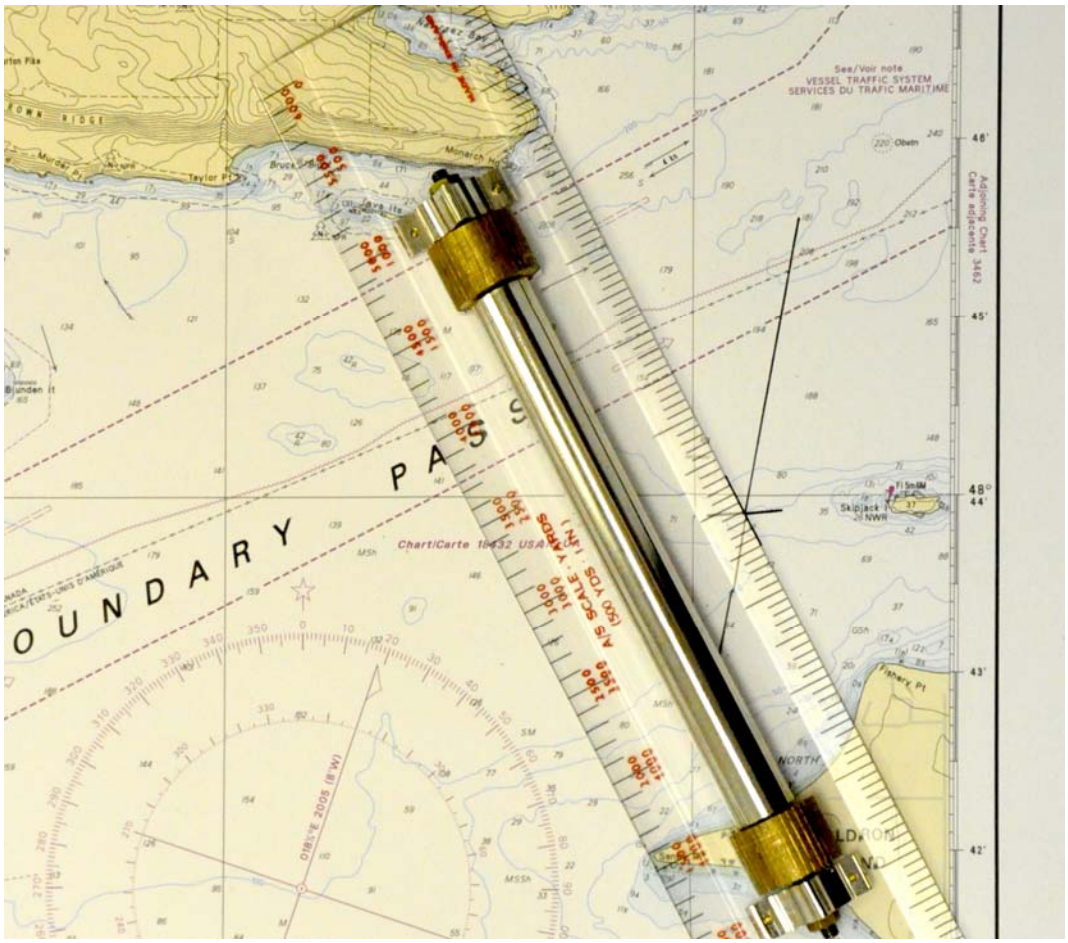


Figure 36 Three Bearing Fix Step 4

5. Once an LOP is drawn it can be shortened to the same size as the diameter of a quarter.

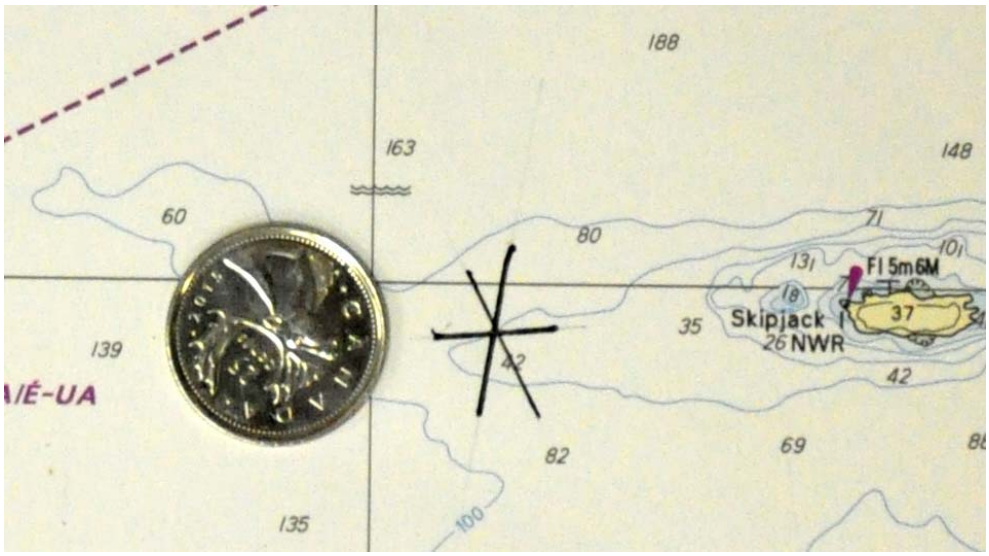


Figure 37 Three Bearing Fix Step 5

6. Draw arrows at the outer ends of the LOPs away from the point that was used. These arrows indicate the direction in which the observer must lie from the observed object.

7. Circle the intersection of the three LOPs and label with the four digit time the bearings were taken next to the fix.

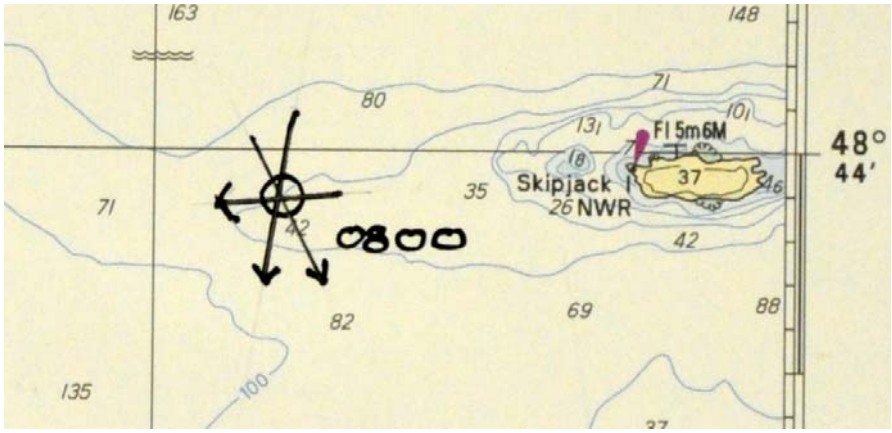


Figure 38 Three Bearing Fix Step 7

8. Add the navigational track and DRs to the fix.

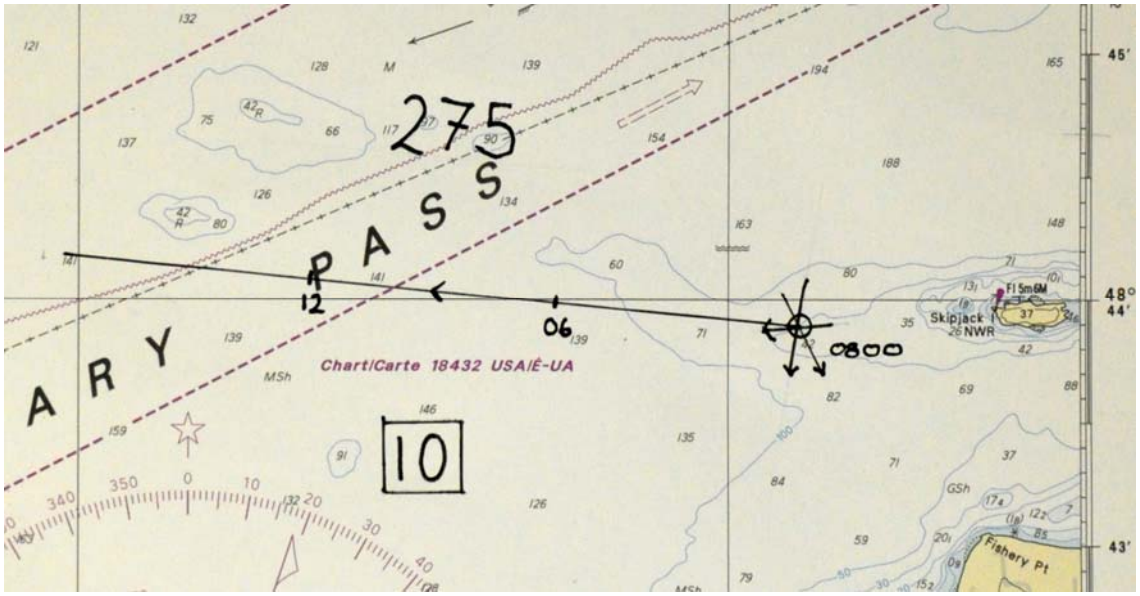


Figure 39 Three Bearing Fix Step 8

When plotting LOPs, plot from the black dot at the bottom of the symbol or from the edge of the points of land.

On *Chart 3441*, have the students plot the following fixes:

0900	Gowlland Pt.	025	0930	Thieves Bay light	050
	Turn Pt.	225		Canoe Rk. light	181
	Wallace Pt.	319		Beaver Pt. light	310
	Course	260		Course	120
	Speed	10 kts		Speed	10 kts
1000	RHE Russell I.	000	1030	Pt. Fairfax light	089
	Isabella I. light	294		Greig I. day mark	160
	Kanaka Bluff light	055		Dock I. light	190
	Course	324		Course	179
	Speed	5 kts		Speed	5 kts

When referring to edges of land, it is common to use RHE for right-hand edge and LHE for left-hand edge.

If the fixes are plotted correctly, the following symbols should be identified:

0900–Border between Canada and USA
0930–64 m depth.
1000–Contour line around 34 m hole.
1030–44 m depth.

Check to ensure the students are using the correct symbol for a fix:

1. Arrows away from the object.
2. Circle around the intersection of the LOPs
3. Four digit time next to the fix.
4. Each fix no larger than the diameter of a quarter.
5. Each fix has a track and at least one DR

CONFIRMATION OF TEACHING POINT 6

The students' plotting a position on a chart using a three-bearing fix will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

Nil.

CONCLUSION

HOMEWORK / READING / PRACTICE

Nil.

METHOD OF EVALUATION

This lesson is assessed IAW Chapter 3.

CLOSING STATEMENT

Locating a position on a chart is an important skill which students can use whenever they navigate small craft.

INSTRUCTOR NOTES / REMARKS

Nil.

REFERENCES

ISBN 0-07-137226-1 Brogdon, B. (1995). *Boat navigation for the rest of us* (2nd ed.). Camden, ME: International Marine.

C-57-007-002/AF-001 Royal Navy. (1987). *Admiralty manual of navigation* (Vol. 1). (Rev. 1987). London, England: Her Majesty's Stationery Office.

ISBN 1-57409-052-6 Larkin, F. (1998). *Basic coastal navigation*. Dobbs Ferry, NY: Sheridan House Inc.

ISBN 0-9694958-0-3 Saunders, A. E. (1990). *Small craft piloting & coastal navigation*. Halifax, NS: Binnacle Navigation Instruments.

ISBN 978-1-55750-248-3 Cutler, T. J. (2004). *Dutton's nautical navigation*. Annapolis, MD: Naval Institute Press.

NOTC Venture. (2012). *CFCD 131 bridge watchkeeping manual for the royal Canadian navy. (2015)*. Victoria, BC: NOTC Venture.

HOW TO USE A HINGED PARALLEL RULER

Hinged parallel rulers are used to plot direction or transfer parallel lines on a chart. They are, essentially, two straight edges that are hinged so that they maintain the same angle. By altering the moving edge, and securely holding the non-moving edge, the ruler can be moved about the chart while maintaining the same angle.

The following steps explain how to use a hinged parallel ruler:

1. Align the edge of the ruler with either the bearing on the compass rose or on the line of latitude or longitude closest to the final position. In this case the bottom of the chart.

2. Hold the bottom half of the ruler stationary and move the top half until the hinges are straight up and down.

3. While holding the top half stationary, close the ruler.

4. Hold the bottom stationary and move the top half until the upper edge aligns with the first parallel of longitude on the chart (on *Chart 3441* it is 48° 36' N). If the ruler has not moved, the edge of the ruler should be precisely aligned with the line on the chart.

5. Practice moving the ruler up and down the chart.

COMMON ERRORS

It is common for novice navigators to make the following errors when learning to use a hinged parallel ruler:

- Not applying consistent pressure along the stationary side of the ruler by only pushing down on the handles. Spread the pressure along the entire side of the ruler and use the handles only when moving the side.

- Always moving the halves in the same direction when opening and closing the ruler. This will make the ruler move in that direction (eg, if you always open and close the ruler by moving the corresponding half to the right, the ruler will move across the chart to the right).

HOW TO USE A ROLLING PARALLEL RULER

Rolling parallel rulers are used to plot direction or transfer parallel lines on a chart. These rulers contain two large brass wheels mounted on a single axle which runs through the centre of the ruler. This will allow the ruler to smoothly roll along the chart while maintaining the same angle.

The following steps explain how to use a rolling parallel ruler:

1. Align the edge of the ruler with either the bearing on the compass rose or on the line of latitude or longitude closest to the final position. In this case, align the bottom edge of the ruler with the bottom edge of the chart.

2. Carefully roll the ruler to the first parallel of latitude on the chart (on *Chart 3441* it is 48° 36' N).

3. If the ruler has not moved, the edge of the ruler should be precisely aligned.

4. Practice moving the ruler up and down the chart.

COMMON ERRORS

It is common for novice navigators to make the following errors when learning to use a rolling parallel ruler:

- Not applying consistent pressure along the length of the ruler. Many times the ruler will wander because the person using it is only pushing down on the centre of the ruler.

- Moving the ruler too fast along the chart. Care must be taken when rolling the ruler to ensure that it remains straight.

- Trying to roll over folds, edges and other obstructions, such as eraser pieces, when moving the roller from one point to another. Before moving the ruler, ensure the path you wish to roll along is clear of anything the ruler may catch on.

HOW TO USE A SPEED-TIME-DISTANCE CALCULATOR

The Speed-Time-Distance (STD) Calculator is a slide rule which can be a navigator's most used tool. The Weems and Plath Nautical Slide Rule consists of two circular dials mounted on a plastic base. The rule can assist a navigator in easily and quickly calculating any required value when given two others. Due to the fact that the speed scale is read through both dials, this setting should always be made last when speed is one of the known factors.

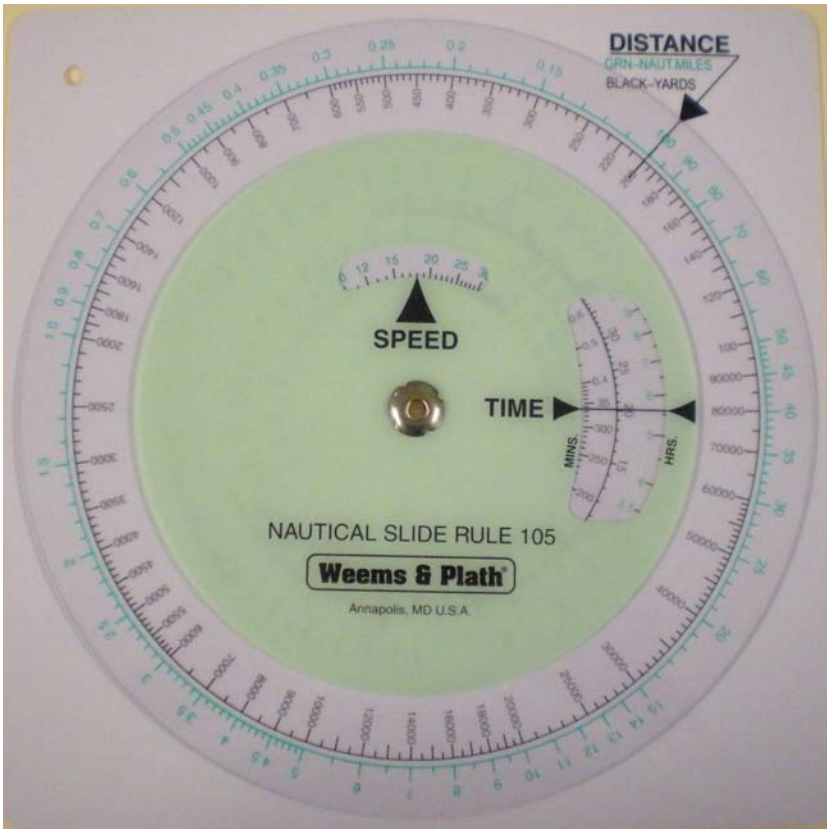


Figure C-1 Weems & Plath Nautical Slide Rule

Scales

1. **Time scale.** The time scale gives hours in green figures and minutes and seconds in black figures. Seconds are listed only to 120 and cannot be used as minutes and seconds, but only as total seconds for timed runs of less than two minutes. The separate hour scale and minute scale are not combined as hours and minutes, but used only as hours and fractions of an hour, or as total minutes.

Have the students set the TIME line on 1.5 minutes and note that it is also on 90 seconds. Either unit may be used.

Have the students set the TIME line on 150 minutes and note that it also reads 2.5 hours.

2. **Distance scale.** The distance scales are given in nautical miles (green figures) or yards (black figures).

Have the students set three nautical miles on the DISTANCE line and note that this can also be called 6,000 yards depending on which unit is being used for distance.

The green distance figures may also be used as statute miles, but the speed will be in statute miles per hour instead of knots. WHEN USING THE STATUTE MILES THE YARD SCALES MUST NOT BE USED.

3. **Speed Scale.** The speed scale reads from 1 to 100 knots or mph

Calculating Time Required

When the speed is known, find the time required to run a given distance, by setting the speed in knots on the inner SPEED circle and the distance travelled on the DISTANCE line in the outer circle. Read the TIME in the inner circle.

Ask the students:

If the boat has a speed of 9 knots and the marina it is going to is 27 NM away, how long will it take to get there?

a. Align 9 knots on the inner circle for speed and 27 NM on the outer circle for distance.
b. Read the TIME in the inner circle. The answer is 3 hours.

Calculating Distance Travelled

To find the distance travelled, when the speed and time travelled are known, set the SPEED in knots and the TIME travelled on the inner circle. Read the DISTANCE travelled in the outer circle.

Ask the students:

If the boat has been travelling at 16 knots for 5 hours, how far will it travel?

a. Align 16 knots on the SPEED inner circle and 5 hours on the TIME inner circle.
b. Read the DISTANCE travelled in the outer circle. The answer is 80 NM.

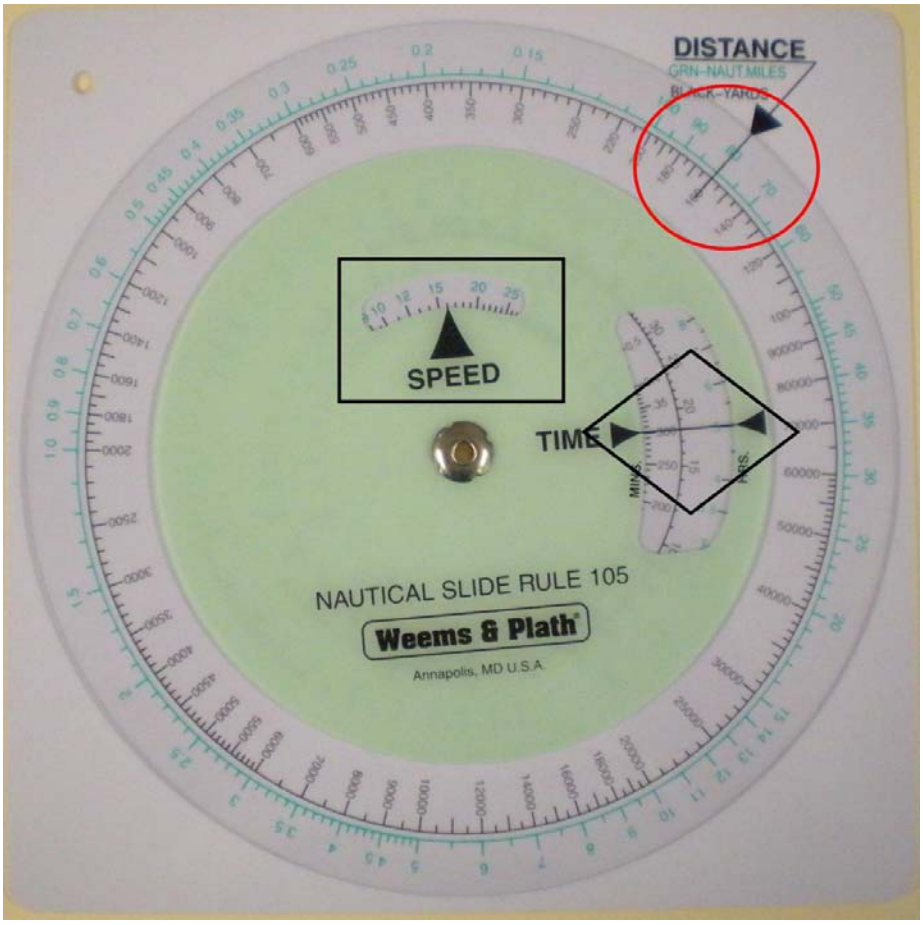


Figure C-2 Calculating Distance

Calculating Speed Made Good

Set the DISTANCE and the TIME and read the SPEED in knots on the inner circle.

Ask the students:

The boat has travelled for 15 NM in 6 hours. What is the speed made good?

a. Align 15 NM on the outer DISTANCE circle and 6 hours on the inner TIME circle.

b. Read the speed made good in the SPEED inner circle. The speed made good is 2.5 knots.

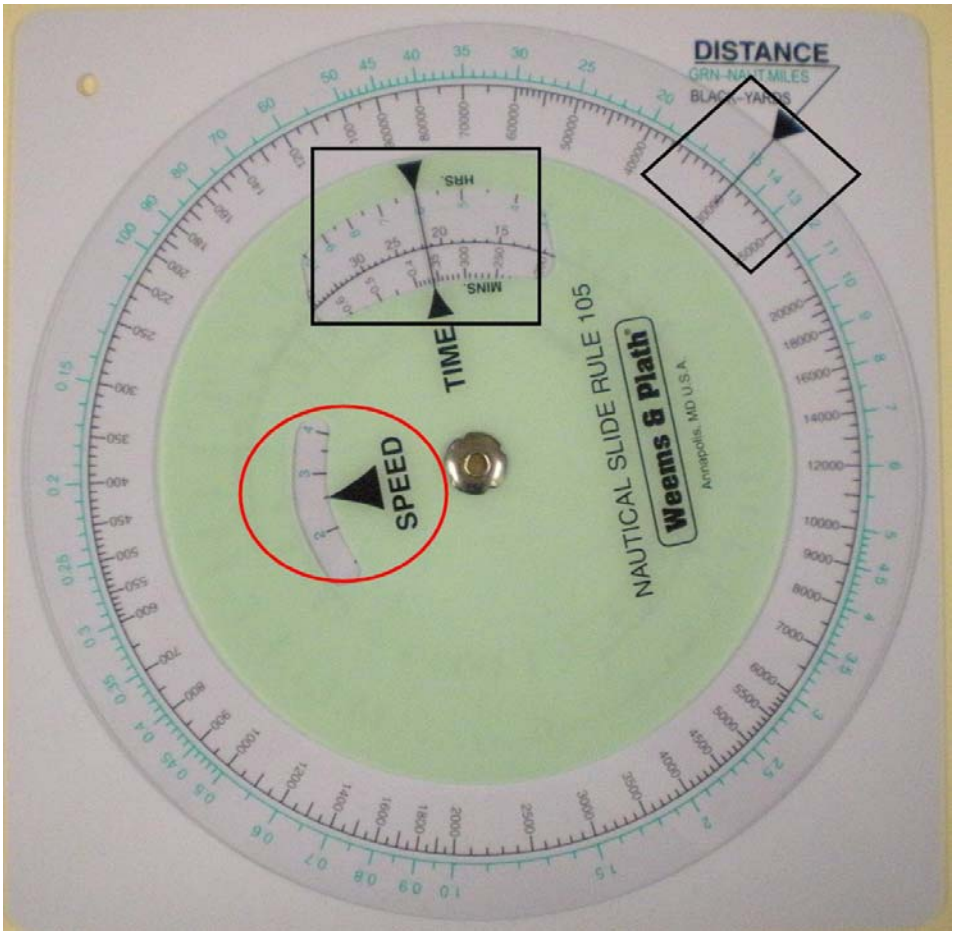


Figure C-3 Calculating Distance

POSITION WORKSHEET

Object	Description	Latitude Longitude
Dock I. light	On west side of Dock I. located east of Sidney Harbour.	
Repulse Rk. day mark	West of Elbow Pt. in Squally Reach (Lower left corner of the chart).	
Wreck located in Reid Harbour	West side of Stuart Island in Haro Strait.	
Hay Pt. light	In Bedwell Harbour on South Pender Island.	
Fir Cone Pt. light	North west end of Coal Island in Colbourne Passage.	
Sidney Island light	Small islet northwest of Sidney Island. East of Sidney.	

POSITION WORKSHEET ANSWER KEY

Object	Description	Latitude Longitude
Dock I. light	On west side of Dock I. located east of Sidney Harbour.	48° 40.30' N 123° 21.41' W
Repulse Rk. day mark	West of Elbow Pt. in Squally Reach (Lower left corner of the chart).	48° 32.76' N 123° 32.37' W
Wreck located in Reid Harbour	West side of Stuart Island in Haro Strait.	48° 40.20' N 123° 11.27' W
Hay Pt. light	In Bedwell Harbour on South Pender Island.	48° 44.67' N 123° 13.79' W
Fir Cone Pt. light	Northwest end of Coal Island in Colbourne Passage.	48° 41.46' N 123° 23.27' W
Sidney Island light	Small islet northwest of Sidney Island. East of Sidney.	48° 39.22' N 123° 20.75' W

LATITUDE AND LONGITUDE WORKSHEET

Object	Latitude Longitude	Symbol
0800 Voyage begins	48° 47.11' N 123° 20.7' W	
0830	48° 43.55' N 123° 17.51' W	
0900	48° 42.21' N 123° 12.6' W	
0930	48° 41.76' N 123° 07.31' W	
1000	48° 38.7' N 123° 05.97' W	
1030 Voyage ends	48° 36.76' N 123° 05.85’ W	

LATITUDE AND LONGITUDE ANSWER KEY

Object	Latitude Longitude	Symbol
0800 Voyage begins	48° 47.11' N 123° 20.7' W	Ferry Track
0830	48° 43.55' N 123° 17.51' W	100 m Contour
0900	48° 42.21' N 123° 12.6' W	Special Notes for Turn Point Special Operating Area
0930	48° 41.76' N 123° 07.31' W	Centre of Compass Rose
1000	48° 38.7' N 123° 05.97' W	Eddy or Whirlpool
1030 Voyage ends	48° 36.75' N 123° 05.85' W	Rock that dries 0.9 m above Chart Datum

CANADIAN CADET ORGANIZATIONS

NAVIGATION MANUAL

INSTRUCTIONAL GUIDE

SECTION 5

EO X51.05 – LOCATE A POSITION USING A GLOBAL POSITIONING SYSTEM (GPS) RECEIVER

Total Time:	80 min

PREPARATION

PRE-LESSON INSTRUCTIONS

This IG supports EO X51.05 (Locate a Position Using a Global Positioning System [GPS]) receiver).

Photocopy the GPS Receiver Handout located at Annex A for each student.

Photocopy the GPS Activity Planning Sheet located at Annex B.

Photocopy and cut out the GPS Activity Game Pieces located at Annex C and the GPS Activity Worksheet located at Annex D for each pair of students.

Gather the required resources:

- GPS receiver (one per two students),
- Tape, and
- Six small watertight containers.

PRE-LESSON ASSIGNMENT

Nil.

APPROACH

An interactive lecture was chosen for TPs 1–3 to orient the students to the components of the GPS.

A demonstration and performance was chosen for TP 4 as it allows the instructor to explain and demonstrate how to scroll through the different screen pages of a GPS receiver while providing an opportunity for the students to practice under supervision.

A practical activity was chosen for TP 5 to allow the students to experience navigating with a GPS in a safe, controlled environment.

INTRODUCTION

REVIEW

Nil.

OBJECTIVES

By the end of this lesson the student shall have located a position using a GPS receiver.

IMPORTANCE

It is important for students to be able to identify the components of the GPS and the information screens so they can effectively operate a GPS receiver when navigating.

Teaching Point 1 **Discuss the GPS.**

Time: 10 min Method: Interactive Lecture

Through the use of open-ended questions, determine the level of understanding the students have about the GPS.

WHAT THE GPS IS

Global Navigation Satellite System (GNSS) is the generic term for satellite navigation systems that provide autonomous geo-spatial positioning with global coverage. The GPS is a constellation of satellites, ground stations and receivers created, owned and operated by the United States. This system is used to navigate and enables anyone with a GPS receiver to know where they are 24 hours a day in any kind of weather.

There are 21 satellites (and three spares) that orbit the Earth and send radio signals to the Earth's surface. A GPS receiver is an electronic device that detects the radio signals from the satellites and calculates the receiver's position on Earth. It is capable of providing location, speed, time and altitude.

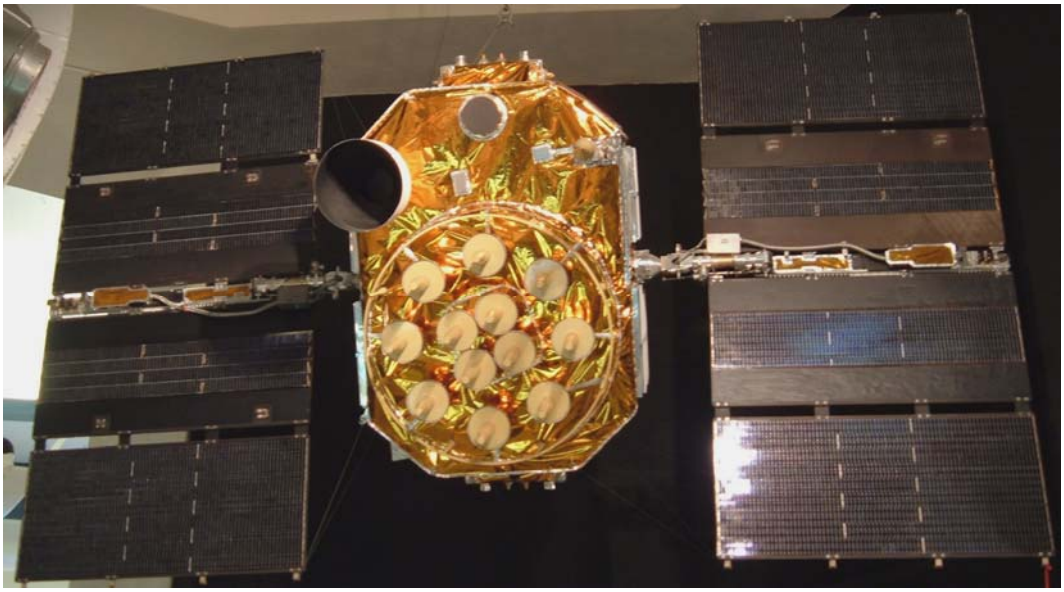


Figure 1 GPS Satellite

Note. From "Wikipedia", *Global Positioning System Satellite*. Retrieved March 27, 2008, from http://en.wikipedia.org/wiki/Image:Global_Positioning_System_satellite.jpg

The United States GPS is not the only satellite navigation system currently deployed. Other nations that have begun or have established a similar satellite navigation system are:

- The European Union—GALILEO Satellite System,
- Russia—GLONASS System, and
- China—Beidou System.

HOW THE GPS WORKS

The system is divided into three parts or segments: space, ground control and users. The space segment consists of 24 satellites that orbit 20 200 km above the Earth and send radio signals to Earth. The radio signals broadcast the position of each satellite in the sky with an electronic code.

Each satellite performs a relatively simple primary task: it transmits a timing signal using its built-in atomic clock. When a device on the ground receives that signal, it can determine its distance from the satellite.

That single measurement alone does not accomplish much, but when a GPS receiver collects timing signals from at least three different satellites, the receiver can determine two precise coordinates: latitude and longitude. With four or more satellite signals, the GPS receiver is able to determine altitude.

A GPS receiver can also determine other variables such as speed and heading.

COMPONENTS OF THE GPS

Satellites

The GPS and its satellites have the following characteristics:

- The minimum number of satellites that are required to cover the entire Earth is 18, however the number of satellites in orbit fluctuates between 24 and 29 satellites due to spares and upgrading.
- Satellites orbit in a semi-synchronous orbit (orbits are coordinated, but not identical).
- Each satellite completes an orbit every 12 hours.
- Satellites orbit the Earth at 20 200 km (12 552 miles) (airplanes routinely fly at 11–13 km [37 000–43 000 feet], the shuttle orbits at 370 km [230 miles]).
- Each satellite has three key pieces of hardware:
    - **Computer.** Controls its flight and order functions.
    - **Atomic clock.** Keeps accurate time within three nanoseconds (approximately three-billionths of a second).
    - **Radio transmitter.** Sends signals to Earth.

Ground Stations

The ground control segment of the GPS is comprised of five ground stations that track the satellites, monitor their condition and make necessary adjustments to keep the system accurate. The entire system is monitored by the US Department of Defence. Information from the stations are sent to a master control station—the Consolidated Space Operations Center (CSOC) at Schriever Air Force Base in Colorado where the data is processed and adjustments are made. The five ground stations are in Hawaii, Colorado, Diego Garcia, Ascension Island and Kwajalein.

Receivers

GPS receivers make up the user segment. It is the GPS receiver, whether it is in an airplane, a truck, a boat or in a hiker's hand, that detects the radio signals from the satellites and calculates the receiver's position.

When a receiver is turned on, it interprets the radio signals and extracts the satellite location information. The GPS signal broadcasts information that tells the receiver the location of each satellite in the system. The receiver then interprets the radio signal to determine the exact time. This is required to calculate position.

The orbits of the GPS satellites ensure that there will be a minimum of four satellites covering any spot on the globe at all times. The receiver uses the signal from one satellite to continuously monitor and be synchronized with the time maintained by the other satellites. The receiver uses the signals from the other satellites and calculates the difference between them. This calculation positions the receiver from

each satellite and triangulates its location. Based on four satellites, the receiver will identify its location giving the user latitude, longitude and altitude (altitude is only possible with four satellites).

CONFIRMATION OF TEACHING POINT 1

QUESTIONS:

Q1. What does GPS stand for?

Q2. What are ground stations responsible for?

Q3. How does a receiver calculate your position?

ANTICIPATED ANSWERS:

A1. Global Positioning System.

A2. Ground stations are responsible for tracking the satellites, monitoring their condition and making any necessary adjustments to keep the system accurate.

A3. The receiver uses the signal from one satellite to continuously monitor and be synchronized with the time maintained by the satellites. The receiver uses the signals from the other satellites and calculates the difference between them. This calculation positions the receiver from each satellite and triangulates its location. This location gives the user latitude, longitude and altitude.

Teaching Point 2 **Explain GPS terminology.**

Time: 5 min Method: Interactive Lecture

As students are introduced to and continue to use GPS receivers they may encounter the following terms. Explain the terms to the students and give examples where possible.

Accuracy. The quality of the measurement of location.

Differential GPS (DGPS). A stationary receiver working in conjunction with the satellites to correct errors in the timing signals, resulting in a more precise measurement of location.

Triangulation. What GPS receivers do to determine position based on data received from three or more GPS satellites.

Three-dimensional (3D) coordinate. Requires a four-satellite signal lock, giving a position as determined by latitude, longitude, and altitude.

Wide area augmentation service (WAAS). Improves GPS accuracy and availability. WAAS was designed with aviation in mind as it improves a GPS receiver's accuracy to within 3 m.

Waypoint. An intermediate position between the starting and destination points along a navigational route. If one makes three stops along the route to the final destination, the GPS receiver will consider each one of these stops as a waypoint.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS:

Q1. What is a 3D coordinate?

Q2. What is triangulation?

Q3. What is a waypoint?

ANTICIPATED ANSWERS:

A1. A 3D coordinate is one's position as determined by latitude, longitude, and altitude.

A2. Triangulation is what a GPS receiver does to determine position based on data received from three or more GPS satellites.

A3. A waypoint is an intermediate position between the starting and destination points along a navigational route.

Teaching Point 3 **Identify and describe the components of a GPS receiver.**

Time: 10 min Method: Interactive Lecture

Distribute GPS receivers to each pair of students. If there is not a receiver for each pair, divide the students into groups so they may share.

Distribute the GPS receiver handout located at Annex A to each student.

COMPONENTS OF A GPS RECEIVER

Antenna. Allows the GPS receiver to receive satellite signals.

Screen. Location where all information is displayed.

Some GPS receivers use an arrow joystick that acts as a mouse, providing a simple-to-use interface with the GPS receiver.

Battery compartment. Stores the receiver power supply.

The buttons in the following list are found on the Magellan eXplorist 200 GPS receiver. Other makes and models of GPS receivers may have different function buttons. Consult the user manual for GPS receiver button functions.

Buttons

On / Off. Turns the receiver on and off.

Backlight. Turns the display backlight on and off and changes the intensity.

Enter. Used to access highlighted menu items or highlighted page menu options.

Escape. Cancels data inputs. Closes the accessed function and goes back to the previous screen and moves backward through the navigation screens.

Zoom in. Used on the map screen to zoom in on the map displayed. The map display can be zoomed in to 35 m (100 feet). Also used to move through the list of waypoints when using an alphabetical search.

Zoom out. Used on the map screen to zoom out on the map displayed. The map display can be zoomed out to 2 736 km (1 700 miles). Also used to move through the list of waypoints when using an alphabetical search.

Menu. Displays a menu with available options. Options may be selected by using the arrow joystick to highlight the option and pressing ENTER to access it.

NAV. Moves through the navigation screens (Map screen, Compass screen, Position screen, Satellite screen).

Mark. Used to save present position as a waypoint. Waypoints are saved and stored in the "My Points of Interest (POI)" database.

GOTO. Creates a one-leg route from the present position to a destination selected from the POI database or by using the cursor on the background map and pressing GOTO on a point.

Arrow joystick (if fitted). Moves the cursor on the map screen. It also moves the highlighted bar to select menu options and data-entry fields.

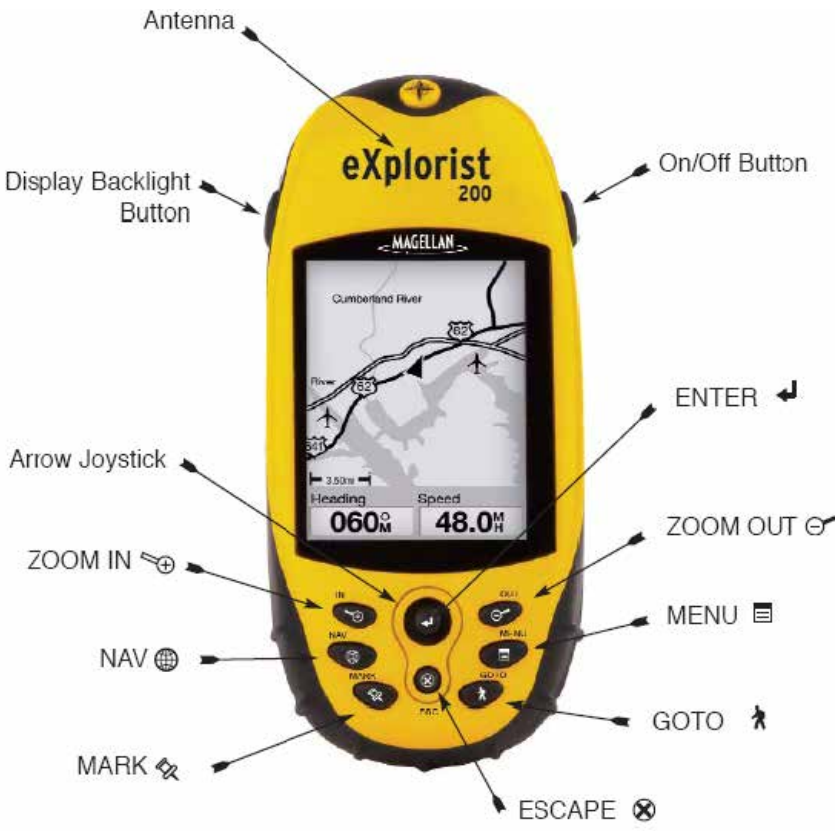


Figure 2 Explorist 200 GPS Receiver

Note. From *Magellan eXplorist 200 Reference Manual* (p. 1), 2004, by Thales Navigation, Inc. Copyright 2004 by Thales Nav, Inc.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS:

Q1. Name three components of a GPS receiver.

Q2. What is the purpose of the NAV button on the GPS receiver?

Q3. What is the GOTO button used for on the GPS receiver?

ANTICIPATED ANSWERS:

A1. Three components of a GPS receiver may be any of the following:

- antenna,
- screen,
- battery compartment, and
- buttons, to include:

- on / off,
- backlight,
- enter,
- escape,
- zoom in,
- zoom out,
- menu,
- NAV,
- mark,
- GOTO, and
- arrow joystick.

A2. The NAV button moves through the navigation screens (Map screen, Compass screen, Position screen, Satellite screen).

A3. The GOTO button creates a one-leg route from the present position to a destination selected from the POI database or by using the cursor on the background map.

Teaching Point 4	**Explain and have the students scroll through the screen pages on a GPS receiver.**
Time: 10 min	Method: Demonstration and Performance

GPS receivers may differ in the way they present information. Identify the screens that are similar to those contained in this TP, and have the students find the different pages and the information they display.

SATELLITE STATUS

The satellite status screen graphically displays satellite signal strength, geometry and the progress of data collection as the satellites are acquired. A bar chart indicates the signal strength and identification of the satellites. As new satellites come into view, a new bar appears in the graph. If a satellite is being monitored but has not been locked yet, the bar will appear hollow. Once they lock on, the bar will appear solid. As satellites pass over the horizon, the bars will disappear.

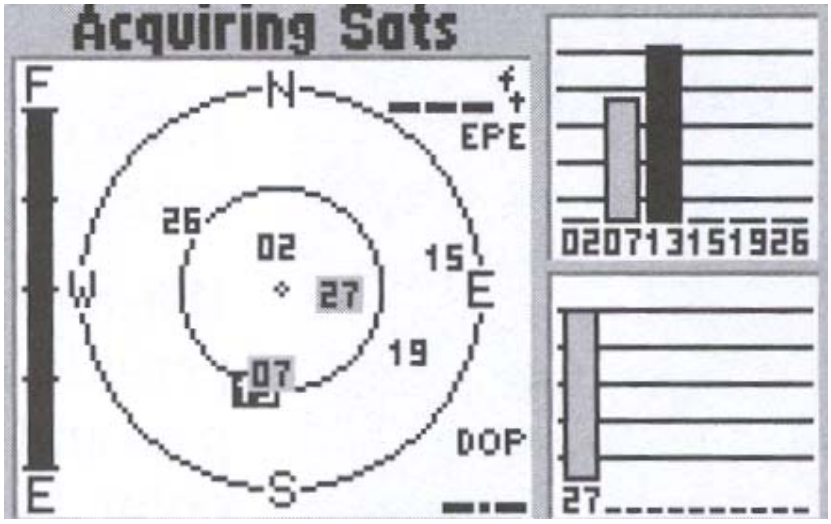


Figure 3 Satellite Status Screen

Note. From *Outdoor Guide to Using Your GPS* (p. 45), by S. Featherstone, 2004, Chanhassen, MN: Copyright 2004 by Creative Publishing International, Inc.

On some WAAS-enabled GPS receivers, the WAAS satellite signal strength is indicated on its own bar on the graph.

POSITION

The position screen provides detailed information that includes current position, accuracy of position fix, date, time and battery condition. Due to its textual nature, this screen is not easy to navigate with.

Coordinates. When enough satellites are locked on, the position is displayed.

Accuracy. The accuracy of the position fix is calculated and displayed. If WAAS is used to increase the accuracy, it will also be displayed.

Date and time. The displayed date and time are automatically adjusted from time information supplied from the atomic clocks in the GPS satellites.

Battery condition. A graphical indicator displays the current condition of the battery in the GPS receiver.

In addition to the information mentioned above, an operator may find current speed, heading and a trip odometer.

On some GPS receivers the information displayed can be changed.

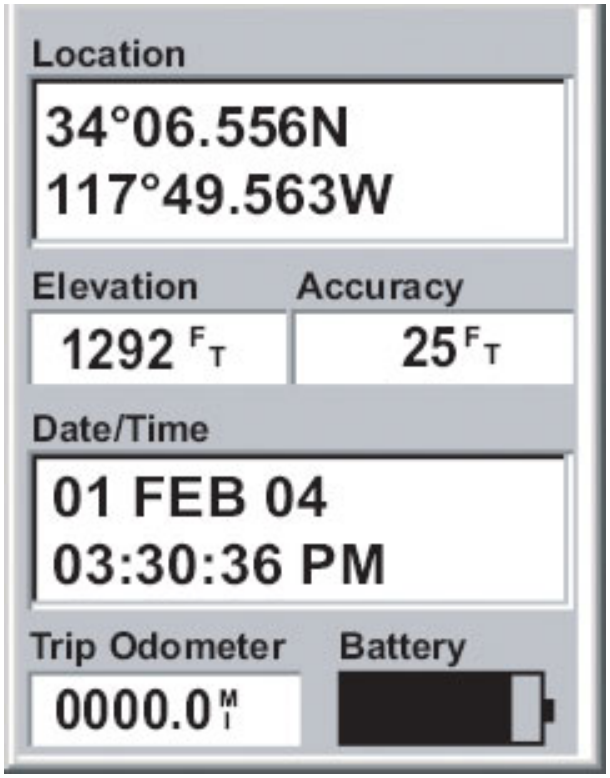


Figure 4 Position Screen

Note. From *Magellan eXplorist 200 GPS User Manual* (p. 22), by Thales Navigation Inc., 2004, San Dimas, CA: Copyright 2004 by Thales Navigation Inc.

COMPASS NAVIGATION

The compass screen provides an simple-to-use graphical compass that indicates direction of travel when no active route is selected. When an active route is selected, an icon representing the destination is displayed outside the compass diameter, with the compass arrow pointing in the direction of travel. To head in the direction of the destination, move so that the compass arrow points directly to the destination icon. This page is used frequently when navigating from point-to-point and for navigating around obstacles.

When not in motion, the compass arrow points to the last direction of travel.

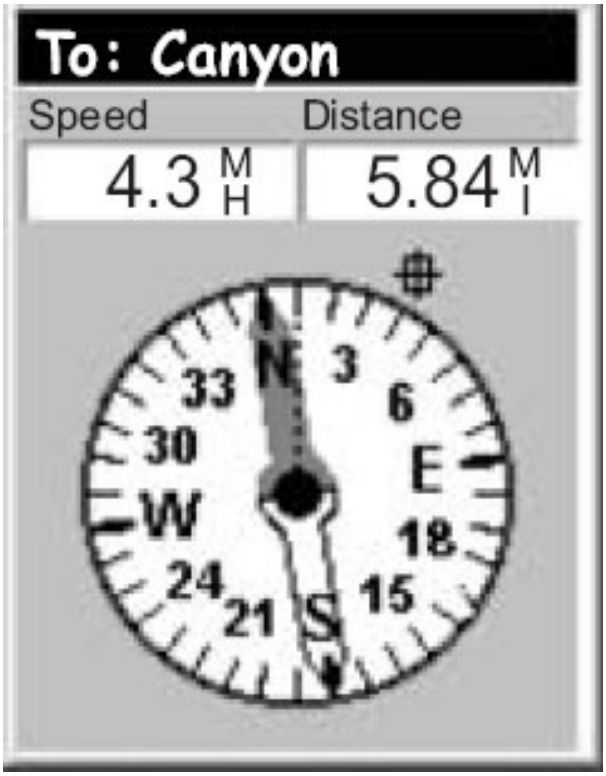


Figure 5 Compass Navigation Screen

Note. From *Magellan eXplorist 200 GPS User Manual* (p. 20), by Thales Navigation Inc., 2004, San Dimas, CA: Copyright 2004 by Thales Navigation Inc.

CONFIRMATION OF TEACHING POINT 4

QUESTIONS:

Q1. What is displayed on the satellite status screen when a satellite is in view but has not been locked?

Q2. How is information displayed on the position screen?

Q3. What does the compass arrow point to when an active route is not selected?

ANTICIPATED ANSWERS:

A1. Hollow bar.

A2. Textual.

A3. Direction of travel.

Teaching Point 5	**Conduct an activity where the students will locate a position using a GPS receiver.**
Time: 35 min	Method: Practical Activity

The following activity is modelled after a world-wide sport known as geocaching. More information on the sport can be obtained by visiting the website http://www.geocaching.com

ACTIVITY

1. Place identical game pieces into a watertight container.

2. Place the containers in six different locations and record their coordinates on the GPS planning sheet located at Annex B.

3. Program these coordinates as waypoints in the GPS receivers to be used by the students.

If time permits, demonstrate and have the students enter the waypoints into the GPS receiver.

ACTIVITY INSTRUCTIONS

1. Brief the students on the following rules of the activity:

   a. Groups shall navigate independently without pooling resources.
   b. Remove only one game piece from each container.

2. Have the students locate the six waypoints using the GPS receiver.

Remember, accuracy can be affected by weather, atmospheric conditions and proximity to tall obstructions. Some searching may be required once the students have reached the waypoints.

3. Once all pieces have been found, have the students arrange them on the worksheet in the correct order and affix them with tape.

4. Have the students answer the question formed by the pieces and record the response on the worksheet.

5. Debrief the students and answer any questions that may arise.

CONFIRMATION OF TEACHING POINT 5

The students' participation in the activity will serve as confirmation of this TP.

END OF LESSON CONFIRMATION

The students' participation in the GPS activity will serve as confirmation of this lesson.

CONCLUSION

HOMEWORK / READING / PRACTICE

Nil.

METHOD OF EVALUATION

Nil.

CLOSING STATEMENT

The GPS is a technological advancement that is continuously evolving to present new ways and methods for navigating. As these advances become available to the Cadet Program, you will be challenged to learn and apply them while navigating.

INSTRUCTOR NOTES / REMARKS

Nil.

REFERENCES

Thales Navigation Incorporated. (2004). *Magellen explorist 200 gps user manual*. San Dimas, CA: Thales Navigation Inc.

ISBN 0-7645-6933-3 McNamara, J. (2004). *GPS for dummies*. Hoboken, NJ: Wiley Publishing, Inc.

ISBN 0-07-223171-8 Broida, R. (2004). *How to do everything with your GPS*. Emerville, CA: McGraw-Hill.

GPS Receiver Handout

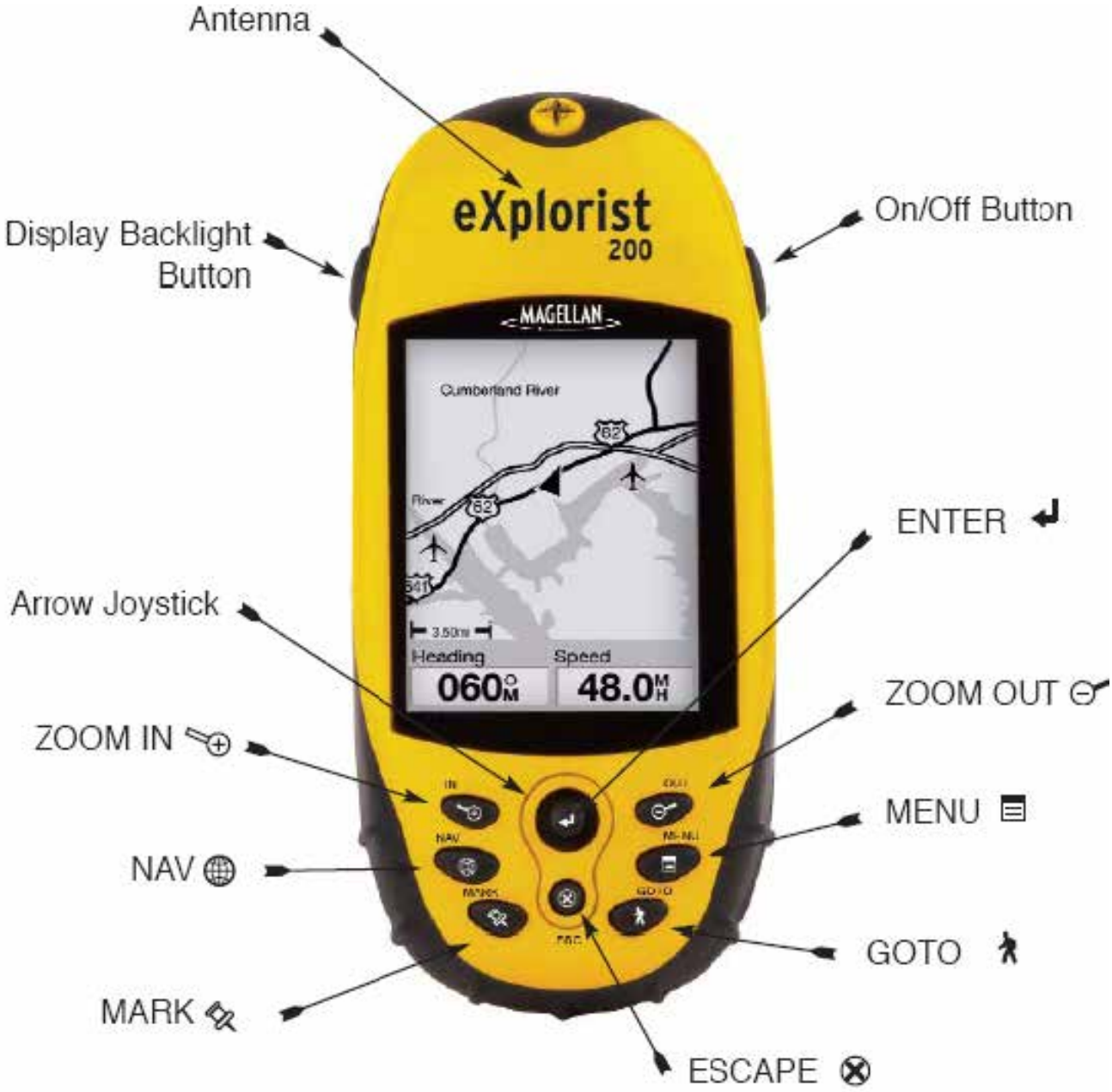


Figure A-1 Explorist 200 GPS Receiver

Note. From *Magellan eXplorist 200 Reference Manual* (p. 1), 2004, by Thales Navigation, Inc. Copyright 2004 by Thales Nav, Inc.

GPS Activity Planning Sheet

Waypoints

WAYPOINT # 1	WAYPOINT # 2
Latitude: **Longitude:**	**Latitude:** **Longitude:**

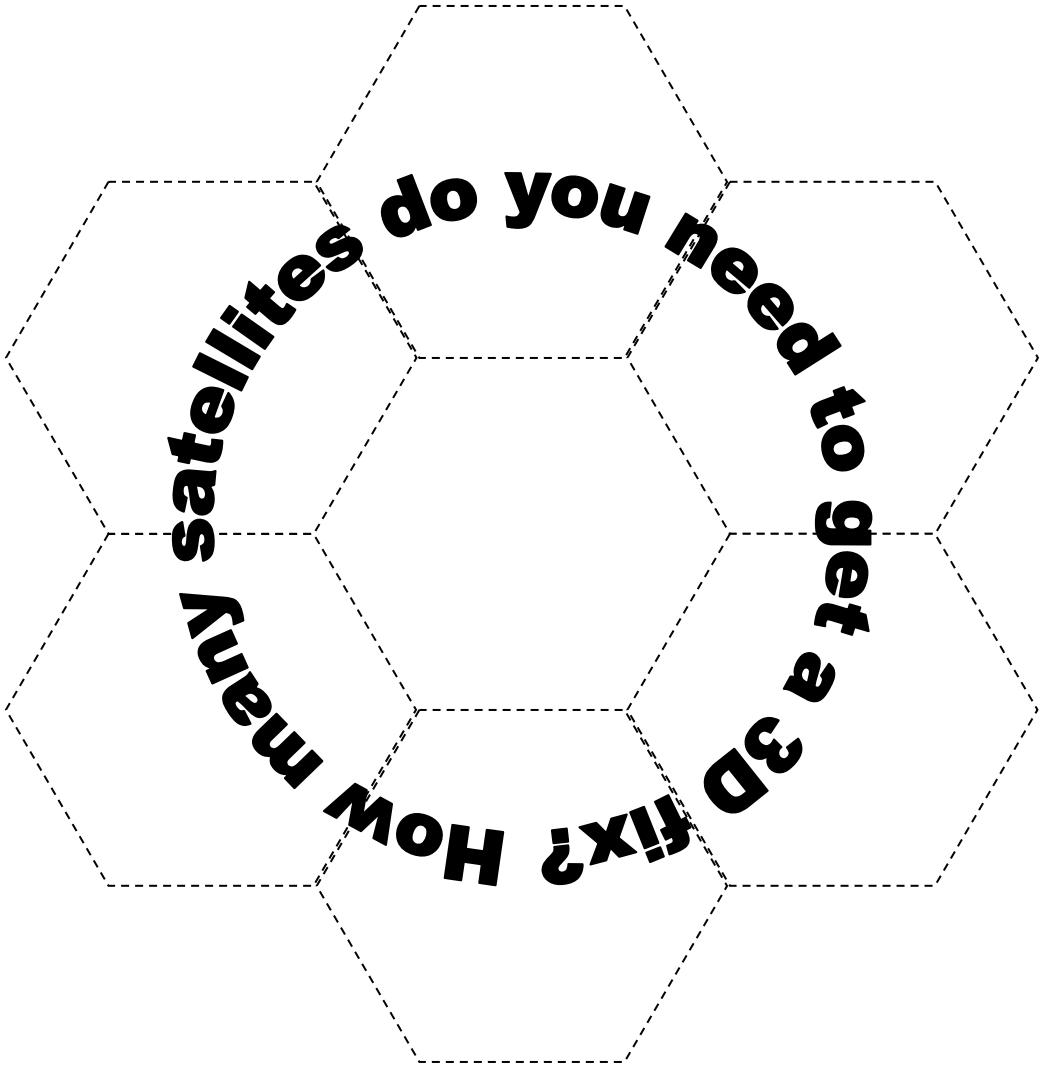
WAYPOINT # 3	WAYPOINT # 4
Latitude: **Longitude:**	**Latitude:** **Longitude:**

WAYPOINT # 5	WAYPOINT # 6
Latitude: **Longitude:**	**Latitude:** **Longitude:**

Game Question

How many satellites do you need to get a 3D fix? **Four**

GPS Activity Game Pieces



GPS Activity Worksheet

TEAM NAME: _____

ANSWER: _____

CANADIAN CADET ORGANIZATIONS

NAVIGATION MANUAL

INSTRUCTIONAL GUIDE

SECTION 6

EO X51.06 – LOCATE A POSITION ON A CHART USING RADAR

Total Time:	80 min

PREPARATION

PRE-LESSON INSTRUCTIONS

This IG supports EO X51.06 (Locate a position on a chart using RADAR).

Photocopy the RADAR Picture handout located at Annex A for each student.

PRE-LESSON ASSIGNMENT

Nil.

APPROACH

An interactive lecture was chosen for TPs 1 and 2 to orient the students to the components of RADAR.

A demonstration and performance was chosen for TPs 3 and 4 as it allows the instructor to explain and demonstrate how to obtain a RADAR range fix and plot its position on a chart while providing an opportunity for the students to practice these skills under supervision.

INTRODUCTION

REVIEW

Nil.

OBJECTIVES

By the end of this lesson the student shall have located a position on a chart using RADAR.

IMPORTANCE

It is important for students to know how to locate a position on a chart using RADAR as they may not be able to determine the ship's position by visual or other electronic means.

Teaching Point 1	**Discuss RADAR.**
Time: 5 min	Method: Interactive Lecture

Distribute the RADAR Picture handout located at Annex A to each student.

RADAR

The word RADAR was originally an acronym derived from *Radio Detection And Ranging* and was developed during World War Two. It is a device which measures the time it takes for a pulsed radio signal to be reflected back from an object while also measuring its bearing relative to the vessel.

RADAR gives a picture of surrounding land that easily relates to a chart. Sometimes its difficult to distinguish headlands from one another by eye. RADAR helps by displaying the shapes of their near sides clearly (as illustrated in Figure 1). Areas beyond hills do not show up on RADAR.

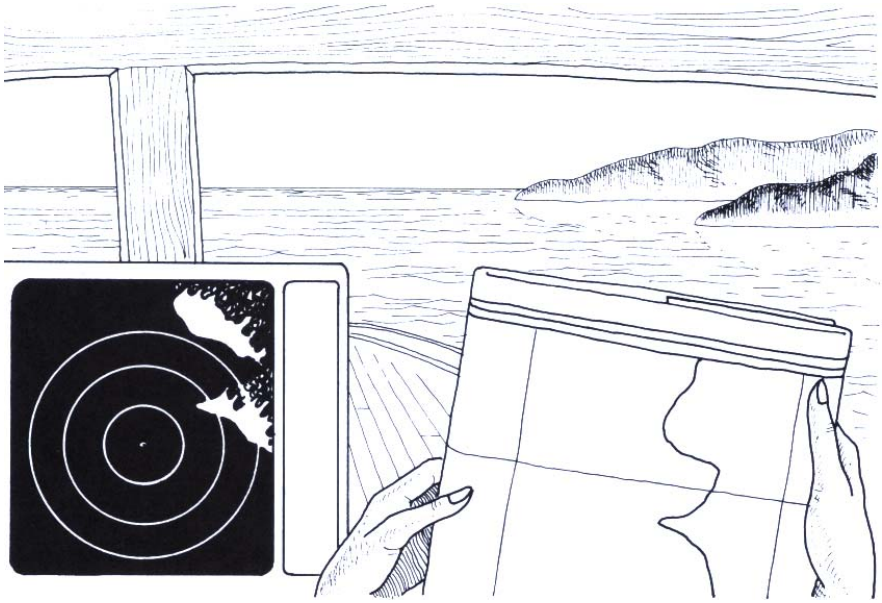


Figure 1 RADAR Picture

Note. From *Boat Navigation for the Rest of Us* (p. 111), by B. Brogdon, 2001, Camden, ME: International Marine. Copyright 2001 by International Marine.

RADAR also functions as an anti-collision aid by providing information about neighbouring vessels, aircraft and coastal outlines. In fog or darkness, situational awareness around the vessel may be lost because of poor or no visibility. RADAR provides the ability to monitor other vessels' movements under these conditions.

How RADAR Works

RADAR works in a similar manner to shouting at a cliff and hearing the echo of the shout. Radio pulses are emitted from the antenna in a certain direction (as illustrated in Figure 2). When the pulse strikes an object such as a vessel or island, some of the energy returns to the antenna. Since radio waves travel at a constant speed, the time required for the reflected echo to return to the antenna can be used to calculate the range to the target.

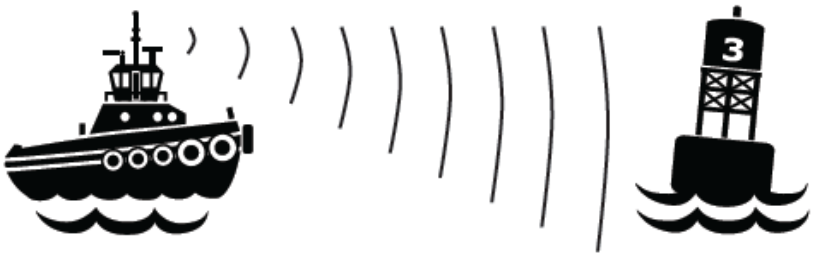


Figure 2 Radio Pulses

Note. From *Operator's Guide to Marine RADAR* (p. 2), 2008, by Furuno USA, Camas, WA: Furuno USA. Copyright 2008 by Furuno USA, Inc.

RADAR targets are displayed on a Plan Position Indicator (PPI). This display is a polar diagram with the transmitting vessels' position at the centre. Images of received target echoes are displayed at their relative bearing and at their distances from the PPI centre (as illustrated in Figure 3). The PPI can also display heading marks and range rings to visually aid the navigator's decision-making process.

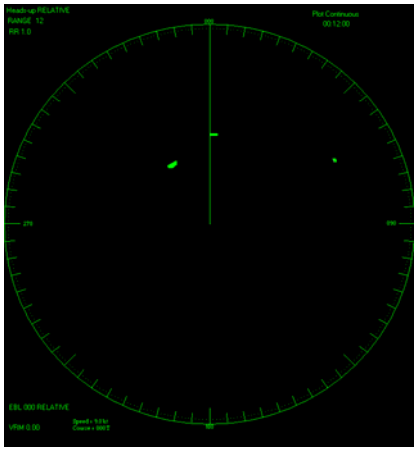


Figure 3 PPI

Components

The basic RADAR system consists of three units: the antenna, the transceiver and the display unit. In smaller RADAR systems, the transceiver is housed in the antenna unit (as illustrated in Figure 4).

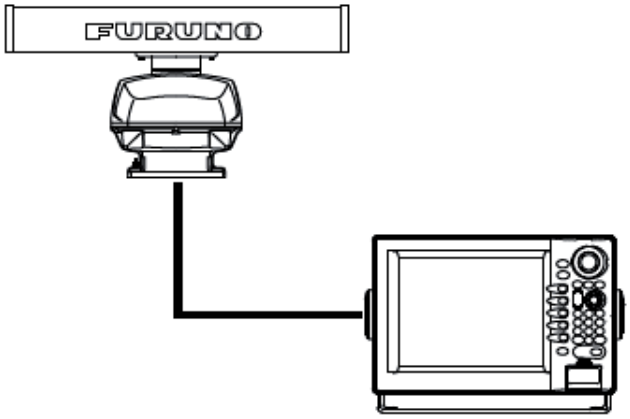


Figure 4 Basic RADAR System

Note. From *Operator's Guide to Marine RADAR* (p. 3), 2008, by Furuno USA, Camas, WA: Furuno USA. Copyright 2008 by Furuno USA, Inc.

Antenna. The antenna for modern RADAR is available in different sizes (as illustrated in Figure 5) based on its range. Some smaller RADAR antennas have their rotating parts protected by a cover. The antenna is used to alternately transmit the radio pulses and receive reflected echoes from any objects. The antenna turns in a full circle so a complete picture of the surroundings of the vessel can be displayed.

Figure 5 RADAR Antennas

Note. From *Operator's Guide to Marine RADAR* (p. 9), 2008, by Furuno USA, Camas, WA: Furuno USA. Copyright 2008 by Furuno USA, Inc.

Transceiver. The transceiver or transmitter-receiver controls the characteristics of the transmitted radio pulses and processes any received echoes for display on the display unit. The transceiver may also calculate other information from the echo such as its distance and bearing from the vessel, its speed and direction of travel and any risk of collision.

Display unit. The display unit (as illustrated in Figure 6) presents the received echoes and any calculated information about the object, producing it on the PPI.

Figure 6 Basic RADAR System

Note. From *Operator's Guide to Marine RADAR* (p. 22), 2008, by Furuno USA, Camas, WA: Furuno USA. Copyright 2008 by Furuno USA, Inc.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS:

Q1. The acronym RADAR stand for what?

Q2. What is a PPI?

Q3. What does a transceiver do?

ANTICIPATED ANSWERS:

A1. Radio detection and ranging.

A2. A polar diagram with the transmitting vessels' position at the centre.

A3. Controls the characteristics of the transmitted radio pulse and processes any received echoes for display on the display unit.

Teaching Point 2	**Explain RADAR terminology.**
Time: 5 min	Method: Interactive Lecture

RADAR TERMINOLOGY

The following terminology is used while working with RADAR:

Gain. A control on the RADAR used to adjust receiver sensitivity. An increase in gain amplifies the received target pulses and allows faint echoes to be displayed on the PPI.

If the gain is set too high, false echoes are displayed that might obscure actual target echoes.

Rain clutter. The reflected echoes from rain, hail and snow. These echoes can obscure the display of actual target echoes. RADAR is not affected by fog making it ideal for navigation through fog.

Range. The minimum and maximum range that a target is detectable by a RADAR is determined by factors including antenna height, vertical beam width, and blind sectors within the antenna beam.

Sea clutter. The reflected echoes from nearby waves which can obscure the display of actual target echoes.

Errors. There are two main errors that affect a RADAR's accuracy: bearing and index.

- **Index error** is the difference between the actual range to a target and the range measured on the PPI.

- **Bearing error** is the difference between the actual bearing to a target and the bearing measured on the PPI.

Features. Each RADAR system has unique features to assist a navigator in the decision-making process. Some examples available on a Sea Cadet Training vessel (SCTV) are:

- **Cursor.** A movable symbol on the PPI that provides an accurate measurement of the range to a target. When the cursor's intersection point is placed on the target echo, the range and bearing are displayed on the PPI (as illustrated in Figure 7). The cursor is moved using the display unit's track ball / mouse / keypad.

- **Echo trails.** A feature on a RADAR that shows the movement of other ships by displaying a faint copy of the target at its previous position on the PPI (as illustrated in Figure 3) to allow for the assessment of target movement and collision possibility.

- **Electronic bearing line (EBL).** A feature on a RADAR that displays an adjustable line for bisecting a target echo (as illustrated in Figure 8). A data box on the side of the PPI displays the bearing of the line in degrees.

- **Variable range marker (VRM).** A feature on a RADAR that displays an adjustable circle for measuring the range to a target (as illustrated in Figure 9). A data box on the side of the PPI displays the range in nautical miles (NM).

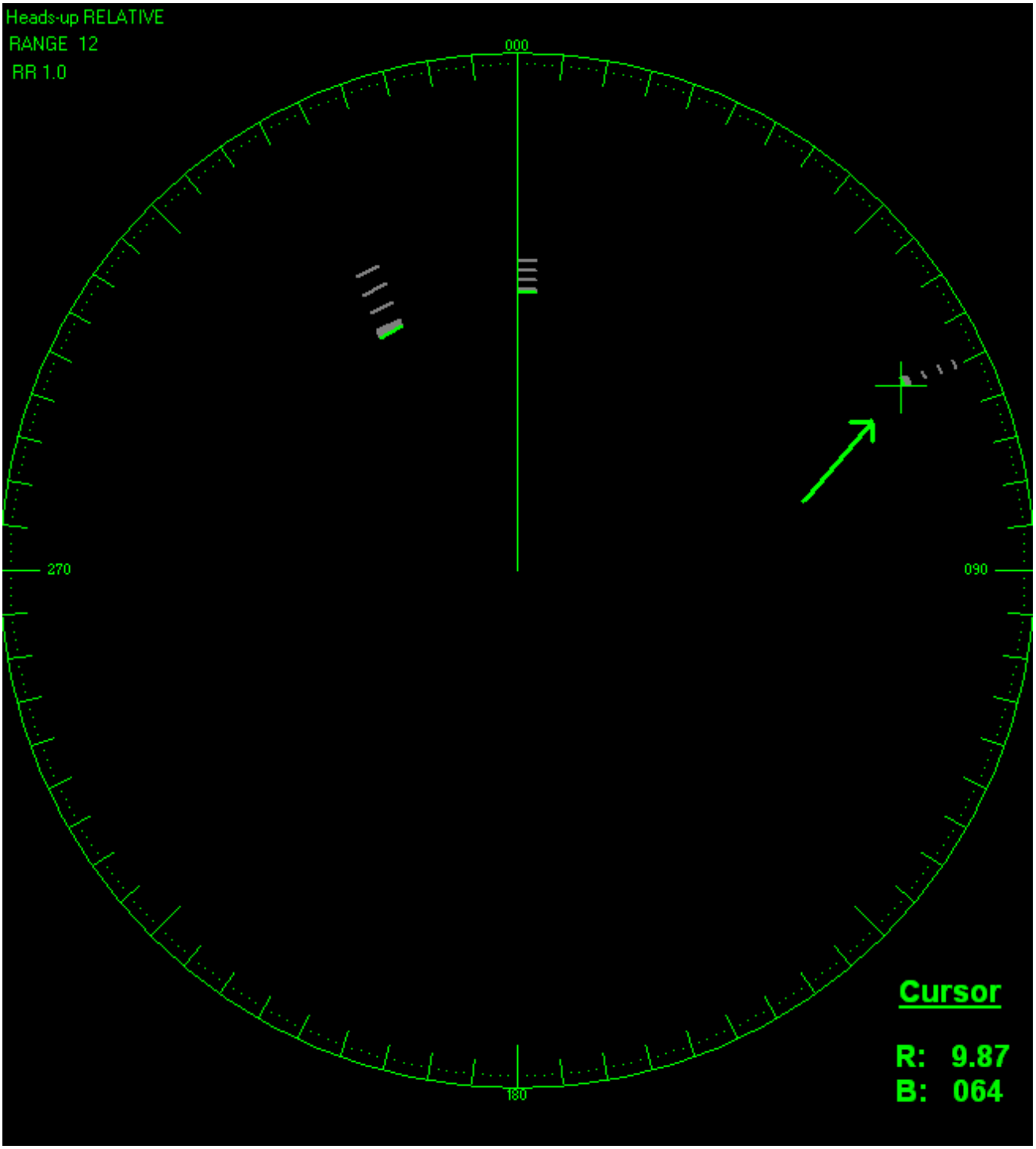


Figure 7 Cursor

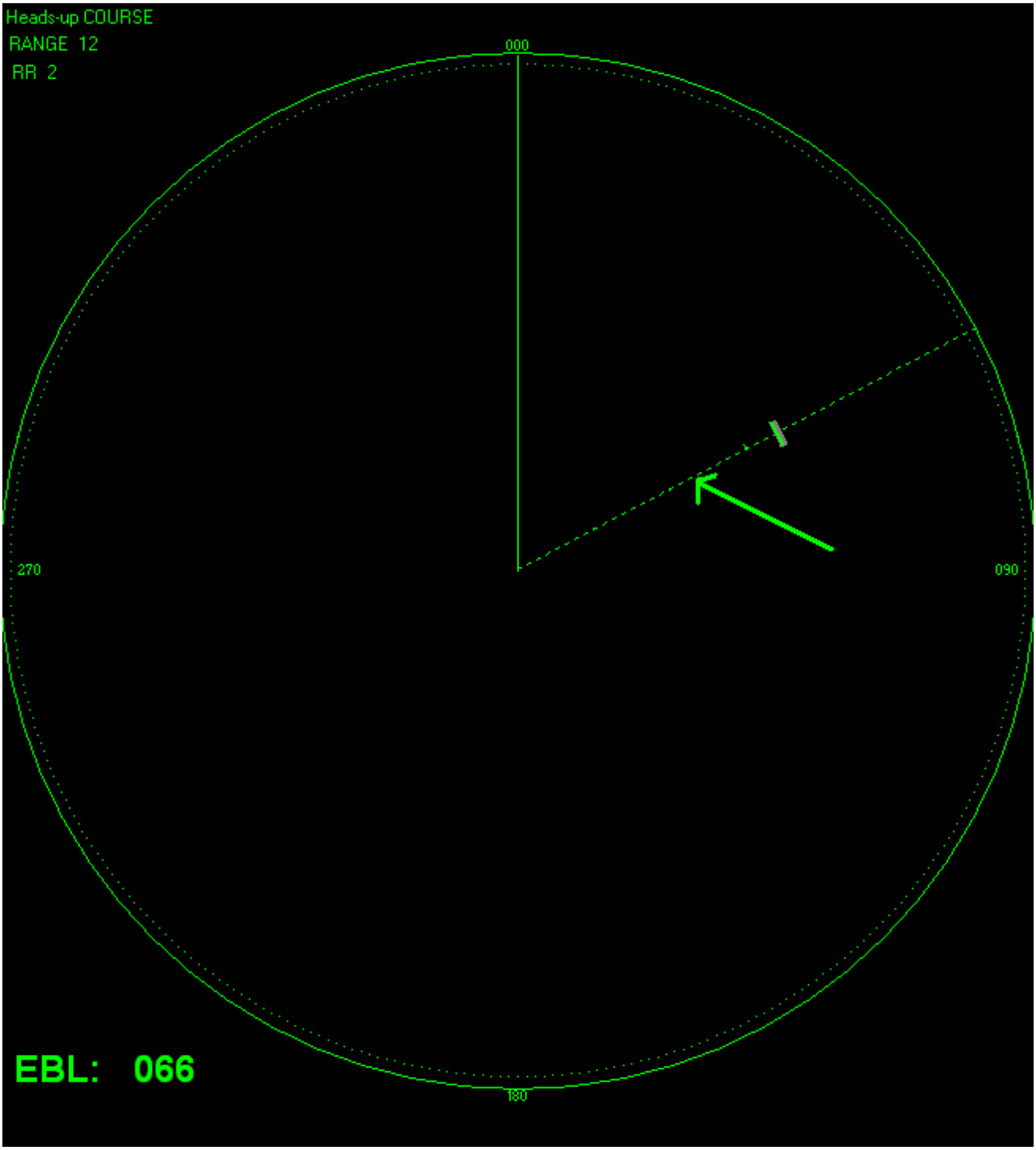


Figure 8 Electronic Bearing Line

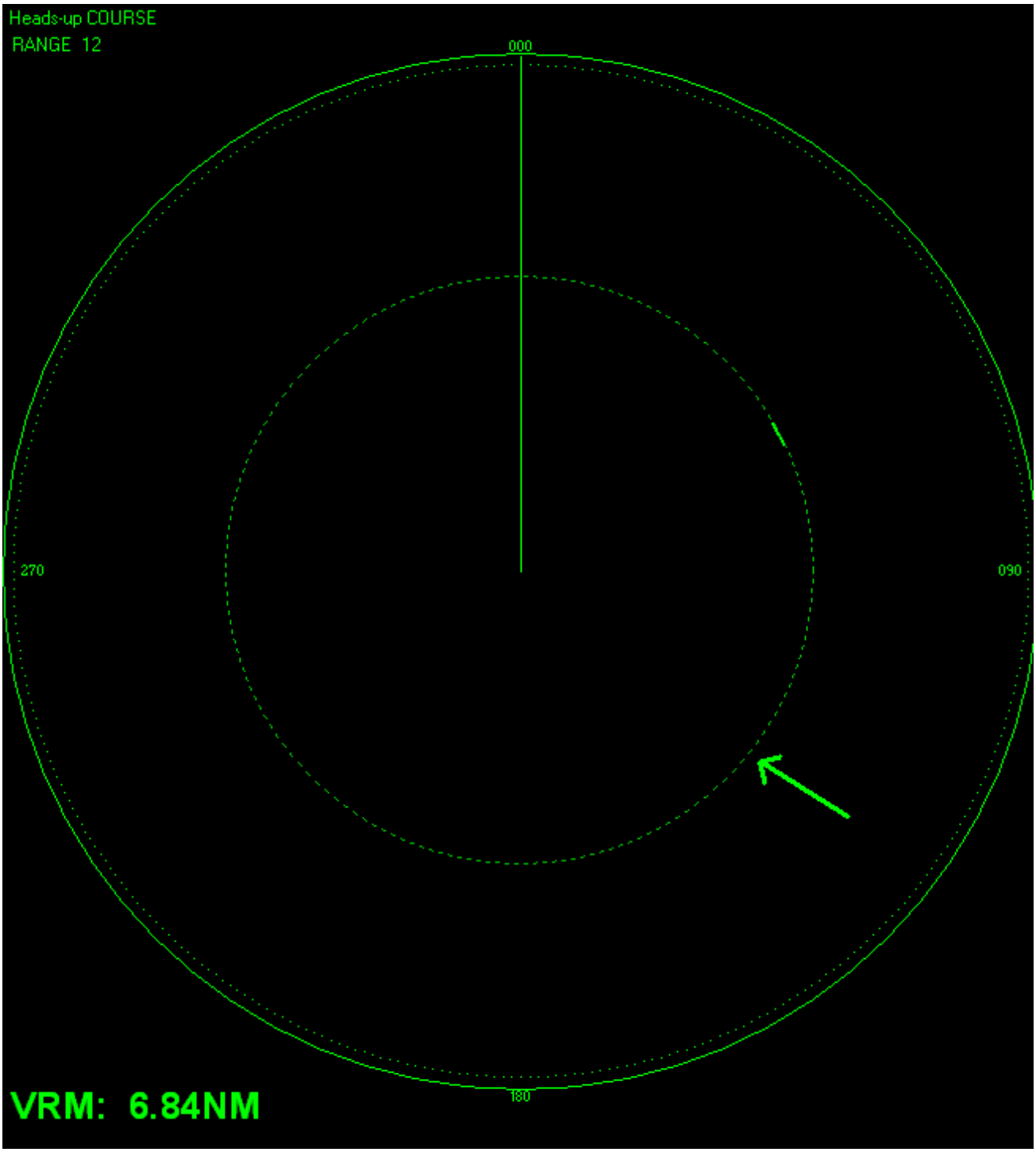


Figure 9 Variable Range Marker

CONFIRMATION OF TEACHING POINT 2

QUESTIONS:

Q1. For what is the gain control used?

Q2. What determines the minimum and maximum range of a RADAR?

Q3. What is an index error?

ANTICIPATED ANSWERS:

A1. To adjust the receiver sensitivity.

A2. Antenna height, vertical beam width, and blind sectors within the antenna beam.

A3. The difference between the actual range to a target and the range measured on the PPI.

Teaching Point 3	**Explain the procedure for obtaining a RADAR range fix.**
Time: 5 min	Method: Demonstration and Performance

Explain and demonstrate the steps for obtaining a RADAR range fix on an SCTV alongside, if possible. Allow each student to become familiar with the operation of the specific RADAR's track ball / mouse / keypad and how it moves the cursor.

FIXING USING A RADAR RANGE FIX

Fixing using a RADAR range fix is the most accurate method of obtaining a fix using only RADAR information. Three RADAR ranges should always be taken, if possible, for the RADAR range fix. This should ensure that:

- Objects are not misidentified.
- Ranges are not read off incorrectly.
- Any unresolved index error becomes apparent.

Use the following directions to obtain a RADAR range fix:

1. Identify three conspicuous headlands on the RADAR that can be found on the chart (as illustrated in Figure 10).

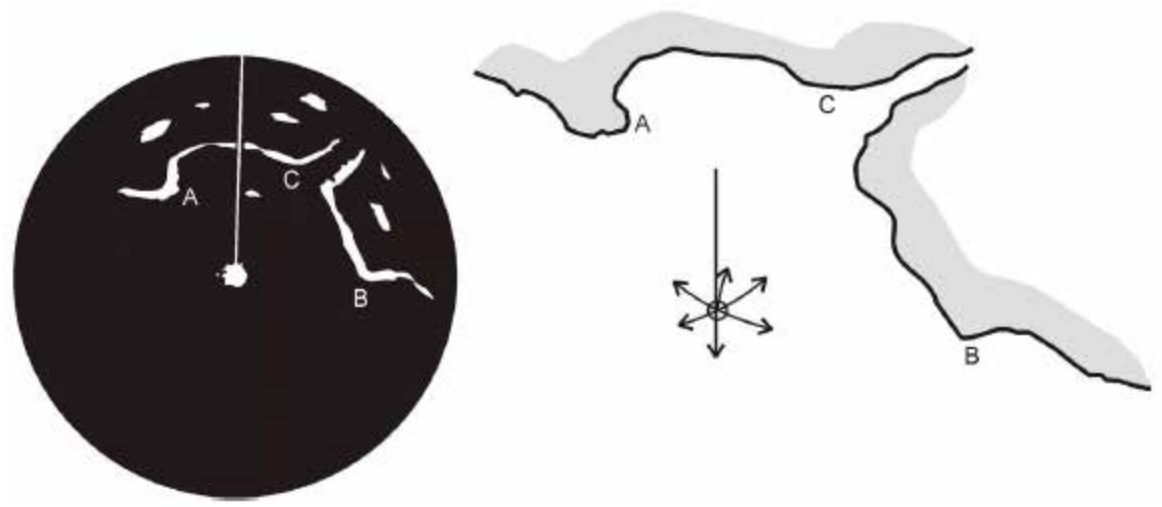


Figure 10 Identifying Three Conspicuous Headlands

2. Place the RADAR's cursor on the first identified point.
3. Record the range and bearing from the PPI.
4. Repeat Steps 2 and 3 for the remaining two points.

RADAR range fixes shall be recorded in the following format:

	Point A	3.2 NM	345
0800	Point B	4.9 NM	105
	Point C	5.2 NM	024

With any time remaining, have the students identify and obtain RADAR ranges to additional conspicuous headlands at their training location.

The bearing to the identified points can be used later to determine if there is any unresolved bearing error.

CONFIRMATION OF TEACHING POINT 3

The students' participation in obtaining a RADAR range fix will serve as the confirmation of this TP.

Teaching Point 4	**Explain, demonstrate and have the students locate a position on a chart using a RADAR range fix.**
Time: 65 min	Method: Demonstration and Performance

Throughout this TP, all bearings given in examples and exercises are to be considered true bearings and all distances given are in nautical miles (NM).

LOCATE A POSITION ON A CHART USING A RADAR RANGE FIX

Demonstrate and have the students plot the following on *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*:

	Wymond Pt.	1.3 NM	305
0800	Kellett Bluff	1.8 NM	068
	Little D'Arcy I.	0.95 NM	245

1. Using the latitude scale on the chart, adjust the drafting compass until it measures 1.3 NM.

Figure 11 Step 1

2. Place the point of the drafting compass on Wymond Pt on the chart.

Figure 12 Step 2

3. Draw an arc in the general vicinity of where the fix was taken.

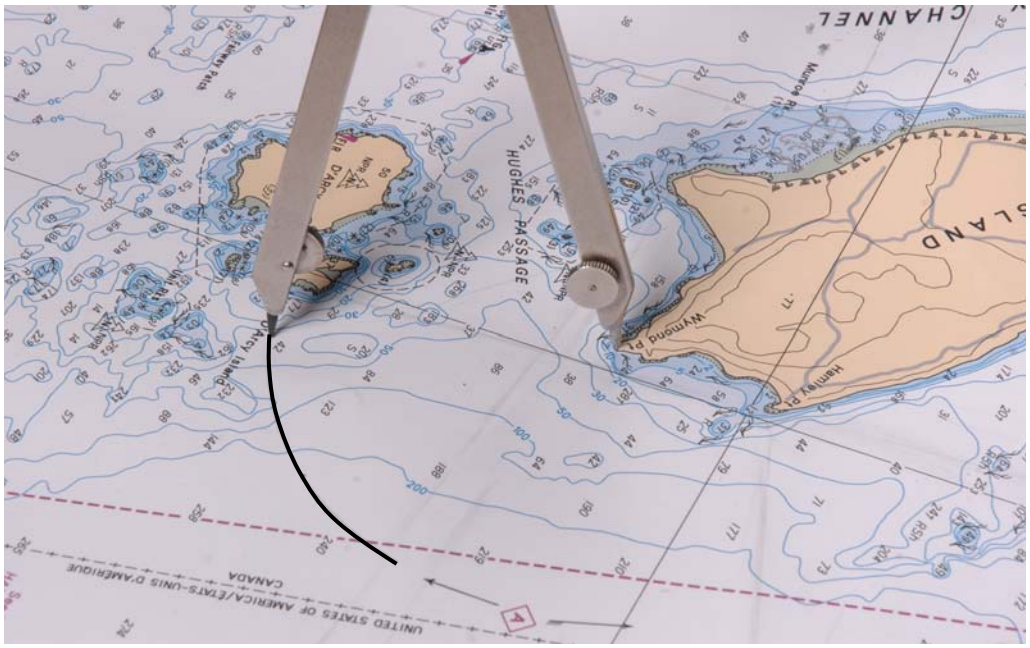


Figure 13 Step 3

4. Repeat Steps 1–3 for the other two RADAR ranges. After the first arc has been drawn, the remaining arcs are only drawn where they intersect the first.

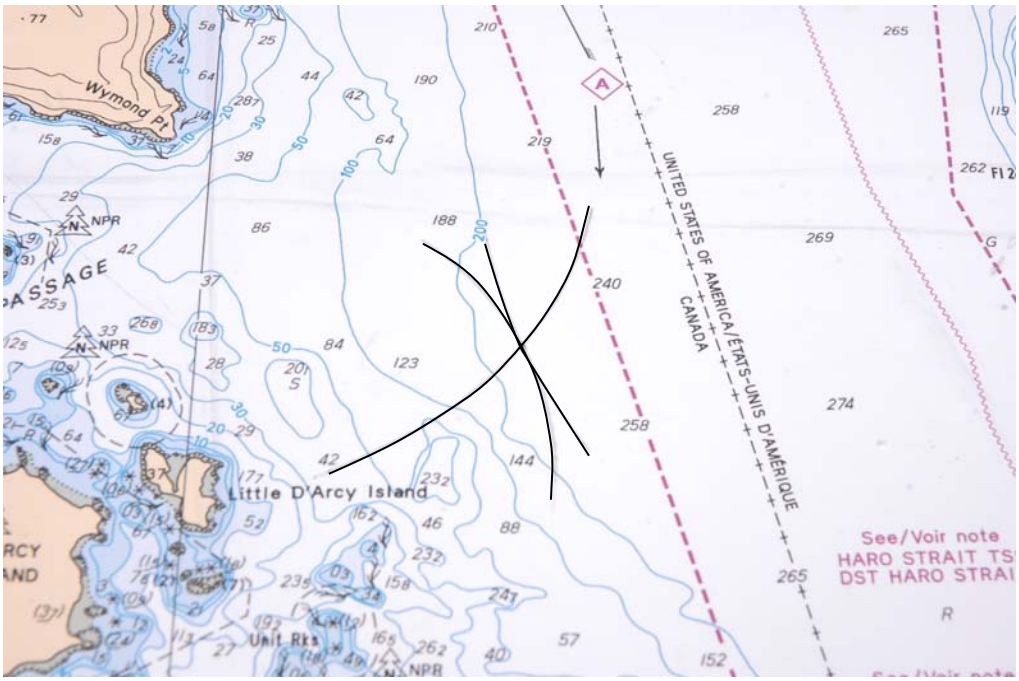


Figure 14 Step 4

5. Shorten the arcs until they are the same size as the diameter of a quarter.

Figure 15 Step 5

6. Draw arrows on the ends of the arcs to indicate it was obtained by a RADAR range.

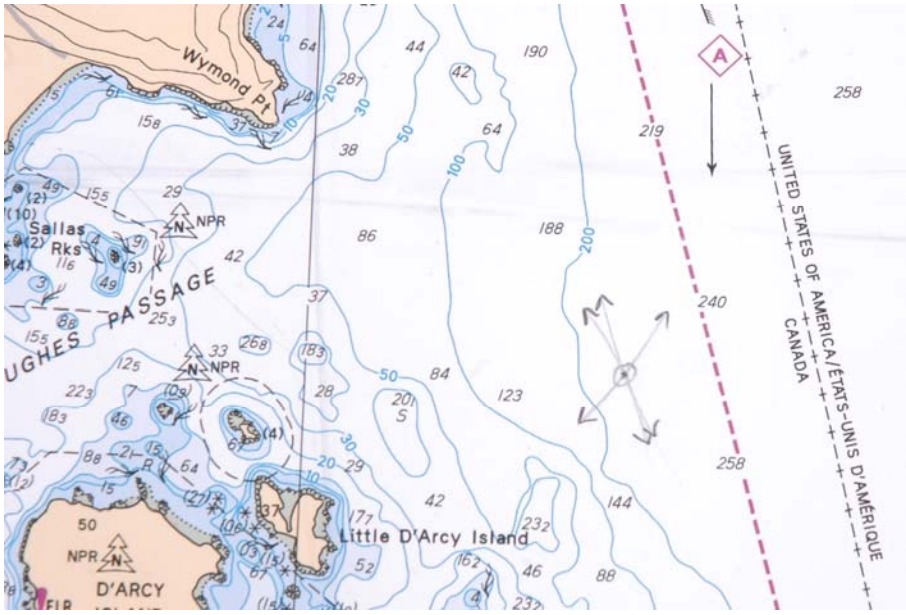


Figure 16 Step 6

7. Circle the intersection of the three arcs and label with the four-digit time the RADAR range fix was taken, next to the fix.

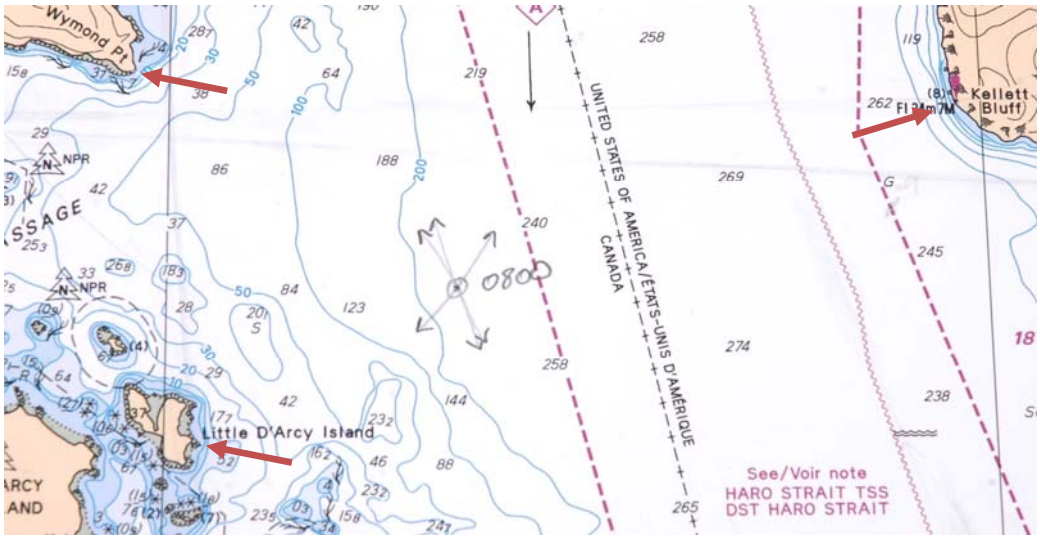


Figure 17 Step 7

On *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*, have the students plot the following fixes with tracks and DRs:

1000	Mandarte I.	2.56 NM	254	1024	Turn Pt.	0.3 NM	120
	Tom Pt.	1.7 NM	287		Pt. Fairfax	2.2 NM	281
	LHE Stuart I.	1.76 NM	354		Arachne Rf.	2.01 NM	258
	Course		340		Course		030
	Speed	5	kts		Speed	10	Kts
1012	Tom Pt.	1.13 NM	247	1036	Tilly Pt.	1.74 NM	003
	Arachne Rf.	2.05 NM	296.5		Satellite I.	1.6 NM	138
	LHE Stuart I.	1.21 NM	199		Stuart I.	1.4 NM	185
	Course		350		Course		064
	Speed	5	kts		Speed	10	kts

To check the students' work, the fixes are located at:

1000–Top of traffic separation arrow.
1012–The right hand corner of precautionary area symbol.
1024–Left side of the tidal rip symbol off Turn Pt.
1036–The centre of the precautionary area symbol north of Stuart Island.

CONFIRMATION OF TEACHING POINT 4

The students' participation in locating a position on a chart using a RADAR range fix will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The students' participation in locating a position on a chart using RADAR will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK / READING / PRACTICE

Nil.

METHOD OF EVALUATION

This EO is assessed IAW Chapter 3, Annex D.

CLOSING STATEMENT

It is important for you to know how to locate a position on a chart using RADAR as you may not be able to determine the ship's position by visual or other electronic means.

INSTRUCTOR NOTES / REMARKS

This EO should be taught on board a sea student training vessel (SCTV) alongside. This will allow the students to learn the operation of the specific RADARs that they will use during EO S455.05 (Act as a Member of an SCTV).

REFERENCES

C-57-007-002/AF-001 Royal Navy. (1987). *Admiralty manual of navigation* (Vol. 1) (Rev. 1987). London, England: Her Majesty's Stationery Office.

ISBN 0-7153-0297-3 Davidson, P. (1995). *Glénans guides: Coastal navigation*. Newton Abbot, Devon: David & Charles.

Furuno USA, Inc. (2008). *Operator's guide to marine RADAR*. Camas, WA: Furuno USA, Inc.

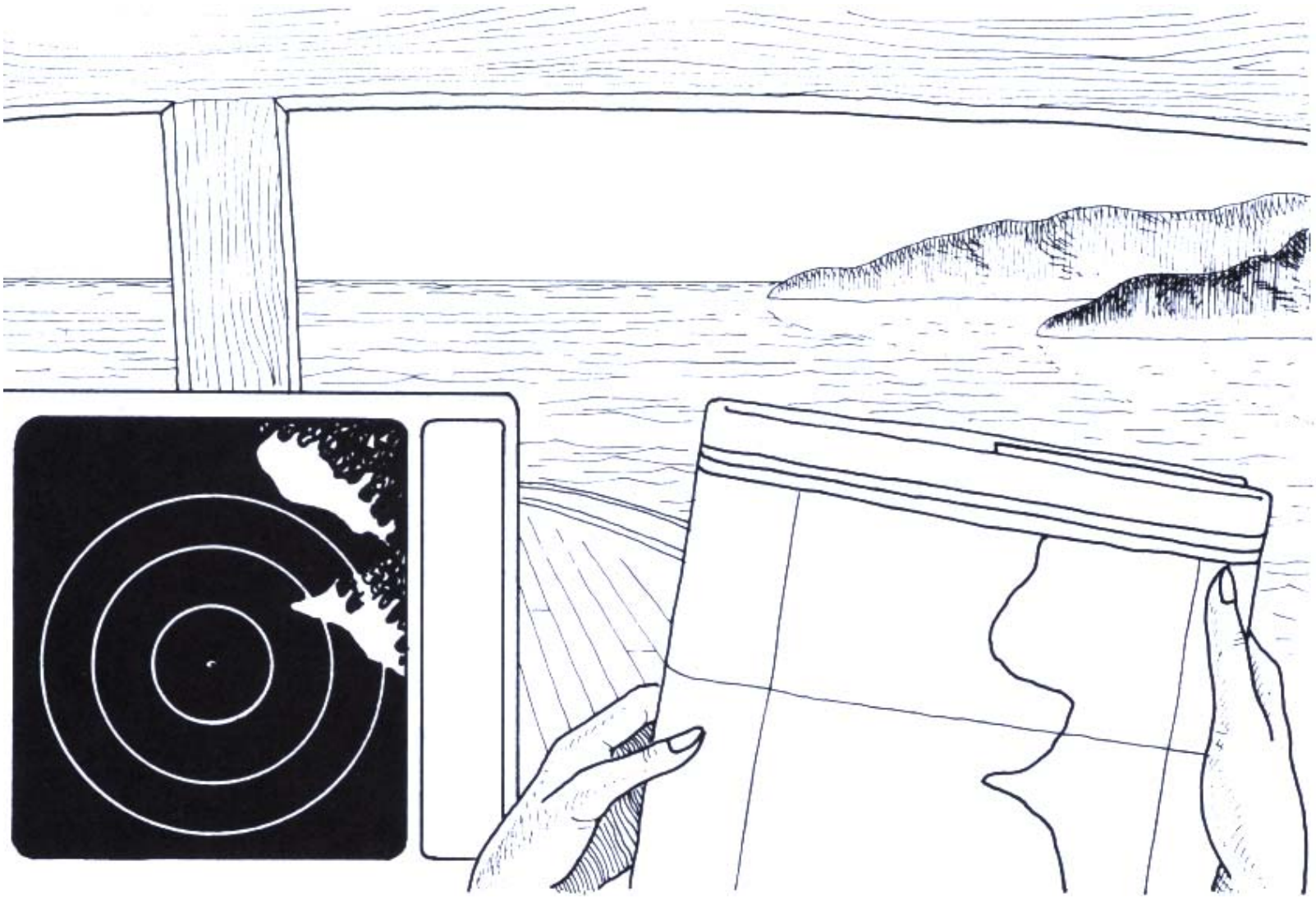


Figure A-1 RADAR Picture

Note. From *Boat Navigation for the Rest of Us* (p. 111), by B. Brogdon, 2001, Camden, ME: International Marine. Copyright 2001 by International Marine.

CANADIAN CADET ORGANIZATIONS

NAVIGATION MANUAL

INSTRUCTIONAL GUIDE

SECTION 7

EO X51.07 – PLAN A PASSAGE

Total Time:	240 min

PREPARATION

PRE-LESSON INSTRUCTIONS

This IG supports EO X51.07 (Plan a Passage).

Photocopy the handouts located at Annex A–E for each student.

PRE-LESSON ASSIGNMENT

Nil.

APPROACH

An interactive lecture was chosen for TPs 1 and 6 to introduce the students to the chart symbols and planning checklist used in the passage planning process.

A demonstration and performance was chosen for TPs 2–5 as it allows the instructor to explain and demonstrate how to label limiting danger lines (LDLs), clearing bearings and wheel over positions on a chart while providing an opportunity for the students to practice these skills under supervision.

A practical activity was chosen for TP 7 as it allows the students to practice planning a passage in a safe and controlled environment.

INTRODUCTION

REVIEW

Nil.

OBJECTIVES

By the end of this lesson the student shall have planned a passage.

IMPORTANCE

It is important for students to plan a passage as it teaches the students the fundamental chartwork symbology and terminology used by a navigator on a Sea Cadet Training Vessel (SCTV). Complete comprehension of the planning process allows the navigator to recognize potential dangers and avoid them.

Teaching Point 1	**Explain the symbols used to label a passage.**
Time: 15 min	Method: Interactive Lecture

SYMBOLS USED TO LABEL A PASSAGE

Chartwork must be clearly intelligible to all personnel. Standard chartwork symbology should be used for all forms of chartwork including the planning and execution phases of the passage. At all times, the navigator must strive to ensure:

- All information which affects the safety of the ship is displayed.
- The most accurate position of the ship is displayed at all times.
- Chartwork is neat and accurate.

Planned Track

Tracks are labelled with a three-digit number. This number is placed on the north side of and parallel to the track. It should be clearly visible when a quick inspection of the chart is made. There is no requirement for a symbol to denote that the course is in degrees. An open arrowhead on the track should be used to indicate the direction of travel. Unless specified otherwise, courses indicated on the chart are always true courses. When this is not the case or when confusion may occur, the following symbology is used:

- True (T),
- Magnetic (M), and
- Compass (C).

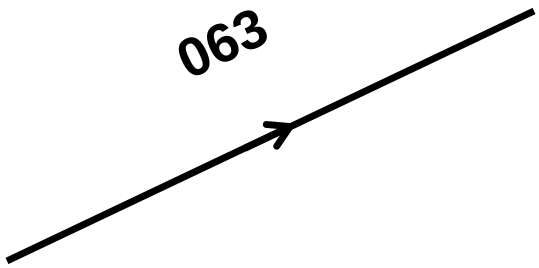


Figure 1 Planned Track

Planned Speed

The planned speed shall be recorded in a square box plotted on the south side of the track and oriented in a north–south direction.

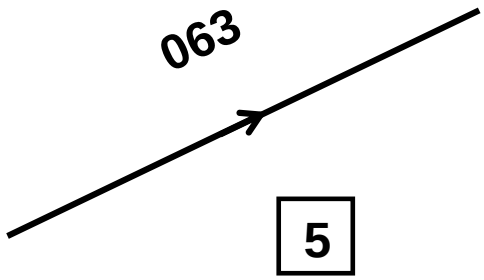


Figure 2 Planned Speed

	The planned track and speed labels should be sufficiently far away from the track to permit the necessary chartwork.

Leadmark / Sternmark (LM / SM)

An LM is labelled with an arrow pointing away from the object, toward and in line with the intended track. An SM is labelled in the same way except it points in the direction the vessel is heading.

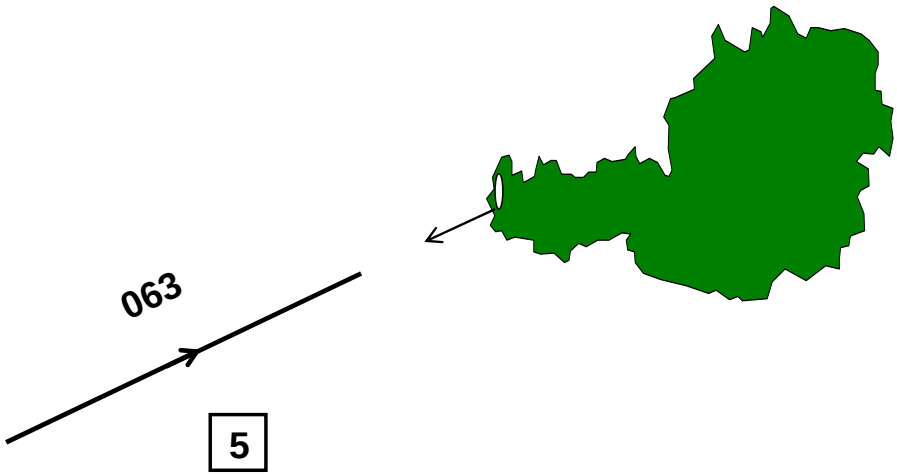


Figure 3 Leadmark

Chart Change

A chart change is indicated by using two parallel lines and the number of the new chart. The parallel lines should reflect the adjoining border of the next chart and as such they are oriented north–south or east–west. The distance to a course alteration not appearing on the chart in use, but expected soon after the chart change, should be noted. This allows for calculations of estimated times to the alteration.

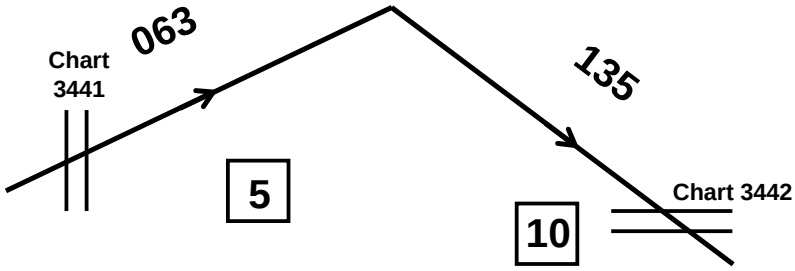


Figure 4 Chart Change

Point of No Return (PNR)

There is usually a position in any passage plan beyond which the ship becomes committed to the plan and can no longer break off from it and take alternative action. The navigator should identify these sections and note whether the ship or its personnel need to be in a required state of readiness. For example, a narrow section of a channel may require that the gyro error be no more than two degrees or an entrance into a harbour may require that the anchor be ready for letting go and the cable party be closed up. If the required states of equipment or personnel are not met before the point of no return, then the navigator must bring it to the attention of the OIC who then decides to proceed or delay the transit. The start of these sections are labelled on the

chart by a solid line drawn perpendicular to the track and labelled with PNR or with text identifying what needs to happen.

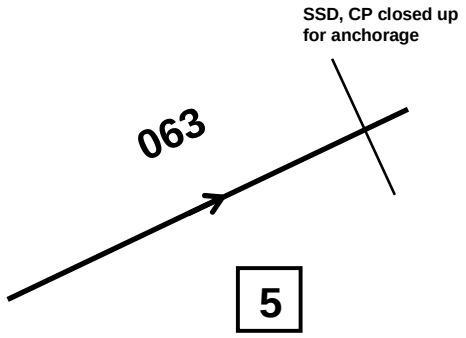


Figure 5 Point of No Return

Distance To Go (DTG)

Whether a ship is proceeding into harbour after an exercise or rendezvousing with another vessel, it is critical to be on time. To assist in arriving on time, the navigator must place DTG bubbles at regular intervals working from the arrival point backwards. The prescribed intervals vary depending on the type and length of the passage but the interval should be reduced as the track gets closer to the arrival point. In any case, the DTGs should allow anyone to quickly ascertain if the ship is ahead or astern of schedule and subsequently change the speed rung on accordingly. The DTGs are neatly drawn on the south side of the track with the information in a north–south orientation.

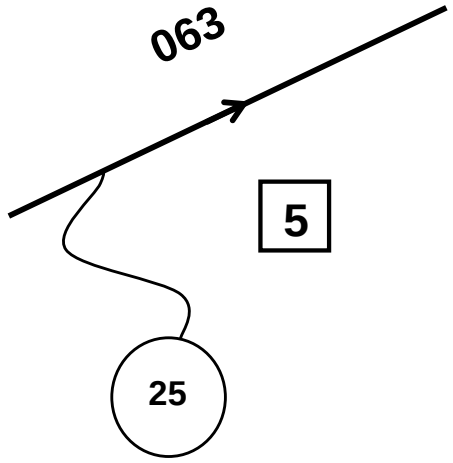


Figure 6 Distance To Go

Calling-In Point (CIP)

To maintain control over vessels in high-traffic areas, points on a route are designated as CIPs. Vessels call in to the Vessel Traffic Management System (VTMS) and give updates to their status and timings for when they will reach the next CIP. The symbol for a CIP is a circle with hat-shaped arrows protruding from it. The arrows indicate that vessels travelling in a specific cardinal direction are to use the CIP. The name of the CIP as well as the distance and the name of the next CIP should be indicated beside the symbol.

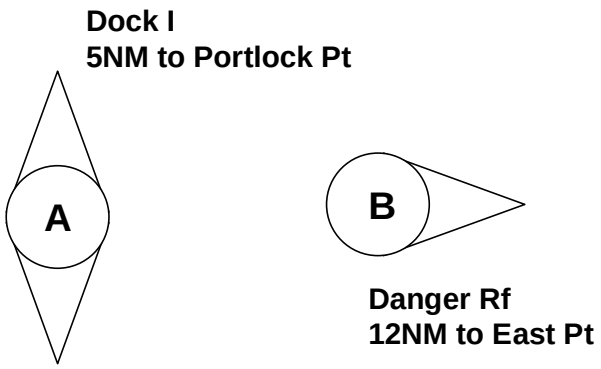


Figure 7 Calling-In Points

Gyro Check

The navigator should conduct frequent gyro checks to confirm the accuracy of the gyrocompass. The gyro checks can be predetermined by using transits that occur on the vessel's planned track. Label with an arrow through the track and pointing to the transit being used. Draw two lines on either side of the track, perpendicular to the arrow. The gyro check may also be labelled with the bearing as a reminder.

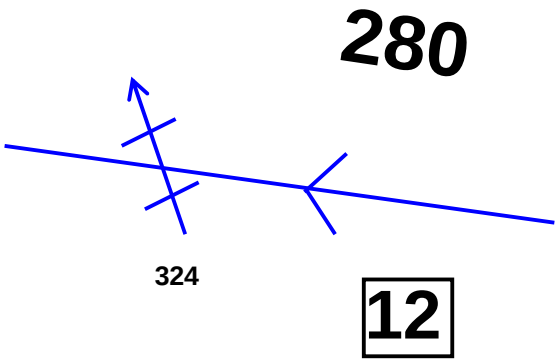


Figure 8 Gyro Check

Estimated Position (EP)

Dead reckoning (DR) was previously taught in EO X51.04 (Locate a Position on a Chart).

An EP is the continuous plotting of a course and position based on the vessel travelling at a constant speed over a set time period. A DR assumes the vessel's actual speed was the same as that ordered by the engine telegraphs. If the navigator can plot two good fixes on the same track, the actual speed made good (SMG) of the vessel can be calculated. This allows for a more precise estimate as to where the vessel will be in the future. The symbol to denote an EP is a dot surrounded by a triangle drawn oriented along the course.

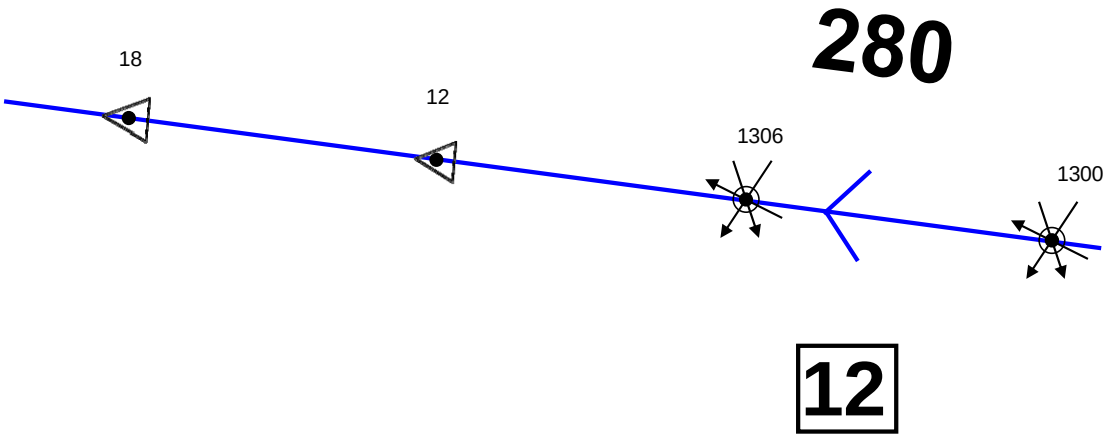


Figure 9 Estimated Position

Course Made Good / Course To Steer (CMG / CTS).

The vessel's direction is affected by wind and current which is sometimes difficult to predict. After taking two good fixes, the vessel's actual course or CMG can be found. The CMG shall be labelled using a three-digit number and two open arrowheads on the track. The CTS is indicated in brackets when it differs from the CMG.

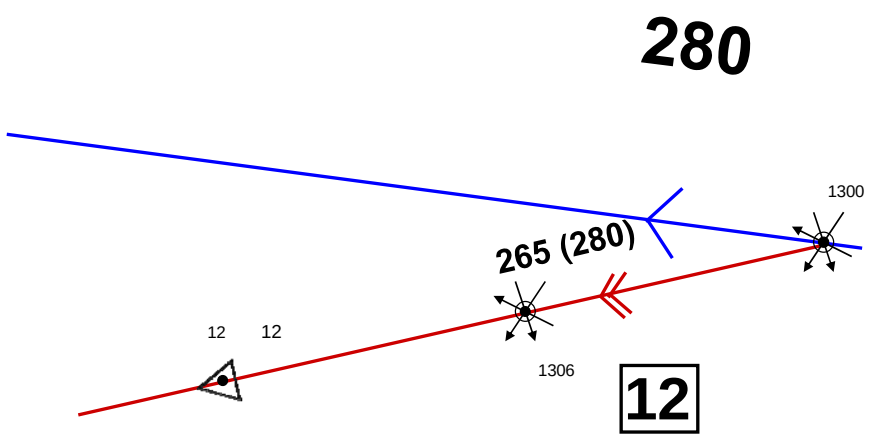


Figure 10 Estimated Position

CONFIRMATION OF TEACHING POINT 1

QUESTIONS:

Q1. At all times, what must a navigator strive to ensure?

Q2. How can a gyro check be predetermined?

Q3. What symbol denotes an EP?

ANTICIPATED ANSWERS:

A1. A navigator must strive to ensure:

- All information which affects the safety of the ship is displayed.
- The most accurate position of the ship is displayed at all times.
- Chartwork is neat and accurate.

A2. By using transits that occur on the vessel's planned track.

A3. A dot surrounded by a triangle drawn in a north–south orientation.

Teaching Point 2	**Explain, demonstrate and have the students label a limiting LDL.**
Time: 10 min	Method: Demonstration and Performance

Have the students sit in pairs at tables with *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel* in front of them.

Demonstrate how to calculate an LDL for the following information:

- Ship's draught is 2.1 m,
- Height of tide is for Fulford Harbour on 23 Jul 2009, and
- Safety margin is 2.0 m.

Distribute the Fulford Harbour Tide Tables located at Annex A to each student.

LDL

The LDL is a line drawn on the chart joining soundings of a selected depth to delineate the area considered unsafe for the ship to enter. The selected depth must provide sufficient water for the ship to remain afloat. The following equation is taken into account when determining the safe depth:

LDL = (Ship's Draught + Safety Margin*) - Height of Tide

* A safety margin of two metres is used in most instances. Operational reasons may preclude this. Command approval is to be sought if a safety of less than two metres is used.

Once the LDL is calculated, it should be drawn on the chart using a pencil. The line must be readily apparent to anyone making a quick inspection of the chart. Hash marks may be used to accent the line (as illustrated in Figure 11). Care must be taken not to obscure any important charted information. The scale of the chart may preclude the use of hash marks without obscuring important coastal features and in these instances particular care shall be taken. The navigator may give consideration to boxing in areas. For instance, even though safe depths may be found between two or more isolated rocks, the width of the passage may make it prudent to encircle the entire area with one limiting danger line.

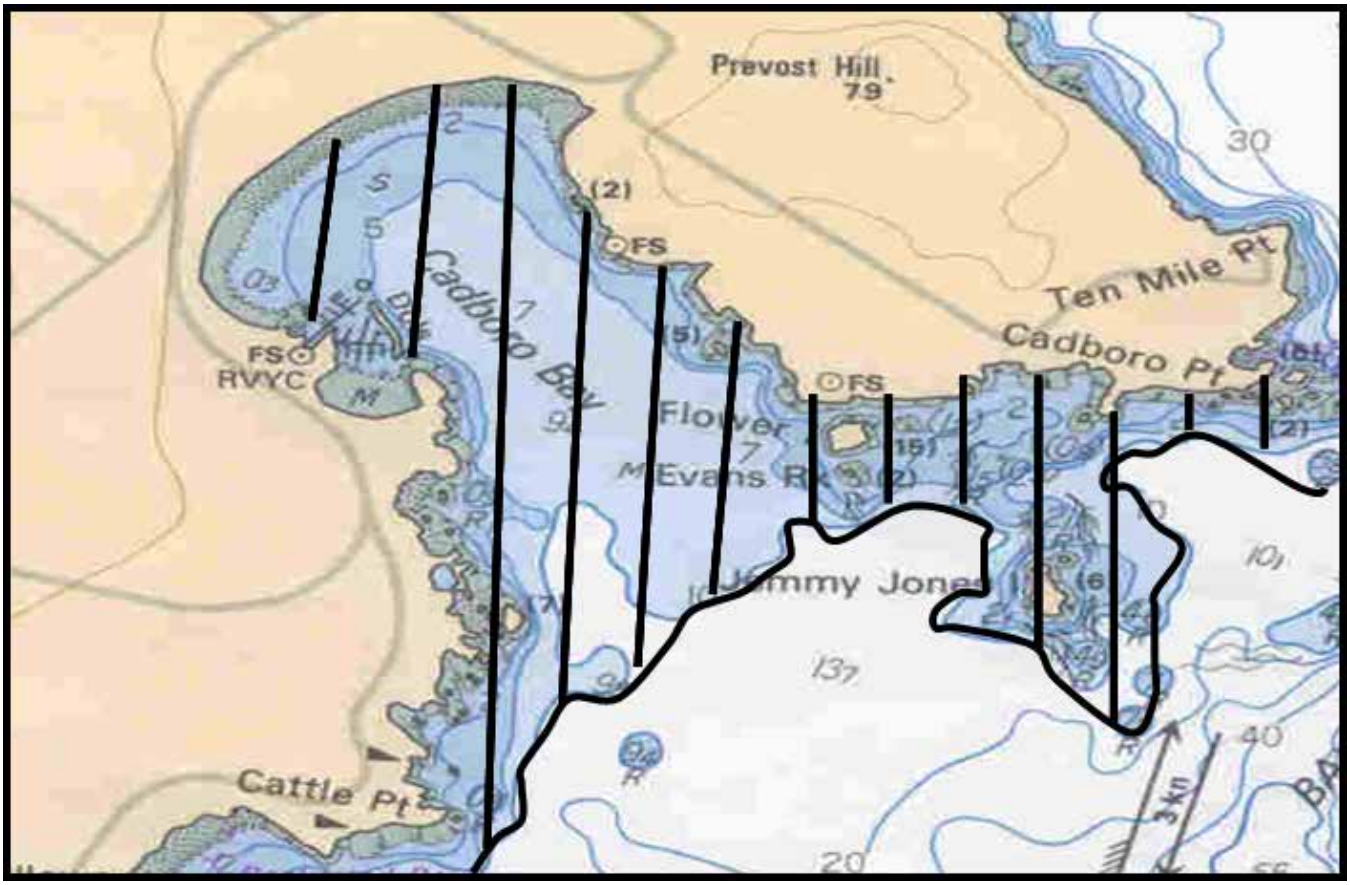


Figure 11 Limiting Danger Line

Have the students label the LDL on *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel* between James Island and Dock Island.

Depending on the scale of chart in use, it may become difficult to label the LDL using the calculated value. In those instances, it is an acceptable practice to label the LDL on a bottom contour line that is of greater value, such as labelling a 4.1 m LDL on the 5.0m contour line.

CONFIRMATION OF TEACHING POINT 2

The students' participation in labelling an LDL will serve as the confirmation of this TP.

Teaching Point 3	**Explain, demonstrate and have the students label a clearing bearing.**
Time: 25 min	Method: Demonstration and Performance

Have the students sit in pairs at tables with *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel* in front of them.

Explain and demonstrate how to label a clearing bearing.

CLEARING BEARING

Clearing bearings should be drawn on the chart clear of the LDL. These clearing bearings define the area of water in which it is safe to navigate (as illustrated in Figure 12). A clearing bearing should be drawn sufficiently clear of the danger so that the ship is still safe even if the bridge is on the bearing line but turning away from danger. Allow for the bridge being on the line with the stem or stern on the dangerous side of it, whichever is the greater distance.

Clearing bearings are denoted by a closed arrowhead in the direction of the object it is based upon. They are clearly labelled as being NMT (no more than) or NLT (no less than) the bearing used. If possible, clearing bearings should be labelled on the side opposite to that of the track. This allows more room for chartwork during the passage.

When there are multiple clearing bearings in close proximity, each should be labelled with the name of the object they are based on.

Clearing bearings should completely box in the safe navigable water while ensuring that the plan remains simple and manageable. There are three considerations:

- Avoid restricting the ship unnecessarily.
- Avoid using too many clearing bearings which make the plan complicated.
- Any object chosen should be close enough to be sensitive to bearing change.

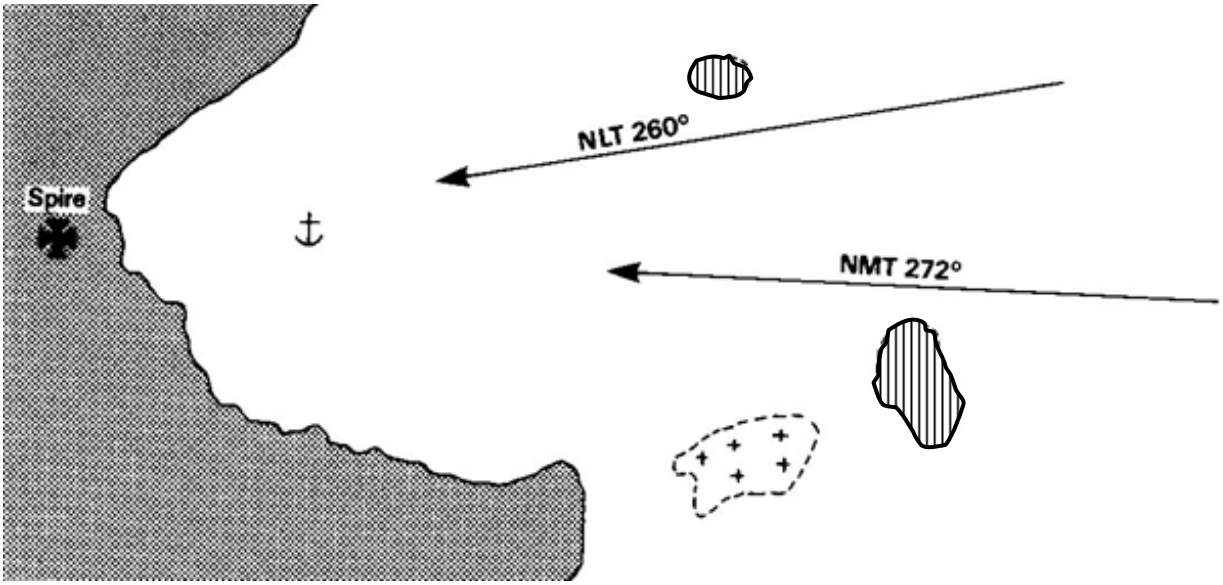


Figure 12 Clearing Bearing

	No hard and fast rule for the distance of the clearing bearing from the LDL can be laid down. It depends on the width of safe navigable water, the angle between the intended track and the LDL, the weather and tidal stream and the safety margin already allowed for in the LDL. For the purposes of this lesson, the clearing bearings will be 200 yards from the LDL.

	Have the students label clearing bearings on the areas they previously labelled LDLs on.

CONFIRMATION OF TEACHING POINT 3

The students' participation in labelling a clearing bearing will serve as the conformation of this TP.

Teaching Point 4 **Explain, demonstrate and have the students label a clearing depth.**

Time: 5 min Method: Demonstration and Performance

Clearing depths may be used in the same manner as a clearing bearing. The following factors shall be taken into account when determining clearing depths:

- The bottom is suitable and provides a clear indication of when approaching and when at the limits of safe water.
- The chosen depth contour should be corrected for the height of tide and draught of the transducer to determine the depth indicated by the echo sounder.

- The error of the echo sounder has been checked and accounted for.

A solid line approximating the contour of the chosen depth with closed arrowheads at either end shall be used to indicate the clearing depth (as illustrated in Figure 13). The echo sounder depth expected on this contour line is to be recorded as NLT (no less than).

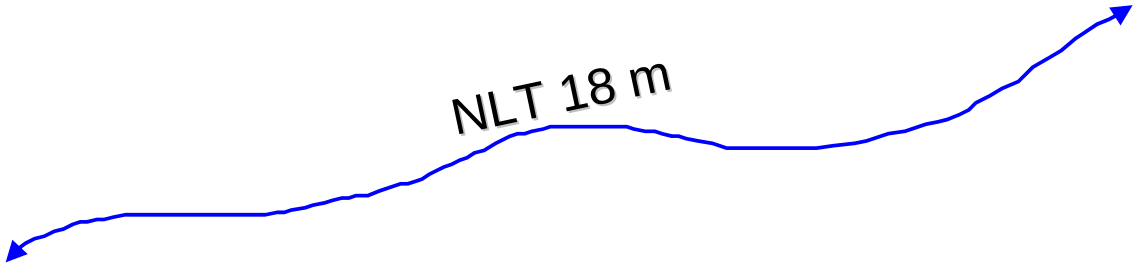


Figure 13 Clearing Depth

Have the students label clearing depths on the areas they previously labelled LDLs on.

CONFIRMATION OF TEACHING POINT 4

The students' participation in labelling a clearing depth will serve as the conformation of this TP.

Teaching Point 5	**Explain, demonstrate and have the students label a wheel over position.**
Time: 20 min	Method: Demonstration and Performance

To better understand the principles outlined, it is important to know the following terms:

Advance. The advance of a ship for a given alteration of course is the distance that her compass platform moves in the direction of her original line of advance, measured from the point where the rudder is put over.

Transfer. The transfer of a ship for a given alteration of course is the distance that her compass platform moves at right angles to her original line of advance, measured from the point where the rudder is put over.

Distance to new course (DNC). The distance to new course is the distance measured along the original line of advance from the position of the compass platform when the rudder was put over to the point of intersection between the old course and the new course.

Distribute the Advance and Transfer handout located at Annex B and the Vessel Turning Data handout located Annex C to each student.

Have the students sit in pairs at tables with *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel* in front of them.

Have the students draw and label a track on the chart using the following three points:

Point AA	48° 41.80' N 123° 21.50' W
Point BB	48° 43.40' N 123° 25.10' W
Point CC	48° 42.55' N 123° 29.00' W

Explain and demonstrate how to label a wheel over position while the students follow along on their charts. Use a speed of 10 knots (kts) and 15 degrees of helm for the demonstration.

WHEEL OVER POSITION

A ship does not instantaneously alter from one track to the next and as a result the navigator must plan where the vessel should turn to intercept the next planned course. The point at which helm is applied is called the wheel over position and is indicated with an open arrowhead pointing in the direction of the wheel over mark.

Follow these steps to locate the wheel over position (as illustrated in Figure 14):

The Vessel Turning Data handout located at Annex C is an example of a chart that would be available for an SCTV. Each box in the handout lists the turning data for a specific speed and amount of helm applied for a turn.

To extract the correct data:

1. calculate the angular difference between the old and new track of the wheel over;
2. find the closest column in the box; and
3. extract the advance, transfer and DNC.

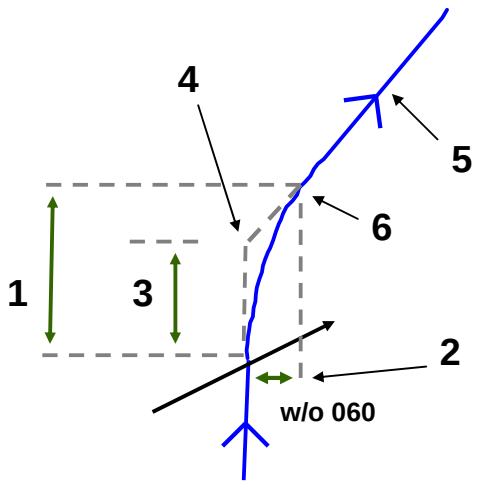
Explain how to extract the required information from the Vessel Turning Data handout to the students.

If DNC is known:

- Measure back from the intersection of the tracks the distance indicated as the DNC and draw the wheel over position.

If DNC is not known:

1. Draw a line parallel to the old track at a distance indicated as the transfer value on the side toward the new track.
2. Draw the transfer mark where the parallel line intersects the new track.
3. Draw a line perpendicular to the old track through the transfer mark.
4. Measure back down the old track from this line and draw the wheel over position.



Legend

1. Advance.
2. Transfer.
3. DNC.
4. Intersection of tracks.
5. Actual vessel track.
6. Transfer mark.

Figure 14 Advance and Transfer

After determining the wheel over position, it is necessary to draw the five, three and one cable marks to the wheel over position (as illustrated in Figure 15). These marks serve as reminders of the upcoming course alteration. Once all marks have been located on the track, erase the track from the wheel over position to the transfer mark and draw in the curved track the vessel will follow.

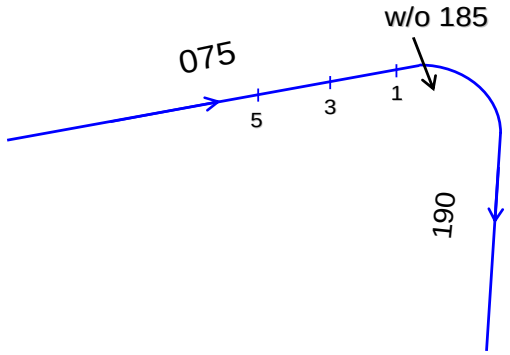


Figure 15 Wheel Over Position

A paper template can be made for the five cable countdown at various chart scales to speed up the labelling process.

The wheel over bearing must be determined next. The following points are to be considered in selecting wheel-over bearings:

1. The wheel over bearing should be parallel to the new course so that the ship turns onto the new track, whether she is on the previous intended track or not. If the wheel over bearing is not parallel to the new course, an error results if the ship is not on the previous intended track.

2. When choosing wheel over marks, use the following in order of best to least desirable:

   a. ahead and inside the turn resulting in a wheel over bearing parallel to the next track;
   b. next LM or SM resulting in a wheel over bearing almost parallel to the next track;
   c. beam bearing; and
   d. ahead and outside the turn.

Caution must be used when using a beam bearing. The bearing to the mark changes rapidly increasing the chance of missing the wheel over.

Wheel over bearings ahead and outside the turn should to be avoided.

3. Consideration must also be given to the distance of the mark being chosen to wheel over off of. Points that are too far away result in little or no bearing change between the five cable mark and the wheel over position, making them a poor indicator of where the ship is in relation to the wheel over.

4. Finally, navigators must plan both a primary and secondary wheel over mark. The secondary point must always be closer than the primary as it is the backup in case the primary cannot be seen or found.

Have the students draw and label a wheel over position on the chart using the following information:

Point AA	48° 37.60' N 123° 30.30' W
Point BB	48° 35.30' N 123° 30.30' W
Point CC	48° 34.70' N 123° 28.70' W
Vessel Data	15° helm 10 kts

With any time remaining, check the students' work and correct any errors.

CONFIRMATION OF TEACHING POINT 5

The students' participation in labelling a wheel over position will serve as the confirmation of this TP.

Teaching Point 6 **Identify and explain the passage planning checklist.**

Time: 5 min Method: Interactive Lecture

Distribute the Passage Planning Checklist located at Annex D to each student.

Explain each step while having the students follow along on their checklist.

PASSAGE PLANNING CHECKLIST

According to Transport Canada, over three quarters of all groundings are attributable to human error. A sound passage plan may not prevent grounding but it does reduce the chances of making mistakes. Passage planning is a methodical process. To ensure that all factors are considered in a passage plan, a checklist was developed. Each step should be considered and actioned before a passage is executed.

Details

This section is used to remind the planner about key information that they need to complete the checklist.

Check Weather Forecast

This information may alter sailing plans as storm advisories, heavy seas, or poor visibility may affect the ship's ability to proceed to the destination.

Select Charts

The largest scale chart for the area should be used as the details are best represented there. Exceptions may be made for occasions when the vessel would only be on that chart for a very short distance and the lack of fixing points or the necessity of a chart change may hinder navigation. Check to make sure the chart is up to date by comparing the printing date to the corrections listed in the lower left-hand corner of the chart.

Study the Charts

With the aid of the Sailing Directions and the List of Lights and Fog Signals, gather information about preferred routes, local phenomena, landmarks, and regulations.

Create Tidal Information

Create tidal graphs for both heights of tide and tidal streams in the areas to be navigated.

Check Timings and Speed Requirements

Before selecting a route, consider the preferred speed to transit at and the time available. This gives an idea of the overall travel distance.

Calculate and draw the LDL

Select the contour line higher than the LDL and plot it in bold. Be wary of safety while doing this—yet do not cut off too much safely navigable water.

Select the Rough Route

Select the route based on information gathered from above. Also consider the following:

1. **Operational requirements** - is there a requirement to transit by a certain route for training or RV reasons.

2. **Shortest route** - saving time and fuel is often a priority.

3. **Depth and proximity of dangers** - ensure that there is sufficient sea room and depth to manoeuvre safely.

4. **Starboard side of the channel** - IAW *Collision Regulations*, stay to the starboard side of the channel when planning the passage. However, ensure that there is sufficient room to starboard to manoeuvre safely if required to do so.

5. **Expected traffic** - heavy traffic can affect navigation.

Plot Clearing Bearings

Clearing bearings should be taken off of prominent and readily identifiable points such that when the ship is approaching a danger, the clearing bearing can be used to quickly identify this. Where possible, use the LM as the clearing bearing as long as this does not cut off too much water that is safely navigable. If clearing bearings are reduced for any reason, brief the OIC so they are aware of the change.

Lay Down the Tracks

Lay down tracks that make sense in light of the previously obtained information. Always try to choose a track that would make sense to an outside observer. Would another vessel be able to determine where the vessel is heading just by observing the track chosen? If so, the number of surprises encountered are reduced.

Pick tracks that favour the starboard side of the channel, yet still leave room to manoeuvre to starboard if required. LMs are very useful for quick determinations of the ship's location in relation to the track. Pick points to be used as LMs that are prominent such as the steep edge of a fairly close island or a light or day mark. Avoid using low sloping edges of land or points that would be obscured by background land or clutter.

Seek Track Approval

Once the above steps have been completed, take the charts to the vessel officer in charge (OIC) or their designate and have them approved. If there are any errors up to this point, they may be corrected before work continues much farther.

Calculate Wheel Over Information

Draw the wheel over position for each alteration using the appropriate turning data. Once this is done, place the five cable countdown marks on each alteration.

Place Planned Transits and Gyro Checks on the Chart

Draw planned transits and gyro checks on the chart.

Place DTG Bubbles on the Chart

Work back from the destination placing at least one DTG bubble on each track. Confirm the speed of advance (SOA) of the passage now that an accurate distance has been determined.

Place CIPs on the Chart

Using the Vessel Traffic Management System (VTMS) guide, place CIP symbols on the chart in the appropriate locations noting the radio channel that has to be called, the name of the CIP, and the distance to the next CIP.

CONFIRMATION OF TEACHING POINT 6

QUESTIONS:

Q1. What must be considered before selecting a route?

Q2. What must happen if clearing bearings are reduced?

Q3. Where should DTG bubbles be placed?

ANTICIPATED ANSWERS:

A1. The following must be considered:

1. operational requirements,
2. shortest route,
3. depth and proximity of dangers,
4. starboard side of the channel, and
5. expected traffic.

A2. The vessel OIC must be informed.

A3. At least one on every track unless the track is too short.

Teaching Point 7	**Conduct an activity where the students will plan a passage.**
Time: 150 min	Method: Practical Activity

ACTIVITY

If desired, an alternative chart, such as one of the local area, may be used. If so, modify the lesson to include the information in the given examples to reflect that chart.

Distribute the Passage Planning Activity handout located at Annex E to each student.

1. Divide the students into pairs.
2. Have the students plan a passage using the instructions on the Passage Planning Activity handout located at Annex E.
3. Monitor the students' progress, correcting any errors.

COMMON ERRORS

It is common for new navigators to make the following errors when learning to plan a passage:

- selecting an incorrect scale of chart for the passage;
- missing key information displayed on the chart that influences the plan;
- layout of the tracks, to include:
  - track too far to starboard of the channel, and
  - track chasing LM / SM;
- incorrect use of clearing bearings, to include:
  - cutting-off too much navigable water; and
  - not labelled; and
- not plotting gyro checks.

CONFIRMATION OF TEACHING POINT 7

The students' participation in the activity will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The students' participation in planning a passage will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK / READING / PRACTICE

Nil.

METHOD OF EVALUATION

This EO is assessed IAW Chapter 3, Annex D.

CLOSING STATEMENT

It is important for you to plan a passage as it teaches you the fundamental chartwork symbology and terminology used by a navigator on a Sea Cadet Training Vessel (SCTV). A sound understanding of the planning process allows the navigator to recognize potential dangers and avoid them.

INSTRUCTOR NOTES / REMARKS

Nil.

REFERENCES

Naval Officer Training Centre Venture. (2009). *Checklist for passage planning*. Esquimalt, BC: Department of National Defence.

C-57-007-002/AF-001 Royal Navy. (1987). *Admiralty manual of navigation* (Vol. 1) (Rev. 1987). London, England: Her Majesty's Stationery Office.

NOTC Venture. (2012). *CFCD 131 bridge watchkeeping manual for the royal Canadian navy. (2015)*. Victoria, BC: NOTC Venture.

FULFORD HARBOUR PST Z+8 **2009** **TIDE TABLES**

July - julliet

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0646	3.0	0.9	16	0540	3.3	1.0
	1500	8.9	2.7		1420	8.2	2.5
WE	1740	8.5	2.6	TH	1544	8.2	2.5
ME	2319	10.2	3.1	JE	2214	10.5	3.2
2	0729	2.3	0.7	17	0627	2.3	0.7
	1607	9.5	2.9		1544	9.2	2.8
TH	1920	9.2	2.8	FR	1711	9.2	2.8
JE	2347	10.2	3.1	VE	2245	10.5	3.2
3	0809	2.0	0.6	18	0717	1.6	0.5
	1655	10.2	3.1		1627	10.2	3.1
FR	2059	9.5	2.9	SA	1848	9.8	3.0
VE				SA	2330	10.8	3.3
4	0021	9.8	3.0	19	0807	0.7	0.2
	0848	1.6	0.5		1705	10.5	3.2
SA	1735	10.5	3.2	SU	2014	10.2	3.1
SA	2212	9.5	2.9	DI			
5	0103	9.8	3.0	20	0030	10.8	3.3
	0926	1.6	0.5		0857	0.3	0.1
SU	1812	10.8	3.3	MO	1739	10.8	3.3
DI	2259	9.5	2.9	LU	2124	9.8	3.0
6	0149	9.8	3.0	21	0135	10.8	3.3
	1003	1.3	0.4		0946	0.0	0.0
MO	1845	10.8	3.3	TU	1811	10.8	3.3
LU	2337	9.5	2.9	MA	2225	9.5	2.9
7	0233	9.8	3.0	22	0241	10.8	3.3
	1039	1.3	0.4		1033	0.0	0.0
TU	1913	10.8	3.3	WE	1841	11.2	3.4
MA				ME	2324	8.9	2.7
8	0012	9.2	2.8	23	0348	10.5	3.2
	0316	9.5	2.9		1118	0.7	0.2
WE	1113	1.6	0.5	TH	1909	11.2	3.4
ME	1937	10.8	3.3	JE			
9	0049	8.9	2.7	24	0025	7.9	2.4
	0359	9.5	2.9		0458	9.8	3.0
TH	1146	2.0	0.6	FR	1201	1.6	0.5
JE	1958	10.5	3.2	VE	1936	11.2	3.4
10	0129	8.5	2.6	25	0126	6.9	2.1
	0445	8.9	2.7		0614	8.9	2.7
FR	1218	2.3	0.7	SA	1243	3.0	0.9
VE	2017	10.5	3.2	SA	2003	11.2	3.4
11	0210	7.9	2.4	26	0225	5.6	1.7
	0537	8.5	2.6		0740	8.2	2.5
SA	1249	3.0	0.9	SU	1324	4.3	1.3
SA	2035	10.5	3.2	DI	2029	11.2	3.4
12	0252	7.2	2.2	27	0321	4.6	1.4
	0639	7.9	2.4		0919	7.9	2.4
SU	1320	3.9	1.2	MO	1407	5.9	1.8
DI	2054	10.5	3.2	LU	2055	10.8	3.3
13	0333	6.2	1.9	28	0415	3.9	1.2
	0759	7.5	2.3		1115	8.2	2.5
MO	1351	4.9	1.5	TU	1454	7.2	2.2
LU	2112	10.5	3.2	MA	2121	10.5	3.2
14	0414	5.2	1.6	29	0507	3.3	1.0
	0943	7.2	2.2		1321	8.5	2.6
TU	1423	5.9	1.8	WE	1556	8.5	2.6
MA	2131	10.5	3.2	ME	2146	10.2	3.1
15	0456	4.3	1.3	30	0559	3.0	0.9
	1151	7.5	2.3		1454	9.5	2.9
WE	1458	7.2	2.2	TH	1736	9.2	2.8
ME	2151	10.5	3.2	JE	2215	9.8	3.0
				31	0651	2.6	0.8
					1551	9.8	3.0
				FR	1952	9.5	2.9
				VE	2254	9.8	3.0

August-août

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0740	2.3	0.7	16	0651	1.6	0.5
	1635	10.2	3.1		1552	10.2	3.1
SA	2117	9.5	2.9	SU	1919	9.8	3.0
SA	2347	9.5	2.9	DI	2313	10.5	3.2
2	0826	2.3	0.7	17	0748	1.3	0.4
	1711	10.5	3.2		1625	10.5	3.2
SU	2201	9.2	2.8	MO	2035	9.5	2.9
DI				LU			
3	0047	9.5	2.9	18	0032	10.5	3.2
	0907	2.0	0.6		0842	1.0	0.3
MO	1741	10.5	3.2	TU	1655	10.5	3.2
LU	2231	9.2	2.8	MA	2128	8.9	2.7
4	0143	9.5	2.9	19	0148	10.5	3.2
	0945	2.0	0.6		0930	1.0	0.3
TU	1806	10.5	3.2	WE	1721	10.8	3.3
MA	2259	8.9	2.7	ME	2217	8.2	2.5
5	0234	9.5	2.9	20	0302	10.2	3.1
	1019	2.0	0.6		1014	1.6	0.5
WE	1826	10.2	3.1	TH	1746	10.8	3.3
ME	2327	8.5	2.6	JE	2306	7.2	2.2
6	0323	9.5	2.9	21	0416	9.8	3.0
	1052	2.3	0.7		1057	2.3	0.7
TH	1842	10.2	3.1	FR	1810	10.8	3.3
JE	2356	7.9	2.4	VE	2355	5.9	1.8
7	0413	9.2	2.8	22	0530	9.5	2.9
	1123	2.6	0.8		1138	3.6	1.1
FR	1857	10.2	3.1	SA	1834	10.8	3.3
VE				SA			
8	0028	7.5	2.3	23	0045	4.9	1.5
	0506	8.9	2.7		0645	9.2	2.8
SA	1153	3.3	1.0	SU	1219	4.9	1.5
SA	1912	10.2	3.1	DI	1858	10.8	3.3
9	0103	6.6	2.0	24	0135	3.9	1.2
	0603	8.5	2.6		0804	8.9	2.7
SU	1222	4.3	1.3	MO	1302	6.2	1.9
DI	1927	10.2	3.1	LU	1923	10.8	3.3
10	0141	5.9	1.8	25	0224	3.6	1.1
	0708	8.2	2.5		0932	8.9	2.7
MO	1252	5.2	1.6	TU	1350	7.2	2.2
LU	1944	10.2	3.1	MA	1948	10.5	3.2
11	0222	4.9	1.5	26	0315	3.3	1.0
	0826	8.2	2.5		1111	9.2	2.8
TU	1323	6.2	1.9	WE	1448	8.2	2.5
MA	2001	10.5	3.2	ME	2013	10.2	3.1
12	0306	4.3	1.3	27	0408	3.0	0.9
	1003	8.2	2.5		1251	9.5	2.9
WE	1357	7.2	2.2	TH	1611	9.2	2.8
ME	2020	10.5	3.2	JE	2040	9.8	3.0
13	0356	3.6	1.1	28	0505	3.0	0.9
	1206	8.5	2.6		1409	9.8	3.0
TH	1438	8.2	2.5	FR	1834	9.2	2.8
JE	2042	10.5	3.2	VE	2114	9.5	2.9
14	0450	2.6	0.8	29	0606	3.0	0.9
	1410	9.2	2.8		1504	10.2	3.1
FR	1542	9.2	2.8	SA	2021	9.2	2.8
VE	2112	10.5	3.2	SA	2213	9.2	2.8
15	0550	2.3	0.7	30	0704	3.0	0.9
	1512	9.8	3.0		1545	10.2	3.1
SA	1728	9.8	3.0	SU	2105	8.9	2.7
SA	2201	10.5	3.2	DI	2334	9.2	2.8
				31	0755	3.0	0.9
					1616	10.2	3.1
				MO	2133	8.5	2.6
				LU			

September-septembre

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0050	9.2	2.8	16	0103	9.5	2.9
	0839	3.0	0.9		0820	2.3	0.7
TU	1640	10.2	3.1	WE	1553	10.5	3.2
MA	2156	8.2	2.5	ME	2124	7.2	2.2
2	0156	9.2	2.8	17	0229	9.5	2.9
	0918	3.0	0.9		0908	3.0	0.9
WE	1659	9.8	3.0	TH	1617	10.5	3.2
ME	2219	7.5	2.3	JE	2202	5.9	1.8
3	0254	9.2	2.8	18	0346	9.5	2.9
	0953	3.3	1.0		0952	3.9	1.2
TH	1715	9.8	3.0	FR	1640	10.5	3.2
JE	2243	7.2	2.2	VE	2242	4.9	1.5
4	0349	9.2	2.8	19	0457	9.5	2.9
	1026	3.6	1.1		1035	4.9	1.5
FR	1730	9.8	3.0	SA	1702	10.5	3.2
VE	2308	6.6	2.0	SA	2322	3.9	1.2
5	0443	9.2	2.8	20	0604	9.8	3.0
	1057	4.3	1.3		1118	5.9	1.8
SA	1744	9.8	3.0	SU	1725	10.5	3.2
SA	2337	5.6	1.7	DI			
6	0537	9.2	2.8	21	0004	3.0	0.9
	1128	4.9	1.5		0709	9.8	3.0
SU	1758	9.8	3.0	MO	1205	6.9	2.1
DI				LU	1749	10.5	3.2
7	0009	4.9	1.5	22	0046	2.6	0.8
	0634	9.2	2.8		0817	9.8	3.0
MO	1159	5.9	1.8	TU	1256	7.9	2.4
LU	1814	10.2	3.1	MA	1815	10.2	3.1
8	0045	3.9	1.2	23	0130	2.6	0.8
	0738	9.2	2.8		0929	9.8	3.0
TU	1232	6.9	2.1	WE	1355	8.5	2.6
MA	1830	10.2	3.1	ME	1840	9.8	3.0
9	0127	3.3	1.0	24	0217	2.6	0.8
	0852	9.2	2.8		1045	10.2	3.1
WE	1311	7.9	2.4	TH	1514	8.9	2.7
ME	1850	10.2	3.1	JE	1904	9.5	2.9
10	0214	3.0	0.9	25	0307	3.0	0.9
	1020	9.2	2.8		1159	10.2	3.1
TH	1358	8.5	2.6	FR	1717	9.2	2.8
JE	1912	10.2	3.1	VE	1926	9.2	2.8
11	0308	2.6	0.8	26	0403	3.3	1.0
	1158	9.5	2.9		1302	10.2	3.1
FR	1507	9.2	2.8	SA			
VE	1941	10.2	3.1	SA			
12	0410	2.3	0.7	27	0505	3.6	1.1
	1318	10.2	3.1		1351	10.2	3.1
SA	1655	9.5	2.9	SU	2022	8.2	2.5
SA	2025	9.8	3.0	DI	2139	8.5	2.6
13	0517	2.3	0.7	28	0608	3.9	1.2
	1413	10.2	3.1		1427	10.2	3.1
SU	1904	9.5	2.9	MO	2039	7.9	2.4
DI	2147	9.5	2.9	LU	2337	8.2	2.5
14	0625	2.3	0.7	29	0706	4.3	1.3
	1453	10.5	3.2		1455	10.2	3.1
MO	2005	8.9	2.7	TU	2059	7.2	2.2
LU	2329	9.5	2.9	MA			
15	0727	2.3	0.7	30	0111	8.2	2.5
	1526	10.5	3.2		0756	4.3	1.3
TU	2045	8.2	2.5	WE	1517	9.8	3.0
MA				ME	2119	6.9	2.1

Figure A-1 Fulford Harbour Tide Table

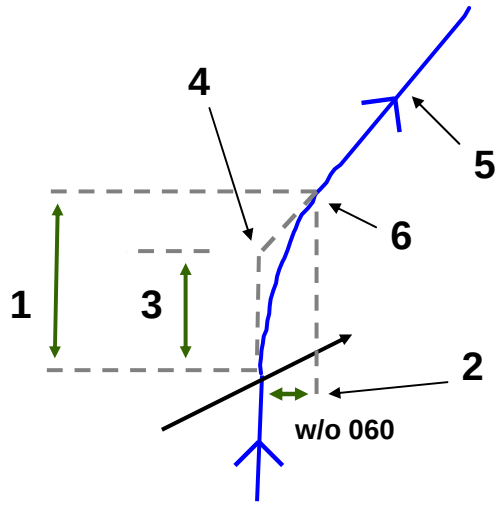
Note. From Fisheries and Oceans Canada, *Tides, Currents and Water Levels*. Retrieved October 15, 2008, from http://www.waterlevels.gc.ca/2009_predictions/vol_5/wlev_ref/00065.pdf

ADVANCE AND TRANSFER

Advance. The advance of a ship for a given alteration of course is the distance that her compass platform moves in the direction of her original line of advance, measured from the point where the rudder is put over.

Transfer. The transfer of a ship for a given alteration of course is the distance that her compass platform moves at right angles to her original line of advance, measured from the point where the rudder is put over.

Distance to new course (DNC). The distance to new course is the distance measured along the original line of advance from the position of the compass platform when the rudder was put over to the point of intersection between the old course and the new course.



Legend

1. Advance.
2. Transfer.
3. DNC.
4. Intersection of tracks.
5. Actual vessel track.
6. Transfer mark.

Figure B-1 Advance and Transfer

Steps for Locating the Wheel Over Position

If DNC is known:

- Measure back from the intersection of the tracks the distance indicated as the DNC and draw the wheel over position.

If DNC is not known:

1. Draw a line parallel to the old track at a distance indicated as the transfer value on the side toward the new track.
2. Draw the transfer mark where the parallel line intersects the new track.
3. Draw a line perpendicular to the old track through the transfer mark.
4. Measure back down the old track from this line and draw the wheel over position.

VESSEL TURNING DATA

HELM 15 DEGREES						SPEED 8 kts		
ALTERATION	15	30	45	60	75	120	150	180
ADVANCE (yds)	72	118	152	197	215	--	--	--
TRANSFER (yds)	--	25	52	92	138	--	--	--
DNC (yds)	--	70	100	140	175	--	--	--

HELM 30 DEGREES						SPEED 8 kts		
ALTERATION	15	30	45	60	75	120	150	180
ADVANCE (yds)	57	85	102	119	132	--	--	--
TRANSFER (yds)	--	15	27	40	53	--	--	--
DNC (yds)	--	52	80	95	115	--	--	--

HELM 15 DEGREES						SPEED 10 kts		
ALTERATION	15	30	45	60	90	120	150	180
ADVANCE (yds)	61	109	153	189	228	219	160	67
TRANSFER (yds)	3	15	41	75	164	266	355	403
DNC (yds)	51	82	113	145	228	372	774	0

HELM 30 DEGREES						SPEED 10 kts		
ALTERATION	15°	30°	45°	60°	90°	120°	150°	180°
ADVANCE (yds)	31	66	85	106	131	126	91	38
TRANSFER (yds)	0	6	18	36	86	143	192	214
DNC (yds)	29	50	67	85	131	167	423	

Figure C-1 Vessel Turning Data

PASSAGE PLANNING CHECKLIST

DETAILS

Passage

Date: _____

From: _____

To: _____

Vessel

Length: _____ **Width:** _____

Draught: _____ **Height:** _____

CHECKLIST

- ☐ **1.** Check weather forecast.
- ☐ **2.** Select charts.
- ☐ **3.** Study the charts.
- ☐ **4.** Create tidal information.
- ☐ **5.** Check timings and speed requirements.
- ☐ **6.** Calculate and draw the Limiting Danger Line.
- ☐ **7.** Select a rough route.
- ☐ **8.** Plot clearing bearings.
- ☐ **9.** Seek route approval.
- ☐ **10.** Lay down the tracks.
- ☐ **11.** Seek track approval.
- ☐ **12.** Calculate wheel over information and plot w/o bearings.
- ☐ **13.** Place planned transits and gyro checks on the chart.
- ☐ **14.** Place distance to go bubbles on the chart.
- ☐ **15.** Place calling-in points on the charts.

PASSAGE PLANNING ACTIVITY

Instructions

1. Plot the following points on *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*.

Point AA	48° 36.00' N 123° 19.00' W
Point ZZ	48° 43.40' N 123° 25.10' W

2. Using the information listed below and the Passage Planning Checklist, plan a passage from Point AA to Point ZZ.

   Vessel Draught: 2.6 m
   Vessel Height: 14.5 m

   Vessel Turning Data:

HELM 15 DEGREES					SPEED 10 kts			
ALTERATION	**15**	**30**	**45**	**60**	**90**	**120**	**150**	**180**
ADVANCE (yds)	61	109	153	189	228	219	160	67
TRANSFER (yds)	3	15	41	75	164	266	355	403
DNC (yds)	51	82	113	145	228	372	774	0

   Clearing bearings to be set at 200 yards.

   Weather forecast: Visibility >12 NM, Winds Calm

   Tides at Fulford Harbour on 21 July 2009:

Time	Feet	Metres
0135	10.8	3.3
0946	0	0
1841	11.2	3.4
2324	8.9	2.7

Points to Remember

- The checklist is there to guide you, use it.
- Calculate all information before laying down any tracks.
- Seek track approval before labelling the details.

CANADIAN CADET ORGANIZATIONS

NAVIGATION MANUAL

INSTRUCTIONAL GUIDE

SECTION 8

EO X51.08 – EXPLAIN ELECTRONIC CHART DISPLAY AND INFORMATION SYSTEMS (ECDIS)

Total Time:	40 min

PREPARATION

PRE-LESSON INSTRUCTIONS

This IG supports EO X51.08 (Explain Electronic Chart Display and Information Systems [ECDIS]).

Photocopy the handouts located at Annexes A and B for each student.

PRE-LESSON ASSIGNMENT

Nil.

APPROACH

An interactive lecture was chosen for this lesson to orient the students to electronic chart standards and ECDIS hardware and software.

INTRODUCTION

REVIEW

Nil.

OBJECTIVES

By the end of this lesson the student shall have explained ECDIS.

IMPORTANCE

It is important for students to explain an ECDIS as they will be exposed to this type of navigation on a Sea Student Training Vessel (SCTV) in the future. As technology matures, the SCTVs will adopt more complex electronic navigation systems that will replace the existing paper-based navigation methods.

Teaching Point 1	**Explain electronic chart standards.**
Time: 25 min	Method: Interactive Lecture

Distribute the handout located at Annex A to each student.

ELECTRONIC CHART STANDARDS

While sailors once charted the seas using the stars, today's navigators use an ECDIS. There are two standards of charts that are used by an ECDIS: raster and vector. The process to create each is dramatically different (as illustrated in Figure 1).

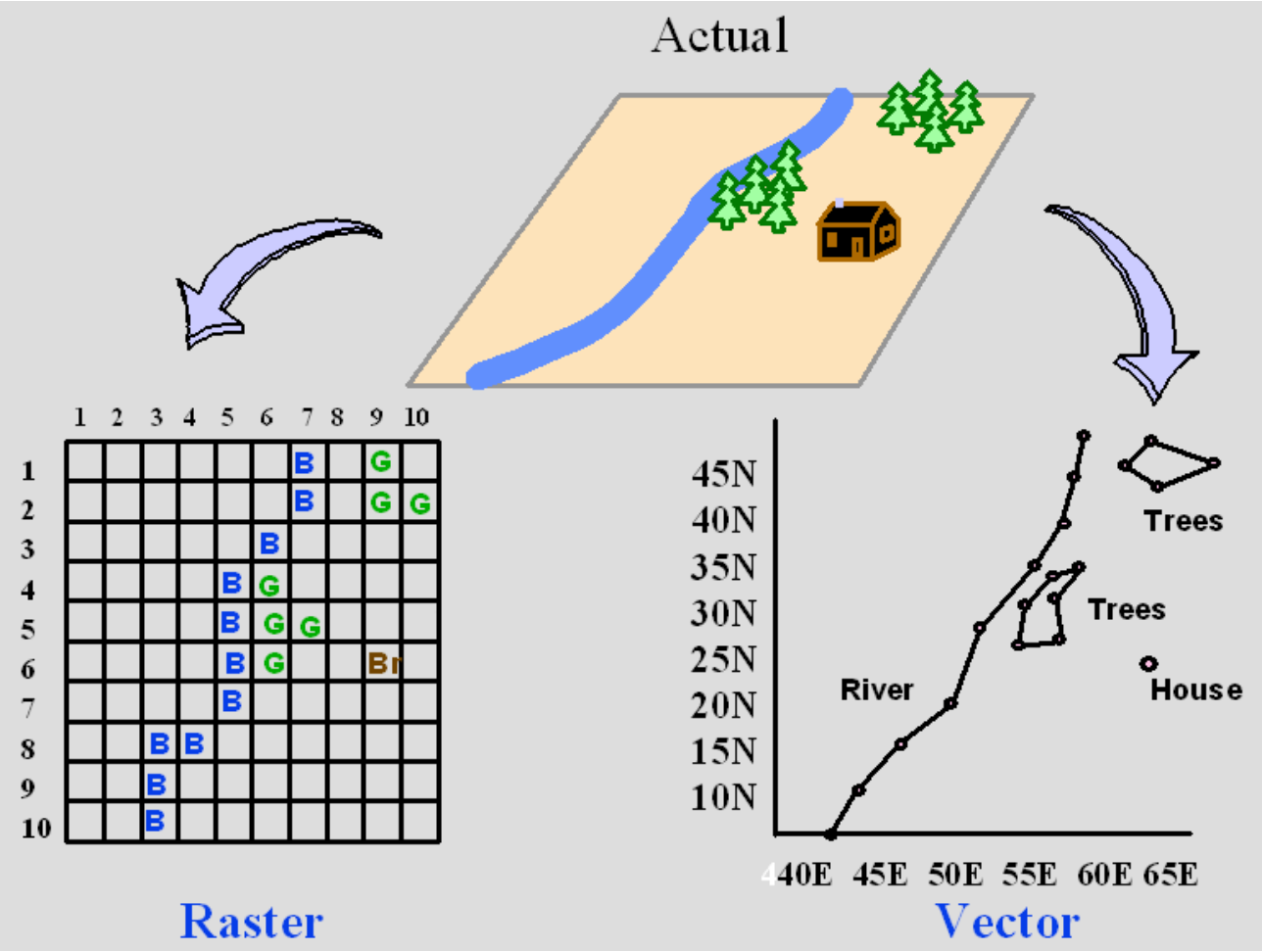


Figure 1 Raster Versus Vector Charts

Raster

Raster chart data is a digitized picture or scan of a paper chart (as illustrated in Figure 2). All data is in one layer and one format. The video display simply reproduces the picture from its digitized data file. With raster data, it is difficult to change individual elements of the chart since they are not separated in the data file. Raster data files tend to be large since a data point must be entered for every picture element or pixel on the chart.

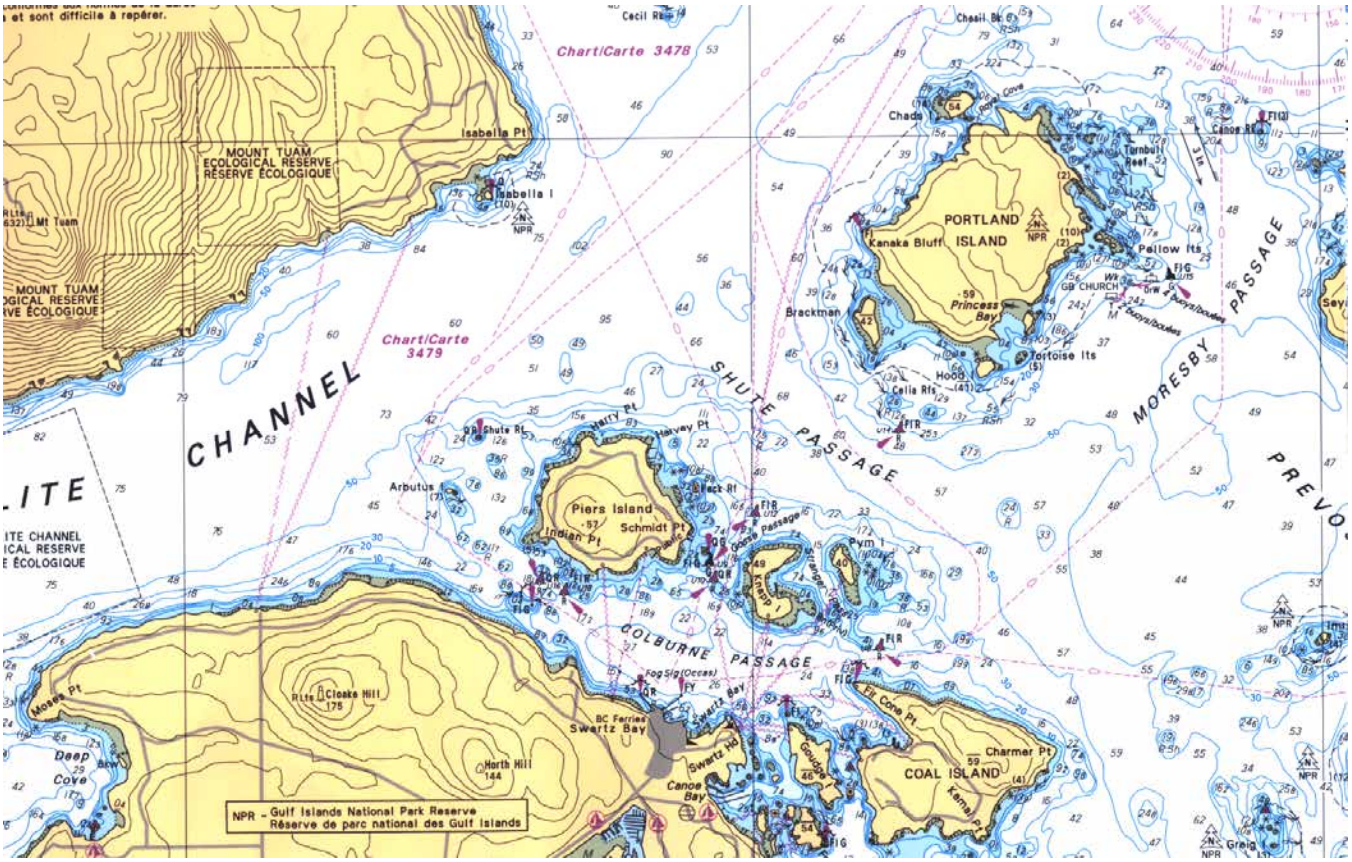


Figure 2 Raster Chart

Vector

Vector chart data is organized into many separate files. It contains graphics programs to produce certain symbols, lines, area colours, and other chart elements. The programmer can change individual elements in the file and tag elements with additional data. Vector files are smaller and more versatile than raster files of the same area as they use layers of data. The navigator can selectively display vector data, adjusting the display according to need by turning on or off different layers.

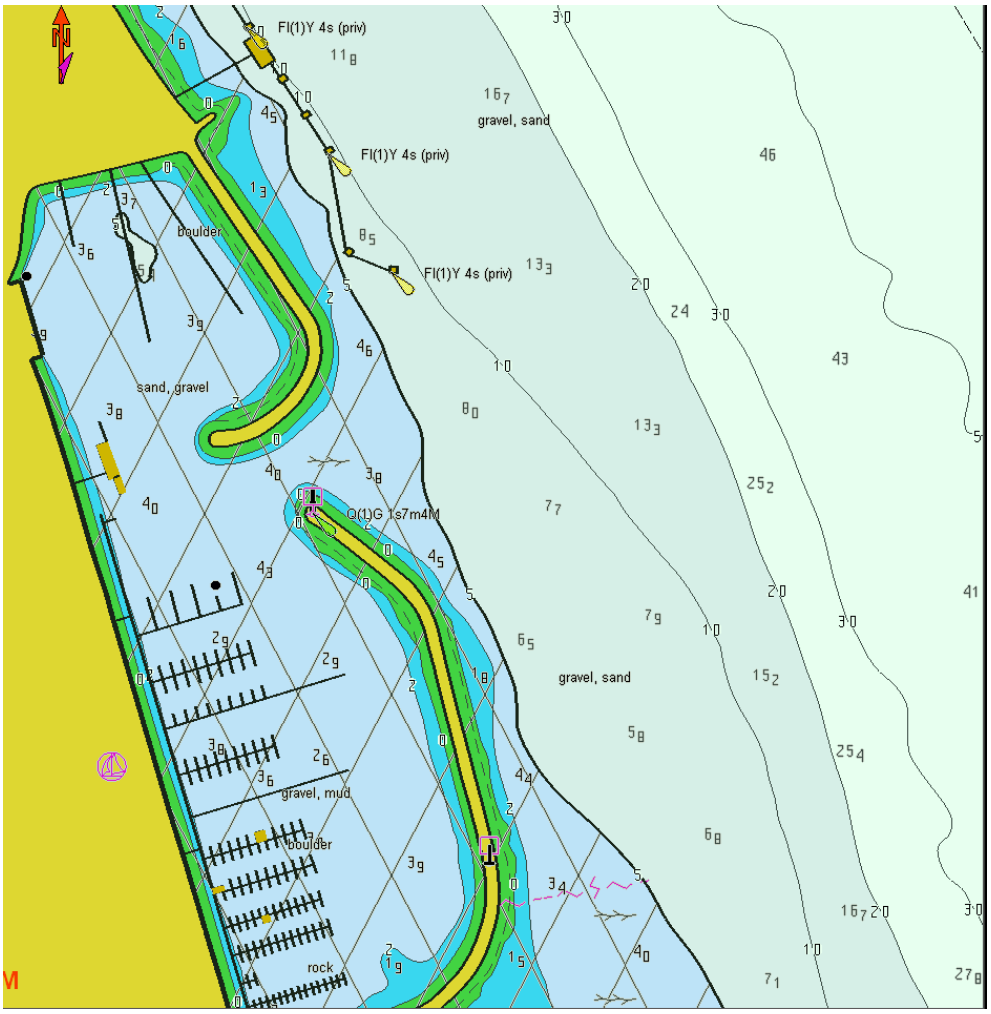


Figure 3 Vector Chart

CONFIRMATION OF TEACHING POINT 1

QUESTIONS:

Q1. What are the two standards of charts used in navigation?

Q2. Why do raster data files tend to be large?

Q3. How can a navigator selectively display vector data?

ANTICIPATED ANSWERS:

A1. Raster and vector.

A2. A data point must be entered for every picture element or pixel on the chart.

A3. By turning on or off different layers.

Teaching Point 2	**Identify and explain the use of ECDIS hardware.**
Time: 5 min	Method: Interactive Lecture

ECDIS HARDWARE

An ECDIS provides route recommendation and position tracking. It also maintains automatic alarms to warn of dangers, such as grounding or prohibited areas. For this to happen, certain hardware must be in place. A basic ECDIS consists of a computer, navigation software, electronic charts and a connected global positioning system (GPS) receiver (as illustrated in Figure 4).

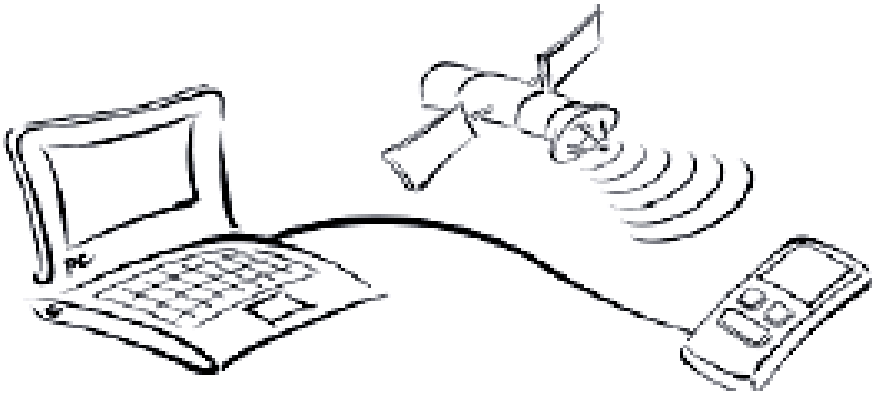


Figure 4 Basic ECDIS

Note. From Jeppesen Marine, Inc., 2008, *NobleTec MaxPRO User Guide*. Retrieved October 14, 2009, from http://www.nobletec.com/products/pdf/userguide_maxpro.pdf

In addition to its sophisticated navigational functionalities and highly accurate rendition of environmental information, an ECDIS offers full integration of data from outside sources such as radar, automatic identification system (AIS), gyroscope, speed logs, depth sounders and weather sensors. Having all this information graphically displayed in one location (as illustrated in Figure 5), allows the navigator to spend less time at the console and more time for situational awareness around the vessel.

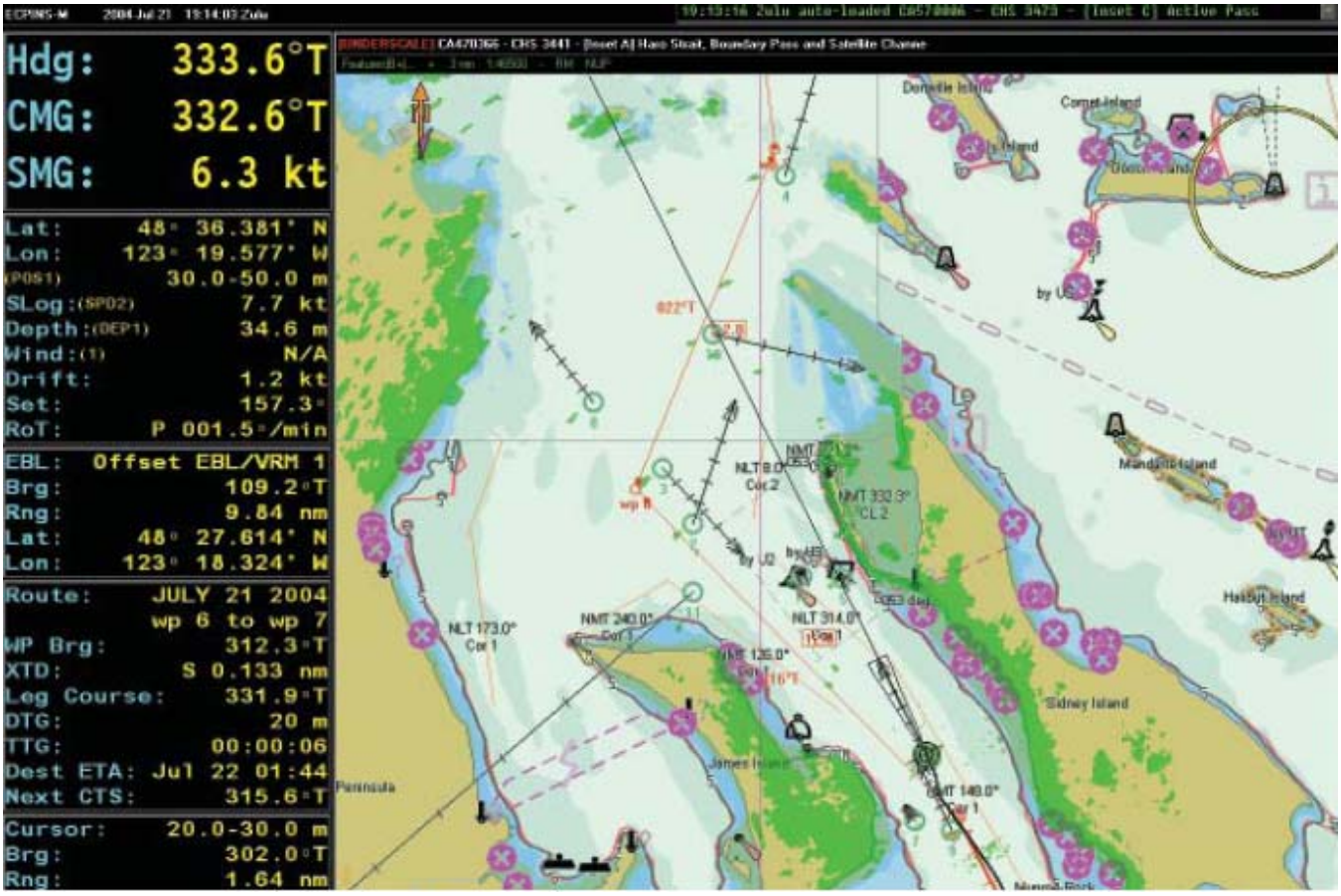


Figure 5 ECPINS® Screenshot

Note. From Offshore Systems Ltd., 2006, *ECPINS®M: The Military ECDIS Solution*. Retrieved October 14, 2009, from http://www.osigeospatial.com/offshoresystems/pdf/osi_ecpins-m.pdf

---

CONFIRMATION OF TEACHING POINT 2

QUESTIONS:

Q1. What does an ECDIS provide?

Q2. Of what does a basic ECDIS consist?

Q3. What does an ECDIS offer in addition to its sophisticated navigational functionalities and highly accurate rendition of environmental information?

ANTICIPATED ANSWERS:

A1. Allows route recommendation, position tracking and provides automatic alarms to warn of dangers such as grounding or prohibited areas.

A2. Computer, navigation software, electronic charts and a connected GPS receiver.

A3. Full integration of data from outside sources.

Teaching Point 3	**Identify and explain ECDIS software screens.**
Time: 5 min	Method: Interactive Lecture

Distribute the handout located at Annex B to each student.

Inform the students that this TP covers generic terms only. To clarify any questions, use examples from software in use on the SCTVs the students will train on.

ECDIS SOFTWARE SCREENS

There are many different versions of ECDIS software installed on SCTVs to meet the vessel's specific needs. Although they may look different, each one has similar screen functions, such as:

Title bar. Contains the name of the software followed by the active chart number and native scale.

Main menu. Drop-down menus that provide various options.

Toolbars. Shortcuts to various functions within the program.

Console display. Series of panels containing specific navigation information, such as vessel position, speed and current course.

Chart window. Displays the chart, the vessel and objects, such as marks and routes.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS:

Q1. What does the title bar contain?

Q2. What type of information is displayed in the console display?

Q3. What information is displayed in the chart window?

ANTICIPATED ANSWERS:

A1. The name of the software followed by the active chart number and native scale.

A2. Vessel position, speed and current course.

A3. The chart, the vessel position and objects, such as marks and routes.

END OF LESSON CONFIRMATION

QUESTIONS:

Q1. What is a raster chart?

Q2. What does an ECDIS allow?

Q3. What information is displayed in the chart window?

ANTICIPATED ANSWERS:

A1. A digitized picture or scan of a paper chart.

A2. Allows route recommendation, position tracking and provides automatic alarms to warn of dangers such as grounding or prohibited areas.

A3. The chart, the vessel position and objects, such as marks and routes.

CONCLUSION

HOMEWORK / READING / PRACTICE

Nil.

METHOD OF EVALUATION

This EO is assessed IAW Chapter 3, Annex D.

CLOSING STATEMENT

It is important for you to explain an ECDIS as you will be exposed to this type of navigation on a SCTV in the future. As technology matures, the SCTVs will adopt more complex electronic navigation systems that will replace the existing paper-based navigation methods.

INSTRUCTOR NOTES / REMARKS

Nil.

REFERENCES

Fugawi Incorporated. (2006). *Fugawi global navigator screenshot*. Retrieved October 14, 2009, from www.fugawi.com/web/images/products/screen_fugawi_enc_bsb_hr.gif

Jeppeson Marine, Inc. (2006). *NobleTec MaxPRO user guide*. Retrieved October 14, 2009, from www.nobletec.com/products/pdf/userguide_maxpro.pdf

Offshore Systems Ltd. (2006). *ECPINS® M:The military ECDIS solution*. Retrieved October 14, 2009, from www.osigeospatial.com/offshoresystems/pdf/osi_ecpins-m.pdf

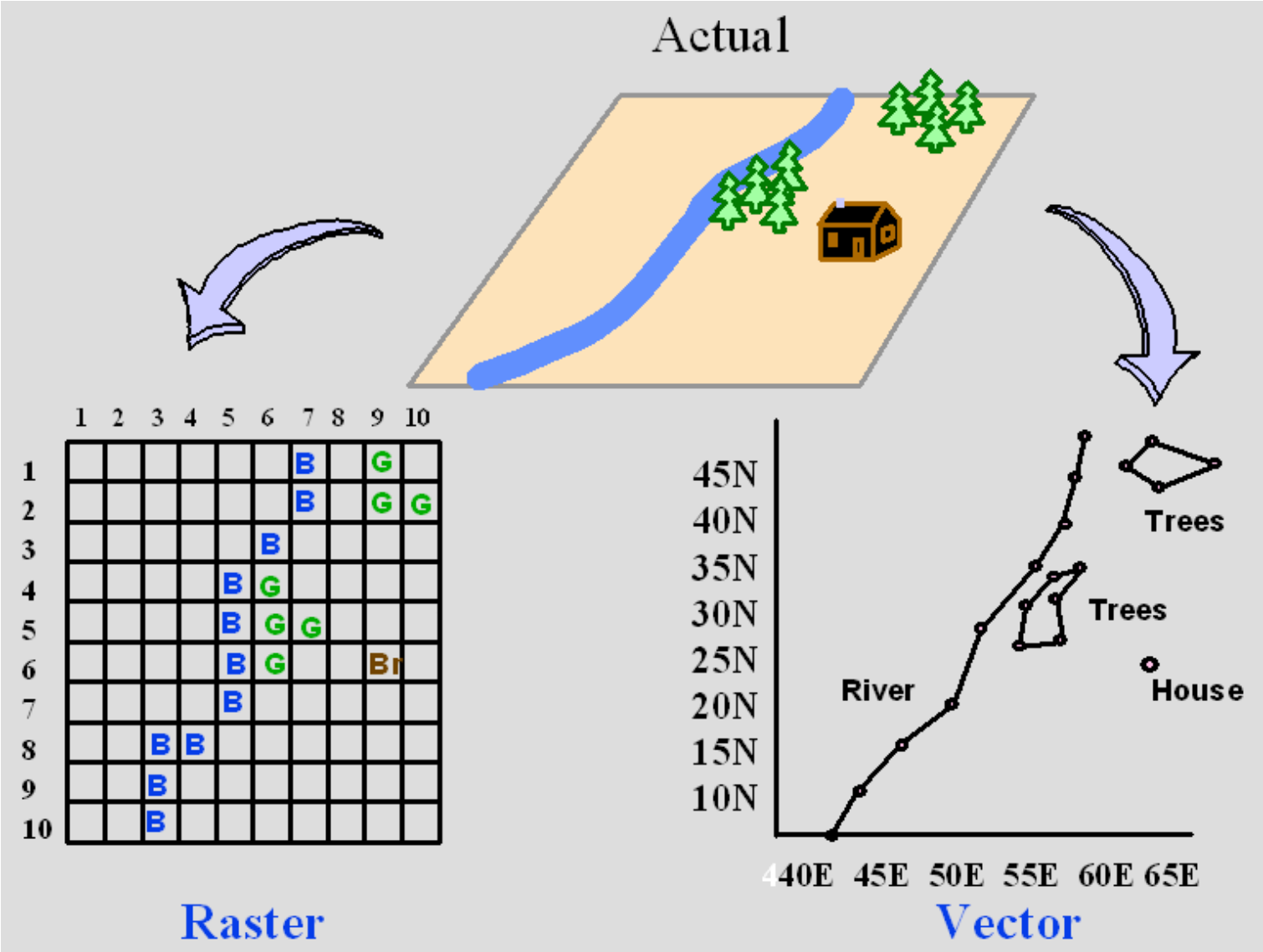


Figure A-1 Raster Versus Vector Charts

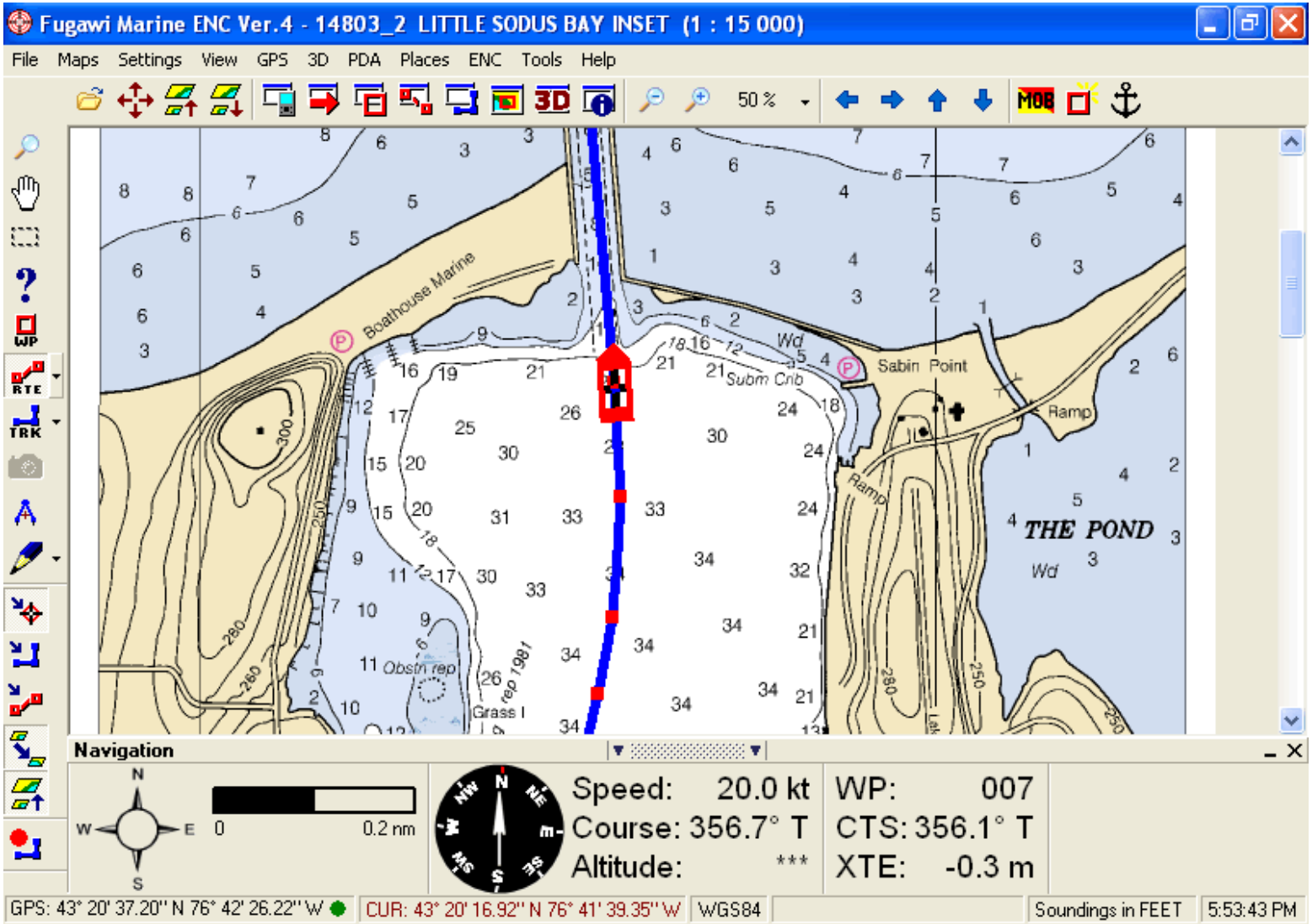


Figure B-1 Fugawi® Marine ENC Screenshot

Note. From Jeppesen Marine, Inc., 2008, *NobleTec MaxPRO User Guide*. Retrieved October 14, 2009, from http://www.nobletec.com/products/pdf/userguide_maxpro.pdf

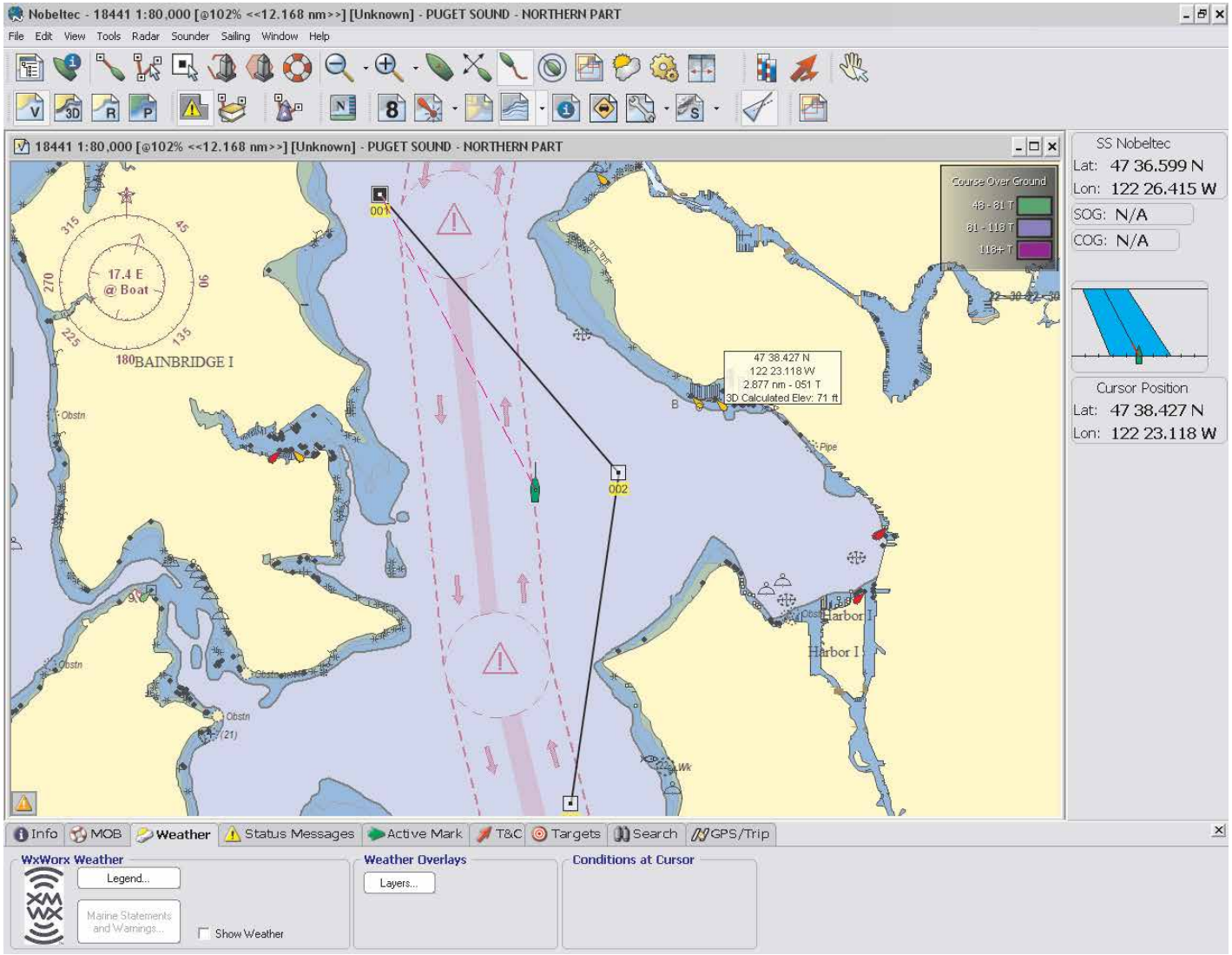


Figure B-2 NobleTec® MaxPRO™ Screenshot

Note. From Jeppesen Marine, Inc., 2008, *NobleTec® MaxPRO™ User Guide*. Retrieved October 14, 2009, from http://www.nobletec.com/products/pdf/userguide_maxpro.pdf

Figure B-3 ECPINS® Screenshot

Note. From Offshore Systems Ltd., 2006, *ECPINS®M: The Military ECDIS Solution*. Retrieved October 14, 2009, from http://www.osigeospatial.com/offshoresystems/pdf/osi_ecpins-m.pdf

CANADIAN CADET ORGANIZATIONS

NAVIGATION MANUAL

INSTRUCTIONAL GUIDE

SECTION 9

EO X51.09 – EXECUTE A PASSAGE

Total Time:	360 min

PREPARATION

PRE-LESSON INSTRUCTIONS

This IG supports EO X51.09 (Execute a Passage).

Photocopy Fixing Paper 1 located at Annex A, Fixing Paper 2 located at Annex C, Fixing Paper 2–Answer Key located at Annex D, Fixing Paper 3 located at Annex F and Fixing Paper 3–Answer Key located at Annex G for each student.

Photocopy Fixing Paper 1–Answer Key located at Annex B and Fixing Paper 3–Instructor's Script located at Annex E.

Gather the required resources:

- *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*,
- *Symbols Abbreviations Terms (Chart 1)*, and
- Navigation instruments.

To accommodate the three fixing papers, this EO shall be conducted in three occurrences:

1. the first occurrence being conducted prior to EO X51.06 (Locate a Position on a Chart Using RADAR), and

2. the second and third occurrences being conducted after EO X51.07 (Plan a Passage).

The PC should be conducted after EO S455.05 (Act as a Member of a Crew of a Sea Cadet Training Vessel [SCTV]).

PRE-LESSON ASSIGNMENT

Nil.

APPROACH

A practical activity was chosen for this lesson as it is an interactive way to allow students to experience executing a passage in a safe and controlled manner. This activity contributes to the development of navigation skills in a fun and challenging way.

INTRODUCTION

REVIEW

Nil.

OBJECTIVES

By the end of this lesson the student shall have executed a passage by completing a fixing paper to an accuracy of 60 percent.

IMPORTANCE

It is important for students to execute a passage as they will be required to perform these skills as they act as a navigator on a Sea Cadet Training Vessel (SCTV). Knowing these skills will prepare them for future training opportunities on board an SCTV.

Teaching Point 1 **Supervise the students while they execute a passage.**

Time: 330 min Method: Practical Activity

ACTIVITY #1

Fixing Paper 1 should be conducted prior to EO X51.06 (Locate a Position on a Chart Using RADAR) as it is designed as a review of all navigation that has been previously instructed.

Encourage the students to complete all sections of the fixing paper.

Time: 110 min

1. Distribute Fixing Paper 1 to each student.
2. Have the students complete the fixing paper and record any answers in the spaces provided.
3. Monitor the students' progress, correcting any errors.

ACTIVITY #2

Fixing Paper 2 should be conducted after EO X51.07 (Plan a Passage) as it is designed to reinforce new material to the students. Maintain an instructional environment where the students are encouraged to ask questions. Provide detailed answers that will facilitate their understanding of the material.

Time: 110 min

1. Distribute Fixing Paper 2 to each student.
2. Have the students complete the fixing paper and record any answers in the spaces provided.
3. Monitor the students' progress, correcting any errors.

ACTIVITY #3

Fixing Paper 3 should be conducted after EO X51.07 (Plan a Passage) as it is designed to expose the students to the requirements of a navigator while executing a passage in a simulated environment. Maintain an instructional environment where the students are encouraged to ask for assistance when required. Provide short, thought-provoking questions that will guide the students to the correct answer.

Time: 110 min

1. Distribute Fixing Paper 3 to each student.
2. Read the Activity Instructions on the Fixing Paper 3 Instructor's Script to the students.
3. Read the Activity Script on the Fixing Paper 3 Instructor's Script to the students. Ensure that the script is delivered at the times indicated.
4. Have the students record any answers in the spaces provided on the Fixing Paper 3.
5. Monitor the students' progress, correcting any errors.

CONFIRMATION OF TEACHING POINT 1

The students' participation in executing a passage will serve as the confirmation of this TP.

END OF LESSON CONFIRMATION

The students' execution of a passage will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK / READING / PRACTICE

Nil.

METHOD OF EVALUATION

This EO is assessed Chapter 3, Annex D.

CLOSING STATEMENT

It is important for you to execute a passage as you will be required to perform these skills when acting as a navigator on a Sea Cadet Training Vessel (SCTV). Knowing these skills will prepare you for future training opportunities on board an SCTV.

INSTRUCTOR NOTES / REMARKS

Nil.

REFERENCES

Nil.

FIXING PAPER 1

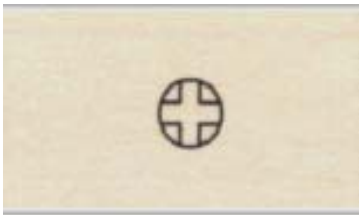
Section 1–Chart Information

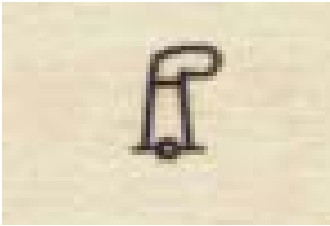
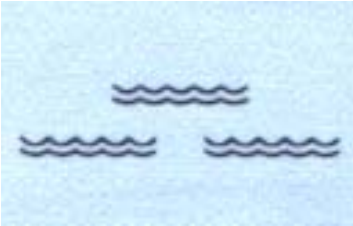
Answer the following questions using *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*.

#	Question		Answer
1.	What is the scale?		
2.	How are soundings measured on this chart?		
3.	Which *Notice to Mariners* outlines information on the Firing Practice and Exercise Areas that are shown on this chart?		
4.	What is the charted height of the following:		
	a.	highest point on Portland I:	
	b.	Tortoise Its:	
	c.	Christmas Pt power cable:	
5.	What area is shown in Continuation A?		
6.	What units of measurement are used for the two distance scales on the chart?		
7.	What is the latest survey used to make this chart?		
8.	Who published this chart?		

Section 2–Chart Symbols

Identify the following sections of *Symbols Abbreviations Terms (Chart 1)* where the following chart symbols are found.

Sections		
		
1.	2.	3.

		
4.	5.	6.
		
7.	8.	

Identify the following symbols on the chart.

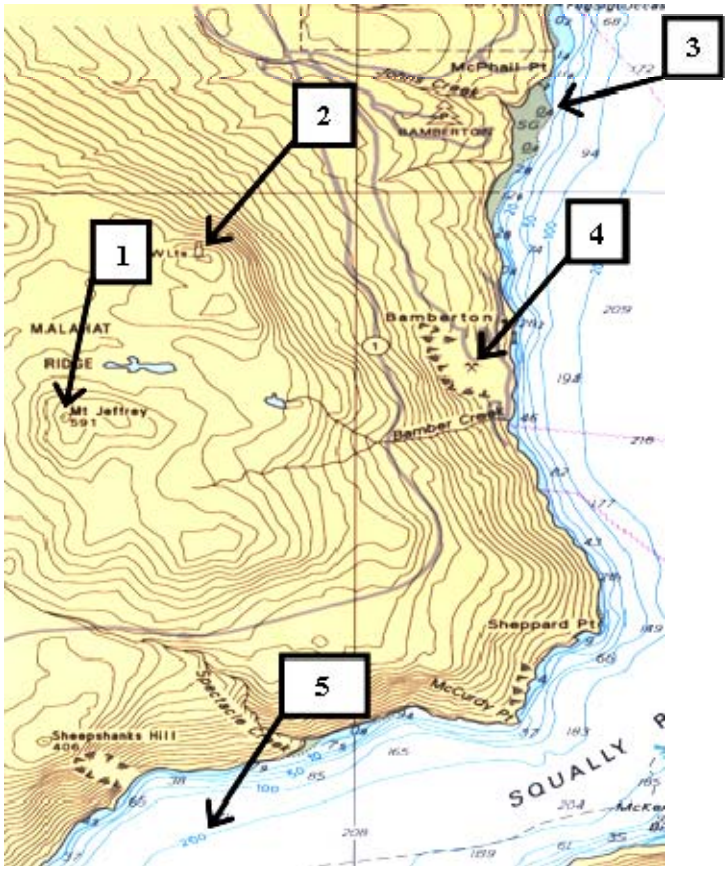


Chart A1

1. _____

2. _____

3. _____

4. _____

5. _____

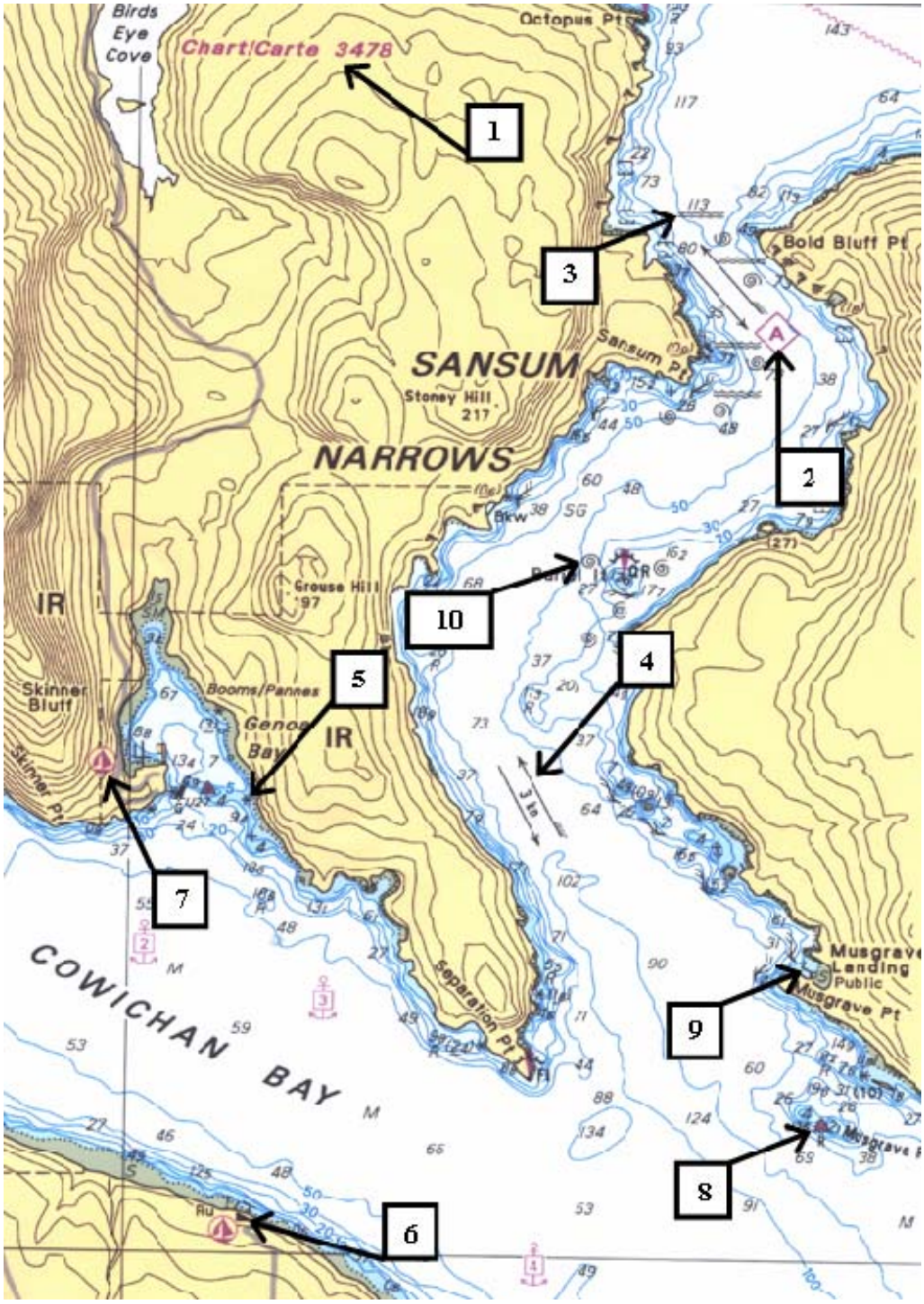


Chart A2

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Section 3–Determine the Latitude and Longitude

Determine the latitude and longitude of the following points on *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*.

#	Point	Latitude	Longitude
1.	Kellett Bluff light		
2.	Danger Sh buoy		
3.	Green Pt light		
4.	Skipjack I light		
5.	Anchorage #5–Plumper Sound		
6.	Skull It daymark		
7.	Mt Tuam tower		
8.	Patey Rk light		
9.	ODAS buoy in Saanich Inlet		
10.	Repulse Rk daymark		

Section 4–Measure Distances on a Chart

Measure the distance between the following points on *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*.

#	From	To	Distance
1.	McCurdy Pt	Whittaker Pt	
2.	Senanus I light	Henderson Pt daymark	
3.	Tozier Rk daymark	Wain Rock light	
4.	Patey Rk light	Shute Reef light	
5.	Separation Pt light	Burial Island light	
6.	Shute Rf light	LHE Imrie Island	
7.	James I light	Sidney Spit light	
8.	D'Arcy Shoals buoy	Wymond Point	
9.	Kelp Reefs light	Turn Point light	
10.	Kellet Bluff light	Kelp Reef light	

Section 5–Fixing

Plot the following three-bearing fixes on *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel* and identify the symbol closest to the fix.

#	Three-Bearing Fix Fix		Symbol
1.	**RHE Yarrow Pt** **Tozier Rk daymark** **Tanner Rk daymark**	**157°** **203°** **225°**	
2.	**Patey Rk light** **Wain Rk light** **RHE Warrior Pt**	**347°** **031°** **100°**	
3.	**Isabella I light** **Shute Rf light** **RHE Arbutus I**	**052°** **116°** **134°**	
4.	**Canoe Rk light** **Thieves Bay light** **Beaver Pt light**	**189°** **114°** **260°**	
5.	**Turn Pt light** **Pt Fairfax light** **Arachne Rf light**	**099°** **323°** **180°**	
6.	**LHE Spieden Bluff** **RHE Sentinel I** **LHE Battleship I**	**077°** **110°** **185°**	
7.	**Green Pt light** **RHE Davison Head** **LHE Flattop I**	**291°** **265°** **002°**	
8.	**Kellett Bluff light** **Kelp Reefs light** **LHE Sidney Is**	**354°** **272°** **318°**	

Plot the following electronic position fixes on *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel* and identify the symbol closest to the fix.

#	Electronic Position Fix Fix	Symbol
1.	48° 41.96' N 123° 17.94' W	
2.	48° 41.40' N 123° 27.00' W	
3.	48° 38.72' N 123° 25.26' W	
4.	48° 48.35' N 123° 13.39' W	
5.	48° 44.81' N 123° 04.45' W	
6.	48° 36.79' N 123° 03.30' W	
7.	48° 40.29' N 123° 21.40' W	
8.	48° 32.74' N 123° 32.35' W	

Calculate the missing information using a Speed Time Distance calculator.

#	Speed (kts)	Time (min)	Distance (NM)
1.	5	6	
2.	6	20	
3.	10	12	
4.	12	9	
5.	15		15
6.	21		7
7.	8		4
8.		30	5.5
9.		10	1
10.		9	1.2

FIXING PAPER 1–ANSWER KEY

Section 1–Chart Information

Answer the following questions using *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*.

#	Question		Answer
1.	What is the scale?		**The scale is 1 : 40 000.**
2,	How are sounding measured on this chart?		**Soundings are measured in metres and are reduced to Chart Datum.**
3.	Which *Notice to Mariners* outlines information on the Firing Practice and Exercise Areas that are shown on this chart?		***Annual Notice to Mariners* Number 35.**
4.	What is the charted height of the following:		
	a.	highest point on Portland I:	**59 m.**
	b.	Tortoise Its:	**5 m.**
	c.	Christmas Pt power cable:	**55 m.**
5.	What area is shown in Continuation A?		**Finlayson Arm (Southern Portion).**
6.	What units of measurement are used for the two distance scales on the chart?		**Nautical miles and metres.**
7.	What is the latest survey used to make this chart?		**1999.**
8.	Who published this chart.		**Canadian Hydrographic Service.**

Section 2–Chart Symbols

Sections	
#	**Section**
1.	**SECTION C**
2.	**SECTION F**
3.	**SECTION K**
4.	**SECTION T**
5.	**SECTION E**
6.	**SECTION H**
7.	**SECTION Q**
8.	**SECTION U**

Chart A1	
#	**Symbol**
1.	**Spot elevation. Mt Jeffery 591 m**
2.	**Tower**
3.	**Drying area (foreshore) to 0.4 m**
4.	**Quarry**
5.	**Depth contour**

Chart A2	
#	**Symbol**
1.	**Large-scale chart reference**
2.	**Tidal diamond**
3.	**Overfalls, tide rips, races**
4.	**Tide direction arrows for flood and ebb currents**
5.	**Rock that covers and uncovers. No height given**
6.	**Boat ramp / launch**
7.	**Marina**
8.	**Starboard hand buoy**
9.	**Jetty**
10.	**Eddies, whirlpools**

Section 3–Determine the Latitude and Longitude

#	Latitude	Longitude
1.	48° 35.32' N	123° 12.15' W
2.	48° 38.37' N	123° 11.09' W
3.	48° 37.99' N	123° 06.36' W
4.	48° 43.95' N	123° 02.35' W
5.	48° 46.20' N	123° 13.17' W
6.	48° 45.12' N	123° 14.30' W
7.	48° 43.62' N	123° 29.06' W
8.	48° 42.04' N	123° 31.25' W
9.	48° 38.95' N	123° 29.60' W
10.	48° 32.77' N	123° 32.37' W

Section 4–Measure Distances on a Chart

#	Distance
1.	1.36 NM
2.	0.40 NM
3.	4.27 NM
4.	3.58 NM
5.	1.63 NM
6.	4.05 NM
7.	2.56 NM
8.	1.75 NM
9.	2.15 NM
10.	2.83 NM

Section 5–Fixing

#	Three-Bearing Fix Symbol	Electronic Position Fix Symbol
1.	**ODAS buoy**	**Pt Fairfax light**
2.	**149m sounding**	**Cloake Hill tower**
3.	**Deactivated submarine Cable**	**Victoria Airport dome**
4.	**Current information symbol**	**Chart change (3477)**
5.	**Ferry route**	**Traffic Separation arrow**
6.	**Nature of the Bottom Mud and Shell**	**Jones I park symbol**
7.	**Eddies, whirlpools**	**Dock I light**
8.	**Traffic separation arrow**	**Repulse Rk (Continuation A)**

Section 6–Speed Time Distance

#	Speed (kts)	Time (min)	Distance (NM)
1.	5	6	**0.5**
2.	6	20	**2**
3.	10	12	**2**
4.	12	9	**1.8**
5.	15	**60**	15
6.	21	**20**	7
7.	8	**30**	4
8.	**11**	30	5.5
9.	**6**	10	1
10.	**9**	9	1.2

FIXING PAPER 2

Student:_____ **Date:**_____

Q#	TIME	QUESTION	ANSWER
1	1030	Use *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel.* The ship's position was read from the GPS as: 48° 41.0' N, 123° 05.0' W. You are steering course 310° and have Speed 10 rung on. Show DRs for 6 and 12 minutes.	
2	1036	Skipjack I light 048° RHE Stuart I 268° RHE Blunden I 322° Plot the fix.	
3		Where are you in relation to your track? Explain how far off, to which side and why you could be off track.	
4		Properly label CMG, SMG and the EP for minute 42 on the chart.	
5	1048	Gowlland Pt 1.91 NM Satellite I 1.95 NM Sandy Pt 3.32 NM Plot the fix. Show two EPs.	
6		Alter course to 275° Speed 12. Lay down and label the new track from the last fix.	
7	1056	Turn Pt light 227° Tilly Pt 344° Gowlland Pt light 023° Plot the fix. Show SMG and DRs for 6 and 12 minutes.	
8	1108	Turn Pt 208 at 1.68 NM Arachne Rf Lt 311° Plot the fix. Show 6 and 12 minute EPs.	
9	1114	Pelorus Pt 1.32 NM Parkin Pt 2.02 NM Parkin Pt 282° Plot the fix.	

Q#	TIME	QUESTION	ANSWER
10		A fishing vessel has been reported taking on water in position 48° 38.0 'N, 123° 15.1' W. Plot the vessel's position. Determine the CTS and DR time to the vessel at your current speed. And alter.	
11	1116	You slowed down due to mechanical difficulties. Pt Fairfax light in transit with Dock I light 234° Turn Pt light 152° Plot the fix.	
12		Does the chart agree with the gyro? If not, what was the gyro error?	
13	1128	Pt Fairfax light 263° Arachne Rf light 233° Turn Point light 134° Plot the fix. Your mechanical difficulties have resolved and you come up in speed to assist the fishing vessel.	
14	1132	RHE Comet I 251° Tom Pt light 212° Arachne Rf light 280° Plot the fix. Show the SMG, CMG, 6 and 12 minute DRs. What is the DR time to the distressed vessel?	
15		Alter course to 180 and increase speed to 20 kts from the 1132 fix.	
16		How close will you pass to the position of the fishing vessel? What time will this be?	
17		What country are you in at 1132?	
18	1146	As you stop to help the fishing vessel, the visibility closes in. When all way is off the ship the following fix is taken: RHE Mandarte I 274° LHE Halibut I 211° RHE Mandarte I 1.08 NM Plot the fix.	
19	1206	Having saved the fishing vessel, you are now ready to proceed. LHE Halibut I 278°	

Q#	TIME	QUESTION	ANSWER
		Halibut I 0.80 NM Hamley Pt 1.22 NM Plot the fix.	
20		How far have you drifted and in what direction? Calculate the speed the vessel has drifted at.	
21		From your last fix, what would be the CTS and speed needed to reach a position with Kelp Rf. light at 270° and five cables away by 1234?	

FIXING PAPER 2–ANSWER KEY

Student:_____ **Date:**_____

Q#	Answers	Mark
1.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12, ☐Course Label, ☐ Speed Box, ☐ Plot Correct	**/ 7**
2.	☐ Fix, ☐ Track, ☐ EP 6, ☐ EP 12	**/ 4**
3.	☐ 0.2NM (400x), ☐ Port, ☐ Wind or Current	**/ 3**
4.	☐ CMG: **300**, ☐ SMG: **11 kts**, ☐ Course Label (CMG[CTS]), ☐ EP Correct	**/ 4**
5.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12	**/ 4**
6.	☐ Track correct, ☐ Course Label, ☐ Speed Box	**/ 3**
7.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12, ☐ SMG: **12.8 kts**,	**/ 5**
8.	☐ Fix, ☐ Track, ☐ EP 6, ☐ EP 12	**/ 4**
9.	☐ Fix, ☐ Track, ☐ EP 6, ☐ EP 12	**/ 4**
10.	☐ Plot correct, ☐ CTS: **176**, ☐ DR Time: **27 min @ 1132**	**/ 3**
11.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12	**/ 4**
12.	☐ Does the chart agree? **YES**	**/ 1**

Q#	Answers	Mark
13.	☐ Fix, ☐ Track, ☐ EP 6, ☐ EP 12	**/ 4**
14.	☐ Fix, ☐ Track, ☐ EP 6, ☐ EP 12, ☐ SMG: **12.7 kts**, ☐ CMG: **176**, ☐ DR Time: **13 min @ 1145**	**/ 7**
15.	☐ Track correct, ☐ Course Label, ☐ Speed Box	**/ 3**
16.	☐ Distance: **0.225 NM (450x)**, ☐ Time: **7 min @ 1139**	**/ 2**
17.	☐ Country: **USA**	**/ 1**
18.	☐ Fix	**/ 1**
19.	☐ Fix, ☐ Track, ☐ EP 6, ☐ EP 12	**/ 4**
20.	☐ Distance: **1.05 NM**, ☐ Direction: **164**, ☐ Speed: **3.15 kts**	**/ 3**
21.	☐ Plot position, ☐ CTS: **166**, ☐ Speed: **10**	**/ 3**
All answers should be accurate to within 100x for distances, 2 minutes for times, 2 knots for speeds and 2 degrees for bearings.		**/ 73**

Evaluator's Notes:

FIXING PAPER 3–INSTRUCTOR'S SCRIPT

The following script is designed to simulate the operational tempo a navigator will experience while on the bridge of an SCTV. Every effort should be made to meet the timings listed in the script. Students may ask for information to be repeated with no stoppage of the clock.

Activity Instructions

1. This fixing paper is designed to simulate the operational tempo you will experience while acting as a navigator on an SCTV while following a six-minute fixing routine.

2. What you will hear are fixes and requests for information as they will be presented to you on the bridge.

3. Work should be completed on the chart including all symbology. All verbal responses and calculated information will be recorded on the answer sheet in the space provided.

4. You are allowed to ask for information to be repeated; however, the time will not stop.

Script

Q#	Person	Time	Instructions
1.	**Instructor:**	**XXXX**	Plot the following waypoints on *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*: AA 48° 45.00' N 123° 05.30' W BB 48° 42.40' N 123° 16.00' W CC 48° 41.65' N 123° 17.65' W DD 48° 42.59' N 123° 23.40' W Speed is 6 knots. Leadmark is 250° on Pt Fairfax light.
2.	**OOW:**	**1000**	Time is 1000 and you are at point AA. Navigator, my track is obscured by a large vessel. I will use the LHE of Saturna Is as my leadmark. What is my course to steer?
3.	**OOW:** **OIC:**	**1006**	STANDBY FIX. LHE Saturna I 285° Gowlland Pt light 253° Monarch Hd 021° Time 1006 Calculate our course made good and speed made good. How far off the 250 track and in what direction? What course would I need to steer to regain the 250 track, in 12 minutes, if we altered at the minute 12 EP and increased speed to make good 9 knots?

Q#	Person	Time	Instructions
4.	**OIC:**	**1012**	OOW, steer the course given by the navigator. You plot a GPS fix as soon as you steady up. 48 45.36' N 123 06.46' W
5.	**OOW:**	**1018**	STANDBY FIX. Croker Pt light 299° Gowlland Pt light 255° Taylor Pt 346° Time 1018 Calculate our speed made good and course made good.
6.	**OOW:** **OIC:**	**1024**	STANDBY FIX. Pt Fairfax light 250° Gowlland Pt light 267° Croker Pt light 312° Time 1024 OIC, we have regained our base track of 250. Recommend coming right to 250. Yes, please. (Instructor: If time permits and personnel are available, verbally act out all alterations of course.)
7.	**OOW:**	**1030**	STANDBY FIX. Pt Fairfax light 250° on track by leadmark. Gowlland Pt light 293° RHE Blunden It 002° Time 1030
8.	**OIC:**	**1034**	Navigator, why are EPs not used from the 1024 fix?
9.	**OOW:**	**1036**	STANDBY FIX. Pt Fairfax light 250° on track by leadmark. Tilly Pt 302° Gowlland Pt light 022° Time 1036

Q#	Person	Time	Instructions
10.	**OIC:** **OOW:**	**1042**	OOW, we need to clear the VTS special operating area. At the next EP, come right to 285 and increase to speed 11 kts. STEER 285, SPEED 11 As soon as you steady up you take a GPS fix. 48 43.23' N 123 12.88' W
11.	**OOW:**	**1048**	STANDBY FIX. Parkin Pt 279° Turn Pt light 175° Pt Fairfax light 237° Time 1048 Calculate our speed made good and our course made good.
12.	**OIC:** **OOW:**	**1050**	OOW, what course and speed do I need from our 1054 EP to make waypoint BB by 1115? Navigator, from our 1054 EP what course and speed is needed to make the BB waypoint by 1115?
13.	**OIC:**	**1054**	OOW, alter course to intercept waypoint BB using the course and speed given by the navigator.
14.	**OOW:**	**1100**	STANDBY FIX. Arachne Rf light 207° Pt Fairfax light 227° Turn Pt light 146° Time 1100 What is the DR time to waypoint BB?
15.	**OOW:**	**1106**	STANDBY FIX. Arachne Rf light 213° Pt Fairfax light 239° Turn Pt light 139° Time 1106 Calculate the course made good and speed made good.
16.	**OOW:**	**1109**	Steer 236, Speed 6

Q#	Person	Time	Instructions
17.	**OOW:**	**1115**	STANDBY FIX. RHE Reay I 243° Pt Fairfax light 259° Arachne Rf light 214° Time 1115 What is the DR time to waypoint CC?
18.	**OOW:**	**1121**	STANDBY FIX. RHE Reay I 246° Pt Fairfax light 287° Arachne Rf light 016° Time 1127 Calculate the course made good and speed made good. What is the EP time to waypoint CC?
19.	**OIC:** **OOW:**	**1124**	OOW, alter to course 284. STEER 284
20.	**OOW:**	**1127**	STANDBY TRANSIT. Dock I light to RHE Reay I 237° LHE Moresby I 317° Time 1133 Calculate the gyro error.
21.	**OIC:** **OOW:**	**1129**	OOW, we have an RV for 1200 at waypoint DD. Navigator, with a corrected gyro, what course and speed do we need to reach waypoint DD for 1200 from the minute-33 DR.
22.	**OIC:**	**1133**	OOW, alter to intercept waypoint DD using the course and speed given by the navigator.
23.	**OOW:** **OIC:** **Helmsman:**	**1135**	**ZAP - [ALARMS]** OIC, we have experienced a power failure and have lost our gyro, radar and GPS. STEADY. STEER BY MAGNETIC. (All magnetic bearings are corrected to 2005) Steady. Steering course 266 magnetic.

Q#	Person	Time	Instructions
24.	**OOW:**	**1139**	STANDBY FIX. RHE Piers I 259 M Fir Cone Pt light 230 M Canoe Rk light 342 M Time 1145
25.	**OOW:** **OIC:** **OOW:**	**1145**	STANDBY FIX. RHE Piers I 258 M Fir Cone Pt light 220 M Charmer Pt 182 M Time 1151 Verify our course made good and speed made good. OOW, will we make our 1200 RV at our current speed? Navigator, what speed do we need to make our 1200 RV?

FIXING PAPER 3

Student:_____ **Date:**_____

Q#	ANSWER	MARK
2.		
3.		
5.		
8.		
11.		
12.		
14.		
15.		
17.		
20.		
21.		
25.		

FIXING PAPER 3–ANSWER KEY

Student:_____ **Date:**_____

Q#	Answers	Mark
1.	Plot Correct: ☐ AA, ☐ BB, ☐ CC, ☐ DD, ☐ Course Labels, ☐ Speed Boxes	**/ 6**
2.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12, ☐Course Label, ☐ Speed Box, ☐ CTS: **286.5**	**/ 7**
3.	☐ Fix, ☐ Track, ☐ EP 6, ☐ EP 12, ☐ CMG: **296**, ☐ SMG: **4.5 kts**, ☐ Distance off: **0.33NM, 3.3c, 666x** ☐ CTS: **229**	**/ 8**
4.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12	**/ 4**
5.	☐ Fix, ☐ Track, ☐ EP 6, ☐ EP 12, ☐ SMG: **9 kts**, ☐ CMG: **228**	**/ 6**
6.	☐ Fix, ☐ Track, ☐ EP 6, ☐ EP 12	**/ 4**
7.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12	**/ 4**
8.	The ship altered course after the fix and therefore, because that fix is not on this track, we have no way of knowing where the ship was when we steadied up.	**/ 2**
9.	☐ Fix, ☐ Track, ☐ EP 6, ☐ EP 12	**/ 4**
10.	☐ Fix, ☐ Track: **(285)**, ☐ DR 6, ☐ DR 12	**/ 4**
11.	☐ Fix, ☐ Track, ☐ EP 6, ☐ EP 12, ☐ SMG: **11.5 kts**, ☐ CMG: **283**	**/ 6**
12.	☐ Course: **175**, ☐ Speed: **4 kts**	**/ 2**
13.	☐ Track, ☐ Course, ☐ Speed	**/ 3**
14.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12, ☐ DR Time: **7 minutes @ 1107**	**/ 5**
15.	☐ Fix, ☐ Track, ☐ EP 6, ☐ EP 12, ☐ CMG: **175**, ☐ SMG: **4 kts**	**/ 6**

Q#	Answers	Mark
16.		
17.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12, ☐ DR Time: **8.5 minutes @ 1123.5**	**/ 5**
18.	☐ Fix, ☐ Track, ☐ EP 6, ☐ EP 12 ☐ CMG: **238,** ☐ SMG: **6**, ☐ EP Time **3 min @ 1124**	**/ 7**
19.	☐ Track, ☐ Course, ☐ Speed	**/ 3**
20.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12, ☐ Gyro Error: **2° Low**	**/ 5**
21.	☐ Course: **282**, ☐ Speed: **8.5 kts**	**/ 2**
22.	☐ Track, ☐ DR 6, ☐ DR 12	**/ 3**
23.		
24.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12	**/ 4**
25.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12, ☐ CMG: **277**, ☐ SMG: **5.3 kts**, ☐ Speed: **10 kts**	**/ 7**
		/ 107

Evaluator's Notes:

CANADIAN CADET ORGANIZATIONS

NAVIGATION MANUAL

INSTRUCTIONAL GUIDE

SECTION 10

EO X51.10 – COMPLETE A NAVIGATION SELF STUDY PACKAGE

Total Time:	90 min

PREPARATION

PRE-LESSON INSTRUCTIONS

This IG supports EO X51.10 (Complete a Navigation Self Study Package).

Self study packages are intended to be completed by the cadet independently. More information about self study packages can be found in the foreward and preface of A-CR-CCP-605/PF-001, *Phase Five Instructional Guides.*

Photocopy the self study package located at Annex A for each cadet.

Photocopy the answer key located at Annex B.

Gather the required resources:

- Self study package,
- Chart 3441 *Haro Strait, Boundary Pass and / et Satellite Channel*, and
- Navigation instruments.

PRE-LESSON ASSIGNMENT

Nil.

APPROACH

A self study was chosen for this lesson as it allows the cadet to enhance their proficiency at their own learning pace. This encourages the cadet to become more self-reliant and independent by focusing on their own learning instead of learning directed by the instructor.

INTRODUCTION

REVIEW

Nil.

OBJECTIVES

By the end of this lesson the cadet shall have completed a fixing paper.

IMPORTANCE

It is important for the cadet to complete a fixing paper as it allows them to practice their navigation skills in a safe and controlled environment. The fixing paper requires the cadet to use their knowledge to perform chartwork, work out a result and respond with the correct information as if they were on the bridge of a vessel.

SELF STUDY PACKAGE INSTRUCTIONS

1. Provide the cadet with a copy of the required resources.
2. Allow the cadet 90 minutes to complete the self study package.
3. Collect the self study package once the cadet has finished.
4. Correct the self study package with the fixing paper answer key.
5. Provide feedback to the cadet and indicate whether or not they have completed the enabling objective (EO).
6. Return the completed self study package to the cadet for their future reference.
7. Record the result in the cadet’s logbook and Cadet Training Record.

END OF LESSON CONFIRMATION

The cadet’s completion of the self study package will serve as confirmation of this lesson.

CONCLUSION

HOMEWORK / READING / PRACTICE

Nil.

METHOD OF EVALUATION

Nil.

CLOSING STATEMENT

It is important for you to be able to complete a fixing paper as it allows you to practice your navigation skills in a safe and controlled environment. The fixing paper requires you use your knowledge to perform chartwork, work out a result and respond with the correct information as if you were on the bridge of a vessel.

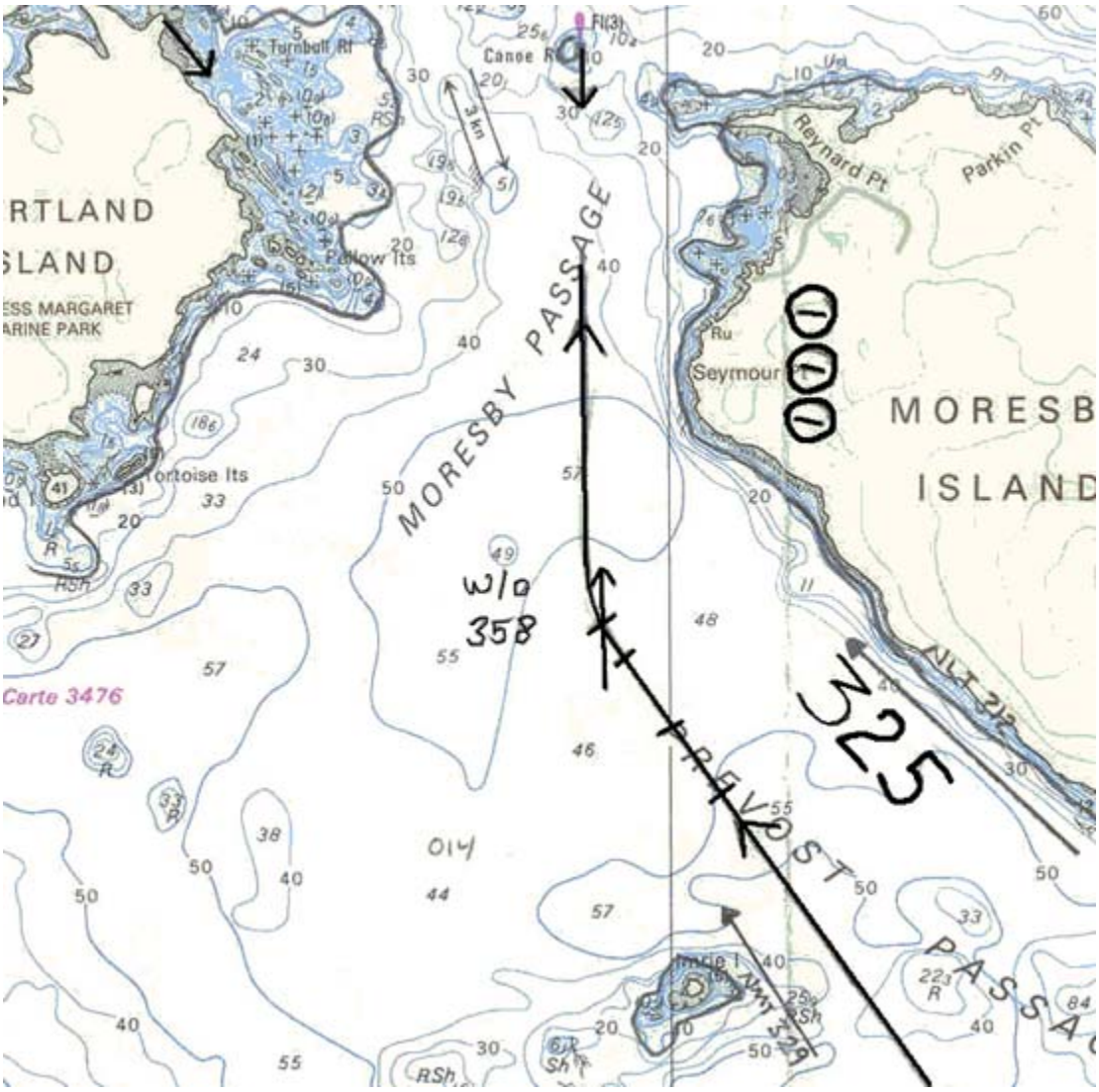
INSTRUCTOR NOTES / REMARKS

Nil.

REFERENCES

C-57-007-002/AF-001 Royal Navy. (1987). *Admiralty manual of navigation* (Vol. 1). (Rev. 1987). London, England: Her Majesty's Stationery Office.

COMPLETE A FIXING PAPER



Self Study Package

Section 1: PLOT A POSITION USING A THREE-BEARING FIX
Section 2: FIXING PAPER TERMINOLOGY
Section 3: COMPLETE A FIXING PAPER

SECTION 1
PLOT A POSITION USING A THREE-BEARING FIX

FIXING TERMINOLOGY

To better understand the principles outlined, it is important to know the following terms:

Heading. The direction in which the bow of the small craft is pointing. Headings are expressed in degrees (°)—000 through 360.

Bearing. A line of position sighted from a small craft to another object. Only true bearings can be plotted on charts.

Lines of Position (LOPs). Lines that are plotted on a chart for the bearings taken of objects.

A fix. The intersection of two or more LOPs. While a fix can be made with two LOPs, it is considered more accurate to use three LOPs in every fix. An ideal three-bearing fix should have 60-degree angles between the LOPs.

Did you know?
True bearings are obtained from a gyrocompass. Small craft are not normally fitted with a gyrocompass due to their weight and size. If taking bearings from a small craft, a handheld magnetic compass may be used to obtain the bearings. However, these bearings should be converted to true bearings before plotting them on a chart.

Throughout this self study package, all bearings given in examples and exercises are to be considered true bearings.

THREE-BEARING FIX

In order to plot a three-bearing fix, three LOPs must cross at a specific point.

Example: Plot the following fix on *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*:

	East Pt. light	010°
0800	Skipjack I. light	085°
	Monarch Hd.	326°

1. Align the parallel ruler with the centre of the compass rose and 010° on the outer ring of the compass rose.

2. Roll the ruler along the chart until the edge aligns with East Pt. light.

3. Draw a line from the light along the ruler.

4. Repeat Steps 1–3 for the other two bearings. After the first LOP is plotted, the remaining LOPs are only drawn across the first LOP plotted.

Figure A-1 Three-Bearing Fix Step 4

5. Once an LOP is drawn it can be shortened to the same size as the diameter of a quarter.

Figure A-2 Three-Bearing Fix Step 5

6. Draw arrows at the outer ends of the LOPs pointing away from the object. These arrows indicate the direction in which the observer must lie from the observed object.

7. Circle the intersection of the three LOPs and label with the four digit time the bearings were taken next to the fix.

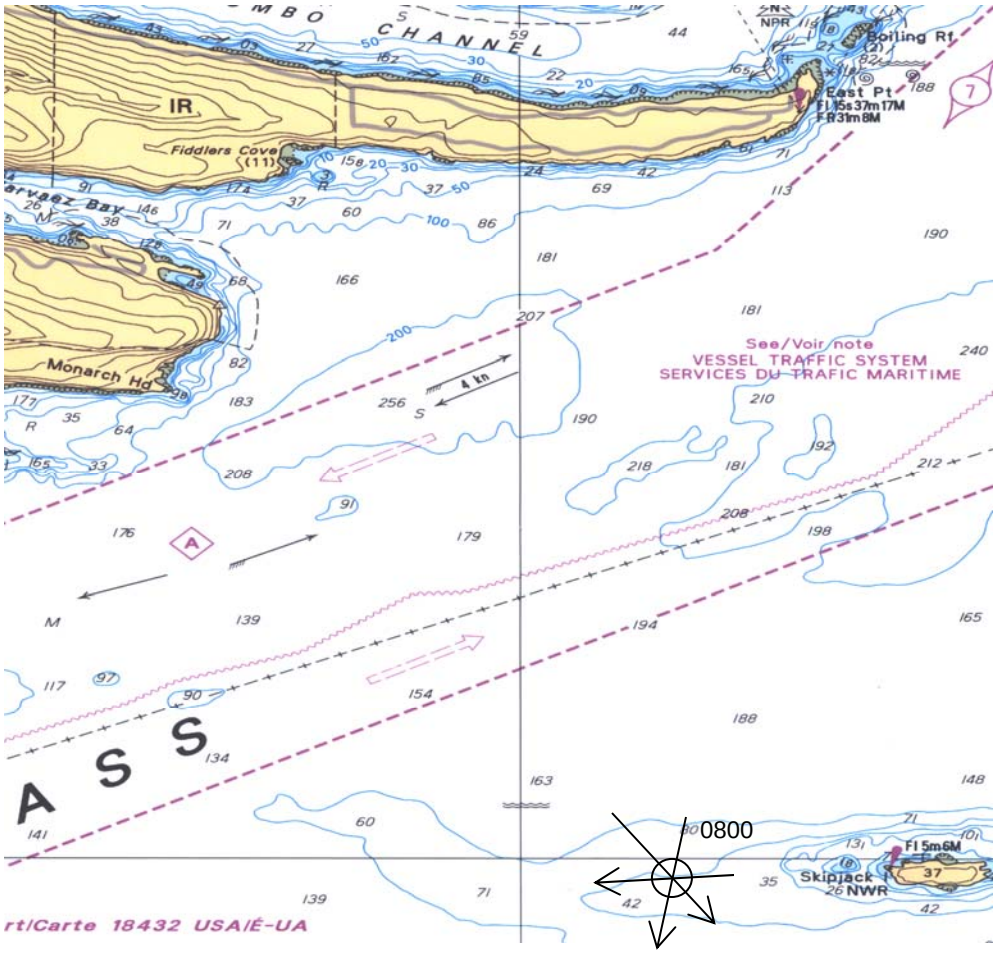


Figure A-3 Three-Bearing Fix Step 7

	When plotting LOPs, plot from the black dot at the bottom of the symbol or from the edge of the points of land.

	When referring to edges of land, it is common to use RHE for right-hand edge and LHE for left-hand edge.

ACTIVITY

Complete the following work on your chart. When you have finished, inform your training / phase officer who will correct your work.

On *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*, plot the following fixes.

		Gowlland Pt.	025°			Thieves Bay light	050°
a.	0900	Turn Pt.	225°	b.	0930	Canoe Rk. light	181°
		Wallace Pt.	319°			Beaver Pt. light	310°

		RHE Russell I.	000°			Pt. Fairfax light	090°
c.	1000	Isabella I. light	294°	d.	1030	Greig I. day mark	160°
		Kanaka Bluff light	060°			Dock I. light	190°

SECTION 2
FIXING PAPER TERMINOLOGY

INTRODUCTION

A fixing paper is a set of written instructions that simulate the execution of a ship's passage, allowing the navigator to practice their skills in a safe and controlled environment. Each instruction requires the navigator to use their knowledge to perform chartwork, work out a result, and respond with the correct information as if they were on the bridge of a vessel.

FIXING PAPER TERMINOLOGY

To better understand the principles outlined, it is important to know the following terms.

Course Made Good / Course to Steer (CMG / CTS)

The vessel's direction is affected by wind and current, which is sometimes difficult to predict. After taking two good fixes, the vessel's actual course or CMG can be found. The CMG shall be labelled using a three-digit number and two open arrowheads on the track. The CTS is the actual course that the helmsman steers and is indicated in brackets when it differs from the CMG.

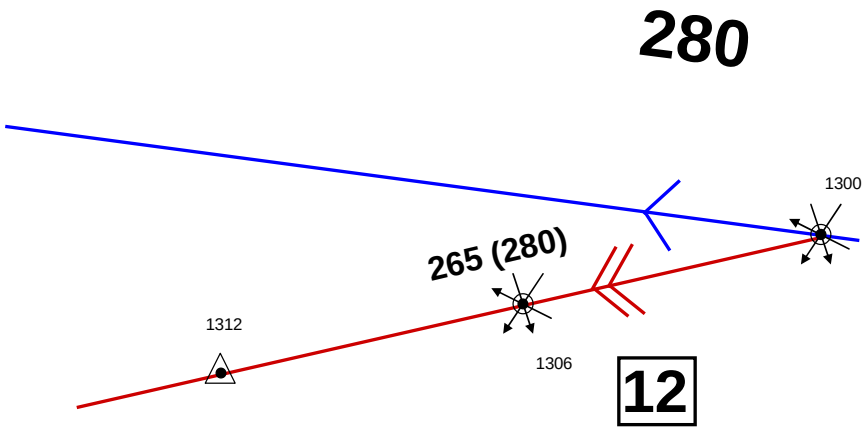


Figure A-4 CMG / CTS

Speed Made Good / Speed Rung On (SMG / SRO)

The vessel's set speed, or speed rung on, is also affected by wind and current. By measuring the distance between two good fixes and dividing by the time interval between them, the SMG can be calculated.

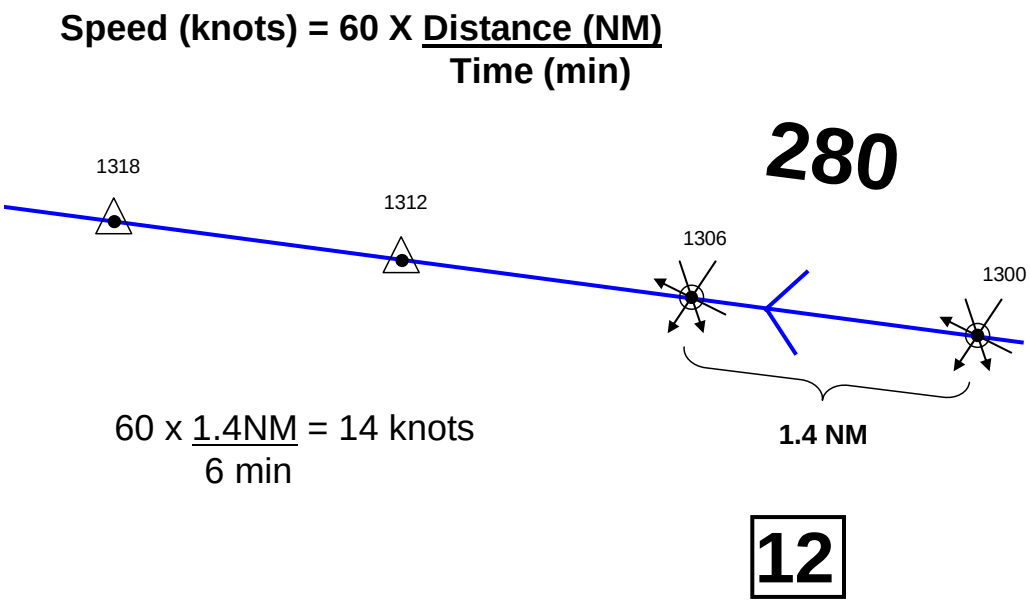


Figure A-5 SMG / SRO

Estimated Position (EP)

An EP is the continuous plotting of a course and position based on the vessel travelling at a constant speed over a set time period. As learned previously, a dead reckoning (DR) assumes the vessel's actual speed was the same as that ordered by the engine telegraphs. If the navigator has calculated the actual speed of the vessel, a more precise estimate of where the vessel will be in the future can be made. The symbol to denote an EP is a dot surrounded by a triangle, drawn in a north–south orientation.

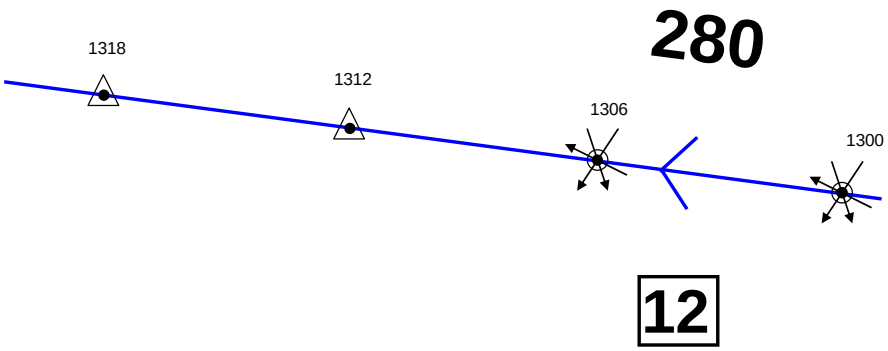


Figure A-6 Estimated Position

Gyro Error

A gyrocompass is a navigational instrument used on a vessel to indicate its direction in relation to True North. Due to the electromechanical nature of a gyrocompass, errors can exist in the direction indicated. Therefore, the gyrocompass should be checked throughout the voyage. If a gyrocompass is not correct, any fixes taken with it will also exhibit the same error. For example, a three-bearing fix is taken that produces a fix known as a cocked hat (as illustrated in Figure A-7).

1300	Danger Shoal	155
	Arachne Reef	267
	LHE D'Arcy Island	195

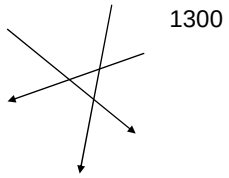


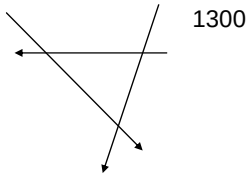
Figure A-7 Cocked Hat

By using a trial and error type procedure known as fix reduction, degrees can be manually added or subtracted from the three bearings (as illustrated in Figure A-8) to find the gyro error. If the gyrocompass reads higher than the actual bearing, the error is high and must be subtracted.

ADD 1

1300	Danger Shoal	155	**156**
	Arachne Reef	267	**268**
	LHE D'Arcy Island	195	**196**

Result: Larger cocked hat



SUBTRACT 2

1300	Danger Shoal	155	**153**
	Arachne Reef	267	**265**
	LHE D'Arcy Island	195	**193**

Result: Fix, Gyro Error is 2° high

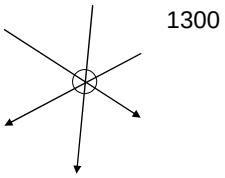


Figure A-8 Fix Reduction

SECTION 3
COMPLETE A FIXING PAPER

Using *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel*, complete the fixing paper below. Show all work on the chart using the correct symbology. Answer any questions in the space provided.

Q#	TIME	QUESTION	ANSWER
1	1030	Use *Chart 3441 Haro Strait, Boundary Pass and / et Satellite Channel.* The ship's position was read from the GPS as: 48° 41.0' N, 123° 05.0' W. You are steering course 310° and have Speed 10 rung on. Show DRs for 6 and 12 minutes.	
2	1036	Skipjack I light 048° RHE Stuart I 268° RHE Blunden I 322° Plot the fix.	
3		Where are you in relation to your track? Explain how far off, to which side and why you could be off track.	
4		Properly label CMG, SMG and the EP for minute 42 on the chart.	
5	1048	Gowlland Pt 1.91 NM Satellite I 1.95 NM Sandy Pt 3.32 NM Plot the fix. Show two DRs.	
6		Alter course to 275° Speed 12. Lay down and label the new track from the last fix.	
7	1056	Turn Pt light 227° Tilly Pt 344° Gowlland Pt light 023° Plot the fix. Show SMG and DRs for 6 and 12 minutes.	
8	1108	Turn Pt 208° at 1.68 NM Plot the fix. Show 6 and 12 minute EPs.	
9	1114	Pelorus Pt 1.32 NM Parkin Pt 2.02 NM Parkin Pt 282° Plot the fix.	

Q#	TIME	QUESTION	ANSWER
10		A fishing vessel has been reported taking on water in position 48° 38.0'N, 123° 15.1' W. Plot the vessel's position. Determine the CTS and DR time to the vessel at your current speed.	
11	1116	Pt Fairfax light in transit with Dock I light 233° Turn Pt light 151° Plot the fix.	
12		Does the chart agree with the gyro? If not, what was the gyro error?	
13	1128	Pt Fairfax light 263° Arachne Rf light 233° Turn Point light 134° Plot the fix.	
14	1132	RHE Comet I 251° Rum I light 212° Arachne Rf light 280° Plot the fix. Show the SMG, CMG, 6 and 12 minute DRs. What is the DR time to the distressed vessel?	
15		Alter course to 180° and increase speed to 20 kts from the 1132 fix.	
16		How close will you pass to the position of the fishing vessel? What time will this be?	
17		What country are you in at 1132?	
18	1146	As you stop to help the fishing vessel, the visibility closes in. When all way is off the ship the following fix is taken: RHE Mandarte I 274° LHE Halibut I 211° Hamley Pt 1.28 NM Plot the fix.	
19	1206	Having saved the fishing vessel, you are now ready to proceed. LHE Halibut I 274° Halibut I 0.80 NM Hamley Pt 1.28 NM Plot the fix.	

Q#	TIME	QUESTION	ANSWER
20		How far have you drifted and in what direction? Calculate the speed the vessel has drifted at.	
21		From your last fix, what would be the CTS and speed needed to reach a position with Kelp Rf. light at 270° and five cables away by 1234?	

	Congratulations, you have completed your self study package on EO X51.10 (Complete a Fixing Paper). Complete the following exercise and hand your completed package to the training officer / phase officer who will record your completion in your Phase Five logbook.

THREE-BEARING FIX – ANSWER KEY

If the fixes are plotted correctly, the following symbols should be identified:

- Border between Canada and USA,
- 64 m depth,
- Contour line around 34 m hole, and
- 44 m depth.

Check to ensure the cadets are using the correct symbol for a fix:

- Arrows away from the object,
- Circle around the intersection of the LOPs,
- Four digit time next to the fix, and
- Each fix no larger than the diameter of a quarter.

FIXING PAPER – ANSWER KEY

Q#	Answers	Mark
1.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12, ☐Course Label, ☐ Speed Box, ☐ Plot Correct	**/ 7**
2.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12	**/ 4**
3.	☐ 0.15 NM (300x), ☐ Port, ☐ Wind or Current	**/ 3**
4.	☐ CMG: **299**, ☐ SMG: **11 kts**, ☐ Course Label (CMG[CTS]), ☐ EP Correct	**/ 4**
5.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12	**/ 4**
6.	☐ Track correct, ☐ Course Label, ☐ Speed Box	**/ 3**
7.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12, ☐ SMG: **12.8 kts**,	**/ 5**
8.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12	**/ 4**

Q#	Answers	Mark
9.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12	**/ 4**
10.	☐ Plot correct, ☐ CTS: **176**, ☐ DR Time: **27 min @ 1141**	**/ 3**
11.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12	**/ 4**
12.	☐ Does the chart agree? **NO, 1° LOW**	**/ 1**
13.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12	**/ 4**
14.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12, ☐ SMG: **12.7 kts**, ☐ CMG: **176**, ☐ DR Time: **13 min @ 1145**	**/ 7**
15.	☐ Track correct, ☐ Course Label, ☐ Speed Box	**/ 3**
16.	☐ Distance: **0.2 NM (400x)**, ☐ Time: **8 min @ 1140**	**/ 2**
17.	☐ Country: **USA**	**/ 1**
18.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12	**/ 4**
19.	☐ Fix, ☐ Track, ☐ DR 6, ☐ DR 12	**/ 4**
20.	☐ Distance: **0.9 NM**, ☐ Direction: **164**, ☐ Speed: **2.7 kts**	**/ 3**
21.	☐ Plot position, ☐ CTS: **164**, ☐ Speed: **10**	**/ 3**

Q#	Answers	Mark
	All answers should be accurate to within 100x for distances, 2 minutes for times, 2 knots for speeds and 2 degrees for bearings.	**/ 77**

Evaluator's Notes: