CANADIAN HYDROGRAPHER CERTIFICATION SCHEME

CANDIDATE HANDBOOK

November 28, 2017

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Abbreviations

ACLS	Association of Canada Lands Surveyors
CBEPS	Canadian Board of Examiners for Professional Surveyors
CHCP	Canadian Hydrographer Certification Panel
FIG	International Federation of Surveyors
IBSC	International Board on Standards of Competence for Hydrographic Surveyors and Nautical Cartographers
ICA	International Cartographic Association
IHO	International Hydrographic Organization

1 Introduction

The Association of Canada Lands Surveyors (ACLS) Hydrographic Surveyor Certification Scheme provides a pathway for certification of hydrographic surveyors to international standards. The certification process is designed to ensure that those purporting to be hydrographic surveying specialists have the appropriate skills, knowledge and experience to meet contemporary demands. It applies FIG/IHO/ICA competency standards for hydrographic surveyors by confirming evidence of academic study and combines this with a detailed assessment of a candidate's verified employment history and relevant experience to assess competency and award certification.

2 Scope

The Canadian Hydrographer Certification Panel (CHCP) is structured within the ACLS, comprising of individuals from Government, Academia and the private sector who are experts in various fields of hydrographic and offshore surveying. The CHCP assesses applications under ACLS Hydrographic Certification Scheme and informs the ACLS Board of Examiners of its decisions.

The ACLS Hydrographic Surveyor Certification Scheme was recognized on 8 April 2016 by the FIG/IHO/ICA International Board on Standards of Competence for Hydrographic Surveyors and Nautical Cartographers (IBSC) as complying with the standards defined in Publication S-5: Standards of Competence for Hydrographic Surveyors, Eleventh Edition, Version 11.1.0 dated December 2014.

The ACLS Hydrographic Surveyor Certification Scheme is open to all persons, and to obtain certification a person need not be a member of the ACLS. A person wishing to achieve certification will have to satisfy the requirements stipulated by the relevant criteria.

3 Minimum Requirements

The minimum academic requirement depends on the level of certification sought by the candidate.

In addition, as a minimum, the candidate shall also be required to show proof of successful completion of the following marine courses:

- Innovation, Science and Economic Development Canada - Restricted Operator's Certificate (Maritime) – ROC(M)
- Transport Canada - Marine Emergency Duties: MED A1 or MED A3
- Transport Canada - Small Vessel Operator Proficiency (SVOP)

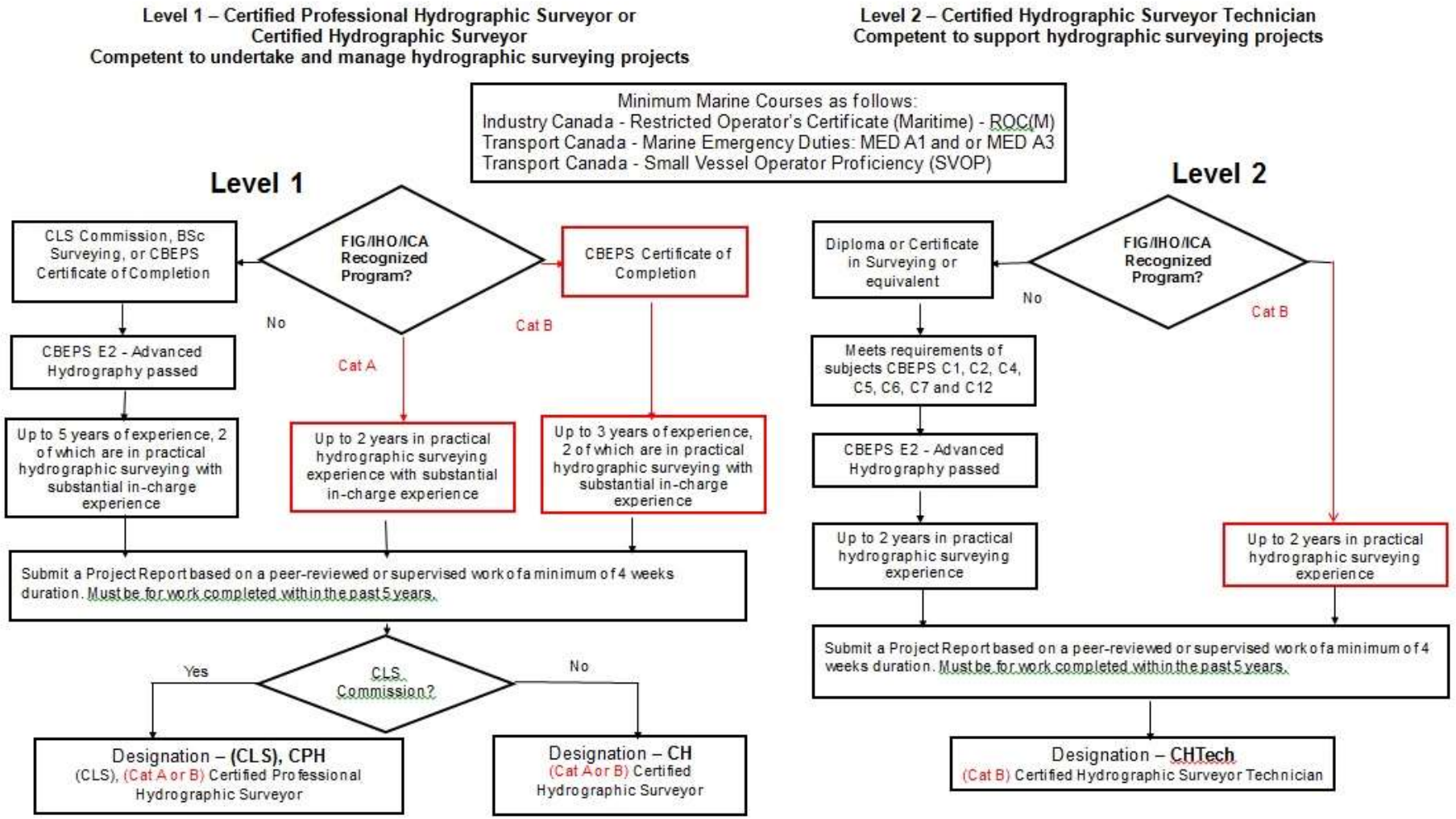
Information on the scope of the above marine courses are provided on the relevant government of Canada websites. The candidate may be exempt from these courses based on experience or other marine qualifications. Candidates may undertake the above courses prior to or after being admitted as candidates, but certification will not be issued until all requirements are met.

In all cases, candidates must submit a project report acceptable by the CHCP. The project report shall be based on a peer-reviewed or supervised work of a minimum of 4 weeks duration and completed within the 5 years prior to the issue of the Hydrographic Certification.

4 Certification Flow Chart

The ACLS Program has two levels of certification as detailed on following pages.

Figure 1 Flow Chart



To be clear, no person shall be allowed to use the Category A or Category B designation unless that person has completed an FIG/IHO/ICA recognized Category A or Category B pathways.

5 Level 1 – Certified Hydrographer (CH)

A Certified Hydrographer (CH) is competent to undertake and manage hydrographic surveying projects. There are three path ways to this level.

5.1 Category A Course

Individuals having successfully completed a IBSC recognize Category A Course are eligible for Level 1 Certification if they have up to 2 years of practical hydrographic surveying experience with substantial in-charge experience acceptable to the CHCP.

5.2 Category B Course

Individuals having successfully completed a IBSC recognize Category B Course and holds a Canadian Board of Examiners for Professional Surveyors (CBEPS) Certificate of Completion are eligible for Level 1 Certification if they have up to 3 years of experience, 2 of which are in practical hydrographic surveying with substantial in-charge experience acceptable to the CHCP.

5.3 CLS Commission, BSc. Surveying or CBEPS Certificate of Completion

Individuals holding a Canada Lands Surveyor (CLS) Commission, a Bachelor of Surveying (or equivalent) or a Canadian Board of Examiners for Professional Surveyors (CBEPS) Certificate of Completion are eligible for Level 1 Certification once they have successfully written the CBEPS E2 Advanced Hydrographic Surveying exam and have up to 5 years of experience, 2 of which are in practical hydrographic surveying with substantial in-charge experience acceptable to the CHCP.

6 Level 2 – Certified Hydrographic Technician (CHTech)

A Certified Hydrographic Technician (CHTech) is competent to support hydrographic surveying projects. There are two path ways to this level.

6.1 Category B Course

Individuals having successfully completed a IBSC recognize Category B Course are eligible for Level 2 Certification if they have up to 2 years of practical hydrographic surveying experience with substantial in-charge experience acceptable to the CHCP.

6.2 Diploma or Certificate in Surveying (or Equivalent)

Individuals who have completed a 2 or 3 year college diploma or certificate in surveying (or equivalent) from a learning institution are eligible for Level 2 Certification if they have successfully written the exams for CBEPS subjects listed below or have taken a CBEPS recognized courses. Candidates also have to demonstrate up to 2 years of practical hydrographic surveying experience with substantial in-charge experience acceptable to the CHCP.

Where the required CBEPS subjects are as follows:

- C1 – Mathematics
- C2 – Least-Squares Estimation and Data Analysis
- C4 – Coordinate Systems and Map Projections
- C5 – Geospatial Information Systems
- C6 – Geodetic Positioning
- C7 – Remote Sensing and Photogrammetry

- C12 – Hydrographic Surveying
- E2 – Advanced Hydrographic Surveying

7 Procedures for Submission

The CHCP meets every four months to review applications and notify the ACLS Board of Examiners of its decision. The deadline for the submission is one month prior to each CHCP meeting. Dates of meetings can be obtained from the ACLS Website.

Candidates must provide the following:

a) A completed application form (available in the "Forms" section of the ACLS Website) and pay the application fee.
b) Completed copies of the ACLS Hydrographic and Offshore Surveyor Experience Logbook (available in the "Forms" section of the ACLS Website).
c) Details of their educational background in support of their application (see section 8).
d) Proof of successful completion of the required marine courses (see section 3).
e) Copy of a suitable Project Report.

Generally the CHCP expects the above documentation to be provided in PDF format legible between 200 to 300 dpi. Candidate will provide as many "ACLS Hydrographic and Offshore Surveyor Experience Logbook" forms as are necessary to meet the experience duration requirements.

Applications will be evaluated in terms of the overall hydrographic and/or offshore surveying competence, taking into account the candidate's relevant academic qualifications and practical experience.

The CHCP may ask the candidate to submit additional supporting evidence. Such evidence would typically, but is not restricted to personal statements, copies of survey documentation, affidavits, academic transcripts and copies of professional licensing/registration. A personal interview by the CHCP will also be an option.

For the submission of these documents and for further information please contact the following:

ACLS Registrar
Association of Canada Lands Surveyors
900 Dynes Road, Suite 100E
Ottawa Ontario K2C 3L6
Canada
Tel: 613-723-9200
Fax: 613-723-5558
Email: jctetreault@acls-aatc.ca

8 Essential Documentation

The application must contain sufficient information to enable the CHCP to assess and candidate's education and experience to determine eligibility for certification.

8.1 Evidence of Educational Qualifications

One of the following should be included with application:

- Copy of CLS Commission
- Copy of certificate for the completion of a Category A or B course
- Copy of CBEPS Certificate of Completion
- Copy of diploma or certificate in surveying

Where the candidate has a Bachelor of Surveying (or equivalent) educational qualifications then the candidate will provide at least the following:

- An official transcript(s) of marks (official copy mailed directly to the ACLS Registrar).
- Detailed course description of material covered in each course during the year taken, together with a breakdown of the number of hours spent on each major part.
- Number of hours in the academic term that were reserved for (a) classes and (b) laboratory assignments.
- List of prerequisite courses for each course taken.

In cases where a candidate wishes to seek exemption from writing the E2 examination or the candidate has a college diploma or certificate, and feels that he or she should be exempted from writing an exam for subjects C1, C2, C4, C5, C6, C7 and C12, then the candidate must submit a completed Exemption Request Form available in “Forms” section of the ACLS Web site.

Complete learning outcomes and study guides for CBEPS Subjects C1, C2, C4, C5, C6, C7 and C12 are available on CBEPS Web site at: http://cbeps-cceag.ca/learning-outcomes-and-study-guides.

8.2 ACLS Hydrographic and Offshore Surveyor Experience Logbook

The purpose of the Logbook is to provide the CHCP with sufficient information to determine the candidate’s achievement of specific hydrographic and/or offshore experience criteria as specified in Section 4 and achieve of the requisite degree of hydrographic and/or offshore surveying competence for the certification level sought.

The Logbook should contain comprehensive descriptions of specific hydrographic surveying tasks or projects undertaken including the following information:

- Task or projects description and their aim.
- The candidate’s personal responsibilities.
- Equipment used by the candidate.
- A brief description of the work undertaken in order that the CHCP can determine the practical requirements of the work undertaken.
- Independent authentication of a candidate’s involvement in these projects. The CHCP considers authentication by signature on the candidate’s Logbook by the candidate’s immediate supervisor to be the preferred option.

Sea-time is a critical component of the certification process and, for the purposes of assessment, is defined as time spent surveying whilst embarked in a hydrographic survey platform (sea-going vessels; a fixed wing aircraft or helicopter undertaking remote sensing hydrographic surveys, etc.). Based on a realistic assessment of full-time employment, one year of sea-time has been defined as 180 days, and for shore-based surveyors one day is defined as 7.5 hours.

Experience need not all be sea-time but may be a combination of practical hydrographic and/or offshore surveying, office related surveying activities and geomatics activities. The candidate shall be obliged to provide sufficient information to determine the candidate’s achievement of the specified

experience criteria and achievement of the requisite degree of surveying competence for the level of certification sought.

For Level 1, the candidate will be assessed as competent to undertake and manage hydrographic or offshore survey projects. Hence it is essential that, for certification at this level, the candidate will have to clearly articulate in their logbook, experience in charge of the planning, management and conduct of a variety of practical hydrographic and/or offshore surveying activities.

8.3 Project Report

The candidate is required to submit a satisfactory Project Report. The purpose of this submission is to allow the CHCP to determine that the candidate has been engaged in hydrographic or offshore surveying at a responsible and professional level. Below are guidelines as to what constitutes an acceptable project, the required level of involvement by the candidate and general project report requirements. It is highly recommend that the candidate structure the project report in accordance with these guidelines.

The subject of the proposed Project Report must be approved by the CHCP before the Report is submitted. In the request for approval the candidate should provide: (a) a general description of the project; (b) the role of the candidate in the project; (c) the purpose of the project, for whom it was done and when it was carried out.

The project must be related to hydrographic or offshore surveying and be of such a nature, extent and level of complexity as to demonstrate clearly the professional competence and judgment required of a professional surveyor.

The candidate must be able to demonstrate a critical analysis of the work performed from a technical and management prospective. The goal of the Project Report is test the candidate's knowledge, implementation, and evaluation of procedures, standards, contracts, logistics, and survey equipment; assess the candidate's ability to liaise with the project team, client and exterior organizations; and project management skills.

The project should be of at least 4 weeks duration and have been completed in the last five (5) years. The project may be related to peer-reviewed or supervised work. Where the candidate is not directly under supervision then peer-reviewed work would be more suitable. If the work is supervised, then the intent is that the field project be performed under the supervision of a practicing professional surveyor or engineer.

The written portion of the report should be presented in a professional style and should be clear and concise with no extraneous information. The report should be submitted with plans, field notes and other pertinent information contained within the appendices of the report. Photos and portions of plans may be included in the text of the document where appropriate. The report should be prepared in a narrative format and should read as a professional report.

For the CHTech designation the candidate should follow the above guidelines but the Project Report should be more focused on technical, equipment and logistic aspects.

8.4 Assessment of Competencies

The CHCP will use the Essential and Optional subject syllabus available in Publication S-5: Standards of Competence for Hydrographic Surveyors, Eleventh Edition, Version 11.1.0 dated December 2014 to assess candidate's competencies in hydrographic and/or offshore surveying.

9 E2 Advanced Hydrographic Surveying Examination

Candidates who cannot provide evidence of having graduated from a FIG/IHO/ICA recognized Cat A or Cat B program or having passed an equivalent course, will have to pass the E2 Advanced Hydrographic Surveying examination. In cases where a candidate has passed an equivalent course, the candidate will be interviewed to ensure academic compliance with S-5 or advised to undertake further training or taking the E2 examination.

If the candidate does not meet the E2 requirements, he or she will be provided with a take home exam which will be followed by an interview conducted using the GoToMeeting web conferencing system.

9.1 Marking of E2 Examination

The examination will be marked by the one or more Special Examiners. The results of the marking will be provided to the candidate as soon as possible according to availability of examiners. The pass mark for is sixty percent (60%) of the total value of marks for the examination.

10 Appeals

If a candidate has been denied certification by the CHCP, that candidate may appeal to the Chair of the CHCP to have his or her application reconsidered. If the candidate is not satisfied with that decision, the candidate can appeal to the Chair of the ACLS Board of Examiners. The basis for appeal would be if the candidate believed they were evaluated unfairly, believed that mistakes have been made in the assessment process, or believed that results of any examination were flawed. This must be done in in writing to the CHCP, within one (1) year from the date of the CHCP's evaluation notification to the candidate.

11 Code of Ethics

All persons with CH or CHTech designations are expected to abide by the ACLS Code of Ethics which is section 3 of the Canada Lands Surveyors Regulations at: http://laws-lois.justice.gc.ca/eng/regulations/sor-99-142/page-1.html#h-2 (last accessed: 09 July 2016).

12 Certificate and Designation

Candidates having met all requirements at the satisfaction of the CHCP for a particular level will be issued a certificate indicating the Level attained. In addition, those who have demonstrated academic training as either Category A or B will have it mentioned on the certificate.

Individuals having completed all of the Level 1 requirements will be able to use the designation CH. If the candidate also completed a Category A or B course, the candidate will be able to use the designation Cat A CH or Cat B CH depending on the IBSC recognized course taken.

Individuals having completed all of the Level 2 requirements will be able to use the designation CHTech. If the candidate also completed a Category B course, the candidate will be able to use the designation Cat B CHTech.

A list of the persons with these designations will be available on the ACLS website. The certificate will remain current providing the maintenance requirements are met.

13 Maintenance of Certification Currency

For either the CH or CHTech designation, CHCP will require re-certification within in one (1) year after the award of the respective designation. Re-certification will require the candidate to provide a detailed account of the experience over the previous twelve (12) months prior to the re-certification submission.

14 Continuing Professional Development

For the purposes of the ACLS Hydrographic Surveyor Certification Scheme, all CH or CHTech designation holders will have to meet the ACLS Mandatory CPD conditions.

The ACLS Registrar and the ACLS CPD Committee manage the ACLS CPD program. The minimum required CPD credit hours is 45 hours over the previous 3 calendar years.

For the ACLS Hydrographer Certification Scheme, a certified individual who is unable to comply with the requirements of the ACLS CPD program due to extenuating circumstances may apply to the Registrar for an exemption.

Where a CH or CHTech does not meet the minimum CPD requirements, the ACLS Registrar will contact this person to determine if there are extenuating circumstances which may give rise to an exemption. Should there be none and this person does not take reasonable steps to meet the minimum requirements, then this person's certificate will not be renewed.

The ACLS CPD program is based on credit hours earned in any of the following recognized CPD activities. For the ACLS Hydrographic Surveyor Certification Scheme the CPD must be focused on hydrographic and/or offshore surveying.

14.1 Courses and Seminars

Courses, seminars, workshops or other training provided by

- the Association;
- academic institutions;
- other surveying or related professional associations or bodies;
- vendors; or
- any other educator,

where the content is related to the Member's professional practice: 1 hour of activity = 1 CPD credit hour. For CH and CHTech designations a minimum of 5 hours per year.

14.2 Participation

Participation on Council, committees or task forces of the ACLS or other surveying or related professional associations or bodies. 2 hours of activity = 1 CPD credit hour.

14.3 Presentations, Papers and Research

Presentations, authored papers and research related to the member's professional practice. 2 hours of activity = 1 CPD credit hour.

14.4 Attendance at meetings

Attendance at annual general meetings or regional meetings of the Association or other surveying or related professional associations: 1 hour of activity = 1 CPD credit hour.

14.5 Self-initiated study

Self-initiated study directly related to a Member's professional surveying practice:

- to research new or historical surveying techniques or legislative requirements, issues, or concerns; or
- to acquire accreditation in any survey jurisdiction:

1 hour of activity = 1/2 CPD credit hour (maximum 10 credit hours per year).

15 Applicable Fees

The following applicable fees would be payable based on current ACLS fee structures as shown in the Table below. The ACLS may amend this schedule of fees from time to time.

Table Applicable Fees

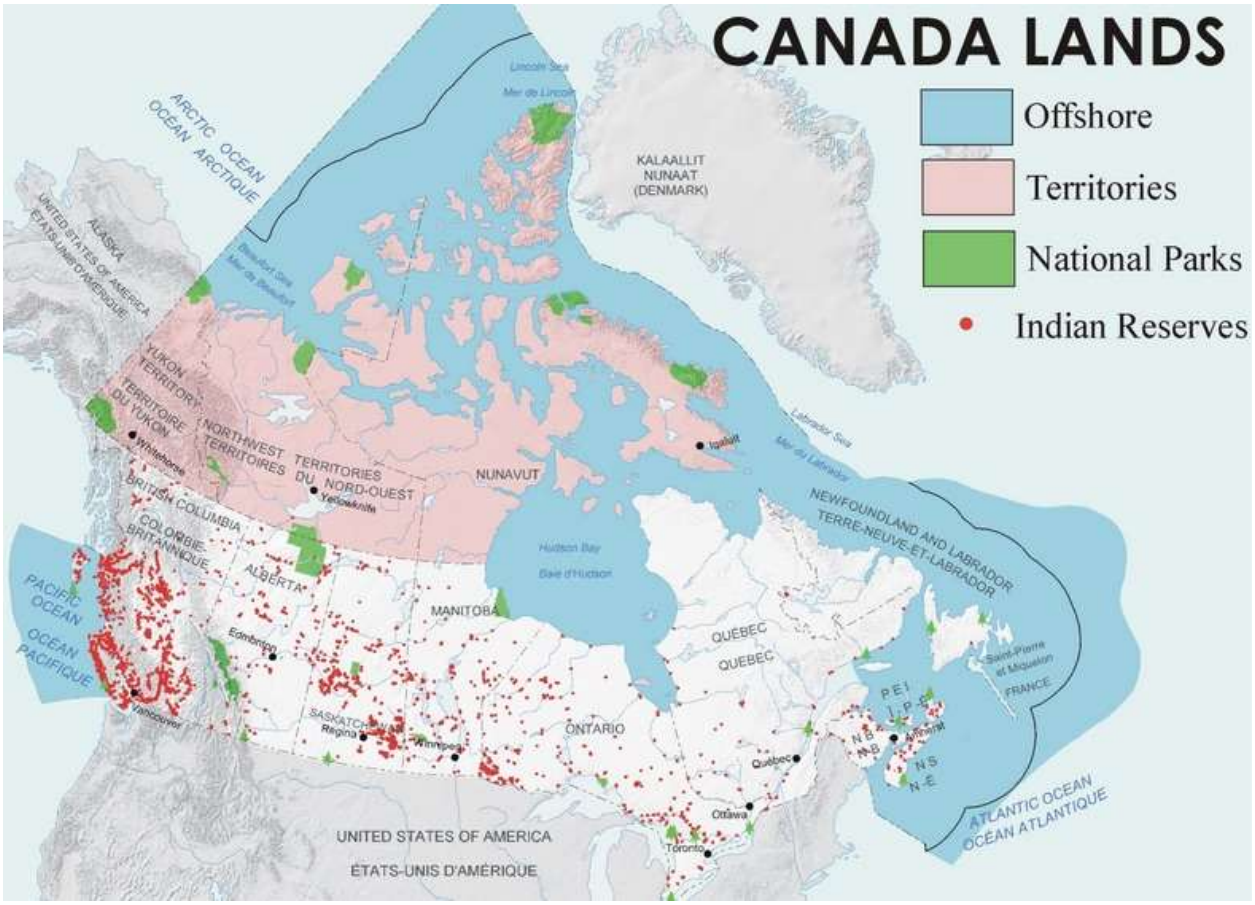
Service	ACLS Member Fees	Non ACLS Member Fees
Candidate fee for initial submission and assessment	C$ 325	C$ 500
Yearly recertification fee for either CH or CHTech designation	C$ 225	C$ 350

16 About ACLS

The ACLS is a non-profit, non-government organization, and the only federally-enacted self-regulated professional surveying association in Canada. The ACLS is multi-disciplinary encompassing all geomatics related services, including hydrographic and offshore surveying.

To clarify "Canada Lands" encompass all of the offshore areas of Canada, from sea to sea to sea, as shown in the Figure overleaf. The ACLS is the national licensing body for all surveyors carrying out property rights and boundary related surveys on and under the surface of Canada's oceans and in the three Canadian territories (Yukon, Northwest Territories and Nunavut), as well as in federal national parks and on First Nations lands.

Figure 2 Canada Lands


CANADA LANDS
Offshore
Territories
National Parks
Indian Reserves
ARCTIC OCEAN
OCEAN ARCTIQUE
KALAALLIT NUNAAT (DENMARK)
ALASKA
UNITED STATES OF AMERICA
ÉTATS-UNIS D'AMÉRIQUE
YUKON TERRITORY
TERRITOIRE DU YUKON
NORTHWEST TERRITORIES
TERRITOIRES DU NORD-OUEST
NUNAVUT
BRITISH COLUMBIA
COLOMBIE-BRITANNIQUE
ALBERTA
MANITOBA
ONTARIO
QUEBEC
QUÉBEC
NEWFOUNDLAND AND LABRADOR
TERRE-NEUVE-ET-LABRADOR
PACIFIC OCEAN
OCEAN PACIFIQUE
ATLANTIC OCEAN
OCÉAN ATLANTIQUE
Whitehorse
Yellowknife
Iqaluit
Edmonton
Vancouver
Regina
Winnipeg
Quebec
Ottawa
Toronto
Saint-Pierre et Miquelon
FRANCE
P.E.I.
N.B.
N.S.

Appendix – Learning Outcomes – CBEPS E2 – Advanced Hydrographic Surveying

Introduction

The advanced hydrographic surveying elective syllabus item E2 criteria covers in depth all aspects of hydrographic and offshore surveying. E2 builds on the CBEPS hydrographic surveying mandatory syllabus item C12. If the candidate has not already passed C12, it is recommended the candidate become fully familiar with and understands the C12 Learning Outcomes, Study Guide and associated questions, and Study Material before proceeding further.

The elective E2 requires a fuller and more in depth understanding of all C12 topics. In addition, E2 covers such topics as follows: contract charting surveys, offshore engineering surveys, and offshore construction support. The charting surveys are usually undertaken under the auspices of the Canadian Hydrographic Service (CHS) or a similar entity, and the offshore surveys are usually undertaken in offshore Canada Lands for various oil and gas companies. The Learning Outcomes of E2 are a combined subset of most of the outcomes defined in the International Hydrographic Organization (IHO) S-5 document “Standards of Competence for Hydrographic Surveyors”, and knowledge in offshore oil and gas surveys. Those topics which are omitted from the S-5 standard are already covered in other CBEPS subjects.

The candidate who successfully passes E2 will be able to further the interest in and activities related to hydrographic surveying within their province or territory.

The elective E2 is a requirement to become a Certified Professional Hydrographer (CPH) if an Association of Canada Lands Surveyors (ACLS) member, or otherwise a Certified Hydrographer (CH), also via the ACLS.

Should any candidate become involved in these surveys, it is suggested that at least the Transport Canada Marine Emergency Duties A1 or A3, and Small Vessel Operator Proficiency certificates are obtained before any of these surveys is carried out, along with any oil and gas industry safety requirements. For candidates who chose to become a CPH or CH then these courses in combination with practical hydrographic and/or offshore survey experience should satisfy the IHO S-5 Basic 4: Nautical Science component, which will be assessed by the ACLS.

Recommended Prior Knowledge and Skills

Item C1: Mathematics
Item C2: Least-Squares Estimation and Data Analysis
Item C3: Advanced Surveying
Item C4: Coordinate Systems and Map Projections
Item C5: Geospatial Information Systems
Item C6: Geodetic Positioning (which includes GNSS RTK)
Item C7: Remote Sensing and Photogrammetry
Item C9: Survey Law
Item C11: Business Practice and the Profession
Item C12: Hydrographic Surveying
Item E1: Spatial Databases and Land Information Systems

Learning Outcomes

In order to fulfil the requirements of this syllabus item, each candidate should possess **IN DEPTH** knowledge of the following topics.

1. Background and the Natural Environment

Topic	Outcome
Historical Context	Describe the history of hydrography including the development of hydrographic related measurement units, the echo sounder, radio positioning, other physical means of positioning, and aids to navigation. Describe the historic role of offshore surveying related to the international oil and gas industry.
Marine Environment Introduction	Describe oceanic marine geology, seawater properties, and seawater circulation. Describe continental margin geology and seawater circulation and composition. Describe near shore geology and seawater circulation, and river fresh and seawater mixing.

2. Underwater Acoustics

Topic	Outcome
Review	Full review of all associated topics in C12
Acoustic Fundamentals	Distinguish between plane and spherical waves. Distinguish between sound speed and particle velocity. Describe the Active Sonar Equation. Define acoustic units, intensities and sound levels
Acoustic Velocity	Calculate sound speed from measurements of temperature, pressure (depth), and salinity (conductivity).
Sound Wave Propagation	Describe how acoustic waves are generated, define source level. Explain the causes of propagation loss and list the differences in water properties that affect propagation loss.
Ray Tracing	Describe the effects of variation of sound speed in the water column on the path of sound rays through the water. Describe the basic principles of ray path development and analysis. Predict shallow zones and sound channels.
Reflection and Scattering of Acoustic Waves	Describe the characteristics of the seafloor and seafloor targets that affect the reflection of acoustic waves. Define the characteristic impedance of an acoustic medium. Assess the effects of varying seafloor composition, texture, and slope on echo strength.
Acoustic Noise and the Directivity Index	Identify the sources of noise in the environment and describe the effect of noise on echo sounding. Define the directivity index. Calculate the effect on sonar range of a variety of noise conditions and sonar directivity circumstances.

3. Single Beam Echo Sounders (SBES)

Topic	Outcome
Review	Full review of all associated topics in C12
Transducers	List the transducer characteristics that affect beam width. Describe the piezo-electric principle and explain its application to transducers. Describe the arrangement of single element and multi-element array transducers.
Data Recording	Evaluate and select appropriate range, scale, and pulse repetition rate for specific applications.
Equipment Evaluation	Describe and provide an in depth analyse the technical performance of various SBES systems and how to select appropriate system(s) for certain site conditions.

4. Multibeam Echo Sounder (MBES)

Topic	Outcome
Review	Full review of all associated topics in C12
Multibeam Transducers	Explain the basic principles of MBES shading and focussing, using flat or curved transducers.
Coverage and Accuracy (or Error Budget)	Estimate depth coverage and uncertainty, taking all factors into account.
Object Detection	Predict the nominal sounding density on the seafloor using available information for depth, vessel speed, beam dimensions, and total swath angle. Determine the beam footprint size and sounding spacing across the swath and assess the limitations and likelihood of detecting objects on the seafloor under varying surveying conditions.
Backscatter	Describe the generation of backscatter data and the various modes of backscatter recording (e.g., beam average, side scan time series, beam time series). Explain the concept of angle dependence and describe the signal processing steps required to obtain corrected backscatter data for seafloor characterization.
Equipment Evaluation	Describe and provide an in depth analyse the technical performance of various MBES systems and how to select appropriate system(s) for certain site conditions.

5. Phase Differencing Bathymetry (Interferometry)

Topic	Outcome
Phase Differencing Systems	Explain the principles and geometry of interferometry and phase differencing bathymetric sonars and the arrangement of transducer arrays.
Deployment and Mounting	Describe the options for deployment and mounting of phase differencing systems.
Equipment Evaluation	Assess the relative merits of multibeam and phase differencing systems for specific mapping applications in water depths from very shallow to full ocean depths.

6. Side Scan Sonar (SSS)

Topic	Outcome
Review	Full review of all associated topics in C12
SSS vs MBES	Explain the differences between side scan sonar and similar data provided by MBES, interferometric multibeam or bathymetric side scan systems.
Equipment Evaluation	Describe and provide an in depth analyse the technical performance of various SSS systems and how to select appropriate system(s) for certain site conditions.

7. Sub Bottom Profiler (SBP)

Topic	Outcome
Sub Bottom Profiler Systems	Explain the effect on sub bottom profiler performance of frequency, resolution, gain, towing speed, and deployment (pole mount and shallow tow). Evaluate and select appropriate sub bottom profiler frequency, features and deployment, for specific applications.
Sub Bottom Profiler Data Interpretation	Describe the different types of sub bottom profilers and their application. Explain sub bottom profiler signatures of such items as typical river bed strata, debris, wrecks, pipelines, and gas.
System Selection	Identify sub bottom profiler characteristics that affect performance in varying survey applications. Specify appropriate sub bottom profiler characteristics (e.g. resolution, frequency, bandwidth, and beamwidth) for specific applications.
Equipment Evaluation	Describe and provide an in depth analyse the technical performance of various SBP systems and how to select appropriate system(s) for certain site conditions.

8. Marine Magnetometer

Topic	Outcome
Marine Magnetometer Systems	Explain the effect on marine magnetometer performance of frequency, resolution, gain, towing speed, and deployment (towed or held by diver). Evaluate and select appropriate marine magnetometer frequency, features and deployment, for specific applications.
Marine Magnetometer Data Interpretation	Describe the different types of marine magnetometers and their application. Explain marine magnetometer signatures of such items as debris, wrecks, and pipelines.
System Selection	Identify marine magnetometer characteristics that affect performance in varying survey applications. Specify appropriate sub bottom profiler characteristics (e.g. resolution and frequency) for specific applications.
Equipment Evaluation	Describe and provide an in depth analyse the technical performance of various marine magnetometers and how to select appropriate system(s) for certain site conditions.

9. Tide and Non-Tidal Water Levels

Topic	Outcome
Review	Full review of all associated topics in C12
Tidal Fundamentals	Describe the static and dynamic tidal theories. Explain the concept of amphidromic points and co-tidal charts.
Tidal Analysis and Prediction	Determine a preliminary sounding datum from observed water levels.

10. Surface Positioning

Topic	Outcome
Surface Positioning	Describe total station, GNSS RTK and inertial navigation systems positioning for small survey launches and explain the issues and benefits of each. Describe GNSS systems for vessel positioning. Describe INS systems used for hydrographic and offshore surveys.

11. Acoustic Positioning

Topic	Outcome
Acoustic Devices	Describe the purpose and operation of acoustic devices such as: transponders, pingers, acoustic release (tripping) devices, speed of sound in water meters and acoustic Doppler current profilers. Select appropriate acoustic devices for particular applications.
Acoustic Positioning Systems	Describe the principles of long, short and super short baseline acoustic positioning system modes. Describe signal structure, sources of error, and expected uncertainties for each mode.
Deployment and Calibration	Describe the deployment and calibration methods for each mode.
Error Sources and Accuracy	Predict and evaluate sources of error and expected uncertainties for each system and appropriate application for positioning diver(s), a towed body(ies), autonomous underwater vehicles (AUV), and remotely operated vehicles (ROV).

12. Hydrometric Surveys (Streams and Rivers)

Topic	Outcome
Hydrometric Surveys	Discuss the requirements for and observations required including water level recording, and stream or river velocity and area of flow to compute discharge. Describe the various aspects of hydrometric surveys including stream reconnaissance, site selection, station design and construction, instrumentation, gauge height measurement, discharge calculation, stage-discharge rating and discharge compilation.
Water Sampling	Discuss the requirements for and the equipment and methods used to collect stream or river water samples.

13. Other Techniques

Topic	Outcome
Laser Bathymetry	Explain the principles, capabilities and limitations of shipborne and submersible laser bathymetry. Select survey areas suitable for laser bathymetry.
LiDAR Bathymetry	Explain the principles, capabilities, and limitations of bathymetric LiDAR. Describe the environmental and operational environments in which bathymetric LiDAR surveys are complementary to echo sounder surveys.
Remote Sensing Bathymetry	Describe other airborne and satellite remote sensing techniques that can be used for bathymetry. Explain the limitations and advantages of remote sensing.
Mechanical Techniques	Describe wire and bar sweeps.
Other Data Capture	Describe other data capture techniques including underwater laser scanning and synthetic aperture sonar.

14. Meteorology

Topic	Outcome
The Atmosphere	Describe the vertical structure of the atmosphere.
Meteorological Elements	Define the following parameters, explain how they are measured / classified and describe their effect on hydrographic operations: temperature, humidity, dew-point, frost-point, atmospheric pressure, clouds and precipitation, rain, snow, visibility, advection fog and radiation fog.
Winds	Explain the relation between atmospheric pressure and winds, the origin of geostrophic winds and Buys Ballot's law. Describe wind circulation around pressure systems and the effect of friction.
Climatology	Describe the general circulation of the atmosphere and the global distribution of pressure systems, air and sea surface temperatures, winds and precipitation over the oceans, local circulation and land and sea breezes.
Weather Systems	Describe the elements of a weather system and their evolution (e.g. air masses, extra-tropical cyclones, anticyclones and associated weather; fronts, clouds and weather at different stages of fronts; intertropical convergence zone, tropical revolving storms and associated weather).

15. Oceanography

Topic	Outcome
Physical Properties of Sea Water	Explain the effects of solar radiation. Describe the optical properties of sea water. Explain temperature and salinity (T/S) distribution and variation. Prepare T/S diagrams.
Marine Circulation Dynamics	Define types of circulation (e.g. geostrophic, wind-driven, Ekman spiral, slope currents, coastal and thermohaline). Explain the effect of friction.
General Circulation of the Oceans	Define the general characteristics of climatic mean ocean currents. Explain the western intensification of ocean currents and the vertical circulation, along with their driving mechanisms.
Wind Waves and Swell	Define wave parameters. Explain the elements involved in the wave growth process including typical fetches. Explain the relationship between winds, waves, swell, sea state (Beaufort scale), and icing conditions.

Topic	Outcome
Wave Propagation	Define, giving practical examples: refraction, diffraction and reflection. Explain breaking waves, and long-shore and rip current processes.
Oceanographic Measurements	Describe oceanographic sampling, and methods for measuring common oceanographic parameters.
Oceanographic Instruments	Describe principles of oceanographic sensors including temperature / salinity (T/S) probes, current meters, wave sensors and acoustic Doppler current profiler. Select equipment for specific applications.

16. Marine Geology and Geophysics

Topic	Outcome
Marine Geology	Describe various river and sea bed grabs, corers and samplers including cone penetration test (CPT) and their uses. Describe various types of dredging equipment.
Seismic Profiling	Define the objective of continuous reflection / refraction seismic profiling, and the equipment needed to conduct it.
Geotechnical Sampling	Define the objective of geotechnical sampling. Describe geotechnical sampling equipment. Explain how samples are obtained, stored, and analysed.
Deposition and Erosion	Identify types of seabed material. Describe the processes of sediment transport and deposition, as well as the normal fluvial process and formation of bars and other focal points of deposition. Describe the methods of spoil dispersal and selection of spoil grounds.
Environmental Impact	Outline the basic concepts of environmental impact studies. List applications (e.g. to water quality, sedimentation, coastal development, shipping, living and non-living resource development, etc.).

17. Data Management

Topic	Outcome
Real-Time Data Acquisition and Control	Collect hydrographic data manually and automatically. Describe and operate integrated navigation systems and data logging systems. Explain the significance and effect of the use of various data logging rates. Describe the process of on-line data sampling, validation and selection techniques. Explain the effects of using various gating and filtering parameters.
Analogue Data Capture	Explain the manual input of alphanumeric data, raster scanning processes and vector digitisation. Describe digitising systems and scanners. Describe digital data formats. Carry out digital data transfer.
Approximation and Estimation	Apply approximation and estimation procedures to survey measurements. Evaluate and select the best filtering and / or cleaning procedure, for specific applications.
Spatial Data Processing and Analysis	Describe the properties of spatial databases and Database Management Systems (DBMS). Explain the concepts of raster and vector data. Explain the concepts of Geographical Information Systems (GIS) and Spatial data Infrastructures (SDI). Recognize algorithms used for spatial data selection, filtering, smoothing, approximation, estimation, correlation and analysis. Describe Digital Elevation Models (DEMs).
Visualisation and Presentation	Explain and perform manual and automatic plotting and contouring of hydrographic data. Describe the use of vector and raster digitising and

Topic	Outcome
	plotting systems. Describe the hydrographic applications of 3D modelling and visualisation.
Chart and Marine Cartography	Describe the chart compilation and composition process and flow line including chart compilation, adding coastal topography, Canadian and international hydrographic publications and correction of charts.
Electronic Charts	Describe Electronic Navigational Charts (ENC), and Electronic Chart Display and Information Systems (ECDIS) (concepts, components, impact on hydrography).

18. Hydrographic and Offshore Surveys

Topic	Outcome
Review	Full review of all associated topics in C12
Flood Plain Mapping	Explain the forecasting of floods and low waters in rivers draining a large basin. Describe methods of mapping flood plains. Explain how surveying is done under flood conditions.
Nautical Charting	Describe and analyse the IHO S-44 specifications with respect to offshore industrial surveys.
Drilling Support	Describe the purpose and conduct of drilling support surveys including drilling rig positioning, drilling rig anchor placement in congested areas, drilling rig leg sea bed inspections and the role of ROVs in such work. Define terms used to describe offshore hydrocarbon structures and drill rig equipment.
Marine Seismic	Explain the principles and conduct of marine seismic surveys including towed streamer and gravity, transition zone and shallow marine, ocean bottom cable, ocean bottom node, and marine controlled source electromagnetic (CSEM) surveys and the role of ROVs in such work.
Site, Hazard and Environmental Surveys	Explain the principles and conduct of site, hazard and environmental surveys including prior to shallow water seismic surveys, engineering surveys prior to platform installation, pipeline route selection, surveys prior to offshore drilling, submarine cable route selection and lay, baseline and monitor environmental surveys. Describe the role of MBES, SSS, SBP, marine magnetometer and of ROVs in such work.
Pipeline Lay and Rectification Work	Explain the principles and conduct of pipeline lay including pre-lay, lay, as-built, trenching and ploughing surveys; and any rectification work required such as dead man anchor deployment(s), pipeline defences and pipeline crossing(s), and the role of ROVs in such work. Describe general pipeline inspection procedures e.g. leak detection, damage, scouring.
Structure Emplacement	Explain the principles and conduct of construction support surveys including platform installation, platform as-built, platform dimensional control surveys, and the role of ROVs in such work. Explain the use of drilling templates.
Platform Decommissioning	Describe gravity-based, pile-driven, guyed, floating, and tension-leg platforms. Explain the principles and conduct of platform decommissioning surveys including hazard survey, decommissioning and platform removal, debris clearance and sea bed rectification, and the role of ROVs in such work.

19. Hydrographic Survey Legal Aspects

Topic	Outcome
Product Liability	Describe the liabilities associated with nautical charting and the above offshore surveys and how these risks are mitigated.
Rivers and Lakes	Describe provincial and federal legislation related to surveys over rivers and lakes.
Law of the Sea Development	Describe the historical development of the Law of the Sea. Explain its influence on hydrographic surveying, marine scientific investigations, and environmental impact.
Near Shore and Offshore	Describe the United Nations Convention of the Law of the Sea (UNCLOS), Canada's Oceans Act, and Canada's offshore boundary regime. Describe federal, provincial and territorial laws and regulations related to coastal and ocean management.
Marine Law	Describe applicable maritime law to Canada's rivers, lakes, near shore and offshore. Describe the basic process of marine accident investigations and court cases, in relation to hydrographic issues.
Marine Cadastre	Describe the concepts and practicalities of a marine cadastre.

With respect to reference material for Section 19 the candidate may have already taken C9: Survey Law, and the following reference material should have already been obtained.

From the CBEPS web site extracts from the new Survey Law in Canada text at https://www.cbeps-cceag.ca/guides-for-sale
Water Boundary Issues – Maritime Boundary Delimitation by David Gray (2011)
Water Boundary Issues – Eastern Canada by Izaak De Rijcke (2012)
Water Boundary Issues – Prairie Provinces by Ken Allred (2014)

In addition, the candidate may already have the text available from the Association of Canada Lands Surveyors by Bruce Calderbank et al., *Canada's Offshore: Jurisdiction, Rights and Management* published in 2006. Copies can be purchased from www.acls-aatc.ca or via www.trafford.com using ISBN 9781412078160.

Appendix – Learning Outcomes – CBEPS E2 – Advanced Hydrographic Surveying

Essential Reference Material:

The associated E2 Study Material contains all of the essential material and associated essential references. In addition, there are many commercial and government sources available online which the candidate can access for further information. Some of the governmental organizations which provide publically available information are listed in alphabetical order below.

Source	Organization	Web Address
CHS	Canadian Hydrographic Service, Nautical Charts, Data Products and Surveys, Hydrographic Surveys	http://www.charts.gc.ca/data-gestion/hydrographic/hydrographic-eng.asp
IHO	International Hydrographic Organization, Standards and Publications, Downloads	http://www.iho.int/iho_pubs/IHO_Download.htm
UNB	University of New Brunswick, Ocean Mapping and Research	http://www.omg.unb.ca/GGE/JHC_courses.html
NOAA	United States National Oceanic and Atmospheric Administration	http://tidesandcurrents.noaa.gov/pub.html
USACE	United States Army Corps of Engineers Publications, Engineering Manuals	http://www.publications.usace.army.mil/USACEPublications/EngineerManuals.aspx

For further reading the candidate may choose to access these documents all of which were available as of March 2015.

Subject: Comprehensive Treatment of Hydrographic Surveying		
Source	**Title**	**Web Address**
CHS	Standards for Hydrographic Surveys published 2005	http://www.charts.gc.ca/data-gestion/hydrographic/standards-normes-eng.pdf
IHO	C-13 Manual on Hydrography, 1st Edition published May 2005 with corrections to February 2011	http://www.iho-ohi.net/iho_pubs/CB/C13_Index.htm
UNB	GGE 3353, Imaging and Mapping II, Submarine Acoustic Imaging Methods last updated September 2010	http://www.omg.unb.ca/GGE/SE_3353.html
USACE	Hydrographic Surveying published 2013	http://www.publications.usace.army.mil/USACEPublications/EngineerManuals/tabid/16439/u43544q/687964726F67726170686963/Default.aspx
Subject: International Standards for Hydrographic Data Collection		
Source	**Title**	**Web Address**

IHO	S-44 Standards for Hydrographic Surveying, 5th Edition, published February 2008	http://www.iho.int/iho_pubs/standard/S-44_5E.pdf
Subject: Tides, Tidal Currents and Currents		
Source	**Title**	**Web Address**
NOAA	Tidal Datums and Their Applications, NOAA Special Publications NOS CO-OPS 1 published June 2000	http://tidesandcurrents.noaa.gov/publications/tidal_datums_and_their_applications.pdf
NOAA	Computational Techniques for Tidal Datums Handbook, NOAA Special Publications NOS CO-OPS 2 published September 2003	http://tidesandcurrents.noaa.gov/publications/Computational_Techniques_for_Tidal_Datums_handbook.pdf
NOAA	Tidal Analysis and Prediction, NOAA Special Publication NOS CO-OP 3 published July 2007	http://tidesandcurrents.noaa.gov/publications/Tidal_Analysis_and_Predictions.pdf
NOAA	Understanding Tides, by Steacy Dopp Hicks published December 2006	http://tidesandcurrents.noaa.gov/publications/Understanding_Tides_by_Steacy_finalFINAL11_30.pdf
NOAA	Tidal Currents, Educational Pamphlet #4 published April 1981	http://tidesandcurrents.noaa.gov/publications/TidalCurrentsEducationalPamphlet4.pdf
UNB	GGE 5013, Oceanography for Hydrographic Surveyors last updated September 2008	http://www.omg.unb.ca/GGE/GGE5013_Current.html
CHS	Canadian Tidal Manual by W.D. Forrester from the Permanent Service for Mean Sea Level, Training and Information, Reading Lists, Tides and Sea Level	http://www.psmsl.org/train_and_info/training/reading/canadian_manual.php
Subject: Specifications		
Source	**Title**	**Web Address**
NOAA	NOS Hydrographic Survey Specifications and Deliverables published April 2014	http://www.nauticalcharts.noaa.gov/hsd/specs/SPECS_2014.pdf
Subject: Hydrographic Terms and Acronyms		
Source	**Title**	**Web Address**
IHO	S-32 Hydrographic Dictionary, 5th Edition published 1994	http://hd.iho.int/en/index.php/Main_Page