



**STANDARDS OF COMPETENCE FOR CATEGORY "A"  
HYDROGRAPHIC SURVEYORS**

**Publication S-5A  
First Edition  
Version 1.0.2 - June 2018**

**Pages 13 to 34 inclusive:**

**FOUNDATION SCIENCE SUBJECTS**

**F1: Earth Models**

**F1.1 Physical geodesy**

- F1.1a The gravity field of the Earth
- F1.1b Gravity observations and their reduction
- F1.1c Height systems and height determination
- F1.1d Geopotential and geoidal Modelling

**F1.2 Coordinate Systems**

- F1.2a Coordinate Systems for Positioning
- F1.2b Datum transformation techniques
- F1.2c Geodetic computations on the ellipsoid
- F1.2d Three-Dimensional Geodetic Modeling

**F1.3 Land surveying methods and techniques**

- F1.3a Trigonometric surveys
- F1.3b Existing survey control
- F1.3c Establishing survey control
- F1.3d Instrument tests
- F1.3e Historical surveys

**F1.4 Levelling**

- F1.4a Levelling instruments
- F1.4b Height reduction

**F1.5 Map Projections**

- F1.5a Map Projections

**F1.6 Trigonometry and least-squares**

- F1.6a Trigonometry
- F1.6b Theory of observations
- F1.6c Least squares

## **F2: Oceanography**

### **F2.1 Physical Oceanography and measurements**

- F2.1a Water masses and circulation
- F2.1b Physical properties of sea water
- F2.1c Oceanographic measurements
- F2.1d Waves

## **F3: Geology and geophysics**

### **F3.1 Geology**

- F3.1a Earth structure
- F3.1b Geomorphology
- F3.1c Substrates

### **F3.2 Geophysics**

- F3.2a Gravity fields and gravity surveys
- F3.2b Magnetic fields
- F3.2c Seismic surveys

## **HYDROGRAPHIC SCIENCE SUBJECTS**

### **H1: Positioning**

#### **H1.1 Vessel and sensor reference frames**

- H1.1a Common reference frames for sensors
- H1.1b Integration of reference frames

#### **H1.2 GNSS positioning**

- H1.2a GNSS Signals
- H1.2b GNSS observables
- H1.2c Relative and absolute techniques
- H1.2d Installation and operation
- H1.2e Quality control

#### **H1.3 Inertial navigation systems**

- H1.3a Accelerometers and gyroscopes, inclinometers, and compass
- H1.3b Strapdown inertial measurement units
- H1.3c Kalman filtering
- H1.3d Aided inertial navigation

#### **H1.4 Subsea positioning**

- H1.4a Acoustic positioning principles
- H1.4b Acoustic positioning systems
- H1.4c Acoustic positioning error analysis
- H1.4d Acoustic positioning applications

#### **H1.5 Line keeping**

- H1.5a Track guidance

### **H2: Underwater Sensors and Data Processing**

#### **H2.1 Underwater acoustics**

- H2.1a Transducers and generation of acoustic waves
- H2.1b Propagation of acoustic waves
- H2.1c Acoustic noise
- H2.1d Reflection, scattering and system performance
- H2.1e Refraction and ray-tracing

## **H2.2 Single beam systems**

- H2.2a Single beam echo sounders principles
- H2.2b Single beam returns interpretation
- H2.2c Single beam survey system
- H2.2d Processing of single beam data

## **H2.3 Sonar imagery systems**

- H2.3a Side-scan sonar systems
- H2.3b Synthetic Aperture Sonar

## **H2.4 Swath echo sounder systems**

- H2.4a Multi-beam echo sounders
- H2.4b Multi-beam system parameters
- H2.4c Multi-beam systems
- H2.4d Multi-beam data processing
- H2.4e Interferometric Sonar

## **H2.5 Backscatter**

- H2.5a Backscatter from side scan, interferometric swath sonars and multi-beam echo sounders

## **H3: LiDAR and Remote Sensing**

### **H3.1 LiDAR**

- H3.1a Airborne LiDAR systems
- H3.1b Airborne LiDAR data products
- H3.1c Terrestrial LiDAR

### **H3.2 Remote Sensing**

- H3.2a Remotely sensed bathymetry
- H3.2b Satellite altimetry
- H3.2c Optical methods of shoreline delineation

## **H4: Survey Operations and Applications**

### **H4.1 Hydrographic survey projects**

- H4.1a Hydrographic survey requirements
- H4.1b Hydrographic survey project management

### **H4.2 Hydrographic survey operations**

- H4.2a Survey planning
- H4.2b Single Beam operations
- H4.2c Multi-beam and Interferometric operations
- H4.2d Magnetic surveys
- H4.2e Airborne LiDAR surveys
- H4.2f Side scan sonar operations
- H4.2g Side-scan sonar data interpretation

### **H4.3 Seabed characterization**

- H4.3a Classification from acoustic data
- H4.3b Classification from optical data
- H4.3c Seabed sampling
- H4.3d Seabed characterization

## **H5: Water Levels and Flow**

### **H5.1 Principles of Water Levels**

- H5.1a Tide theory
- H5.1b Non-tidal water level variations

## **H5.2 Water level measurements**

- H5.2a Water level gauges
- H5.2b Tidal measurement
- H5.2c Uncertainty in water level

## **H5.3 Tide modelling**

- H5.3a Harmonic analysis
- H5.3b Ocean water level

## **H5.4 Ellipsoid separation models and vertical datums**

- H5.4a Separation models
- H5.4b Vertical Datums
- H5.4c Sounding reduction

## **H5.5 Currents**

- H5.5a Tidally induced currents
- H5.5b Current measurement, portrayal and surveys

## **H6: Hydrographic Data Acquisition and Processing**

### **H6.1 Real-time data acquisition and control**

- H6.1a Hydrographic Data acquisition
- H6.1b Real-time data monitoring
- E6.1c Survey data storage and transfer

### **H6.2 Bathymetric data filtering and estimation**

- H6.2a Filtering and estimation of single beam data
- H6.2b Filtering and estimation of multi-beam data
- H6.2c Spatial data quality control
- H6.2d Spatial data interpolation
- H6.2e Spatial data representation

## **H7: Management of Hydrographic Data**

### **H7.1 Data organization and presentation**

- H7.1a Databases
- H7.1b Marine GIS basics

### **H7.2 Marine data sources and dissemination**

- H7.2a MSDI
- H7.2b Open access marine data

### **H7.3 Spatial data integration and deliverables**

- H7.3a Spatial data integration
- H7.3b Spatial data visualisation
- H7.3c Deliverables

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### **H8.1 Product liability**

- H8.1a Responsibilities of the hydrographic surveyor
- H8.1b Contracts

### **H8.2 Maritime zones**

- H8.2a Delimitations
- E8.2b Impact of surveys



**STANDARDS OF COMPETENCE FOR CATEGORY "B" HYDROGRAPHIC SURVEYORS**

**Publication S-5B  
First Edition  
Version 1.0.1 - June 2017**

**Pages 12 to 24 inclusive:**

**ESSENTIAL SUBJECTS**

**E1: Underwater Acoustics**

**E1.1 Acoustic Theory**

- E1.1a Generation of acoustic waves
- E1.1b Propagation of acoustic waves
- E1.1c Reflection, scattering and system performance
- E1.1d Reception of acoustic waves

**E1.2 Single Beam Systems & Side Scan Sonar**

- E1.2a Single beam echo sounders
- E1.2b Single beam echo sounder data recording
- E1.2c Range uncertainty
- E1.2d Side scan sonar

**E1.3 Swath Systems**

- E1.3a Beam characteristics
- E1.3b Backscatter and water column returns
- E1.3c Bottom spatial coverage
- E1.3d Installation and configuration
- E1.3e Range and angle uncertainty
- E1.3f Operation

**E2: Remote Sensing**

**E2.1 LiDAR**

- E2.1a Airborne LiDAR systems
- E2.1b Airborne LiDAR data products
- E2.1c Terrestrial LiDAR

**E2.2 Remote Sensing**

- E2.2a Remotely sensed bathymetry
- E2.2b Shoreline delineation

### **E3: Water Levels and Flow**

#### **E3.1 Principles of Water Levels**

- E3.1a Tidal fundamentals
- E3.1b Tidal information
- E3.1c Non-tidal water level variations

#### **E3.2 Water Level Measurement**

- E3.2a Water level gauges
- E3.2b Tidal measurement
- E3.2c Water level datums
- E3.2d Uncertainty in water level

#### **E3.3 Water Level Reduction**

- E3.3a Water level reduction of soundings
- E3.3b Reduction of soundings using GNSS observations

#### **E3.4 Currents**

- E3.4a Tidal streams and currents
- E3.4b Current measurement and portrayal

### **E4: Positioning**

#### **E4.1 Geodesy**

- E4.1a Introduction to Geodesy
- E4.1b Coordinate systems, frames and datums
- E4.1c Geodetic transformations and associated computations
- E4.1d Ellipsoidal computations

#### **E4.2 Principles of Cartography**

- E4.2 Map projections

#### **E4.3 Positioning Measurements, Methods and Techniques**

- E4.3a Positioning fundamentals
- E4.3b Satellite positioning
- E4.3c Positioning systems
- E4.3d Historical surveys
- E4.3e Survey control

#### **E4.4 Vertical Positioning**

- E4.4a Height systems
- E4.4b Elevation measurements and computation

#### **E4.5 Acoustic Positioning**

- E4.5a Acoustic positioning concepts
- E4.5b Acoustic positioning systems

#### **E4.6 Inertial Navigation**

- E4.6a Inertial Measurement Units
- E4.6b Inertial Navigation Systems

#### **E4.7 Uncertainty in Positioning**

- E4.7 Sources of uncertainty

## **E5: Hydrographic Practice**

### **E5.1 Hydrographic Survey Projects**

- E5.1a Hydrographic survey purposes
- E5.1b Hydrographic survey execution requirements
- E5.1c Hydrographic survey project organization

### **E5.2 Hydrographic Survey Operations**

- E5.2a Operational survey data transfer
- E5.2b Survey systems
- E5.2c Calibration and corrections
- E5.2d Line planning
- E5.2e Line keeping
- E5.2f Survey operations
- E5.2 Quality control

### **E5.3 Hydrographic Survey Documentation**

- E5.3a Documentation

### **E5.4 Legal Aspects**

- E5.4a Liability of the hydrographic surveyor
- E5.4b Delimitations

## **E6: Hydrographic Data Management**

### **E6.1 Real-Time Data Acquisition and Control**

- E6.1a Hydrographic Data acquisition
- E6.1b Real-time data monitoring
- E6.1c Data transfer and storage

### **E6.2 Data Processing and Analysis**

- E6.2a Spatial data cleaning
- E6.2b Spatial data quality control
- E6.2c Spatial data representation

### **E6.3 Data Organization and Presentation**

- E6.3a Databases
- E6.3b Marine GIS basics
- E6.3c Visualization and presentation
- E6.3d Deliverables

## **E7: Environment**

### **E7.1 Oceanography**

- E7.1a Physical properties of sea water
- E7.1b Oceanographic measurements
- E7.1c Waves

### **E7.2 Marine Geology and Geophysics**

- E7.2a Seabed characteristics
- E7.2b Magnetic surveys
- E7.2c Seismic surveys

### **E7.3 Environmental impact**

- E7.3a Impact of surveys

EXTRACT OF SYLLABUS OUTLINE FROM:

INTERNATIONAL  
FEDERATION OF  
SURVEYORS



INTERNATIONAL  
HYDROGRAPHIC  
ORGANIZATION



INTERNATIONAL  
CARTOGRAPHIC  
ASSOCIATION



**STANDARDS OF COMPETENCE  
for  
Hydrographic Surveyors**

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Eleventh Edition  
Version 11.0.1 – May 2011**

Guidance and Syllabus for Educational and Training Programmes

Pages XVIII to XXII inclusive:

**ESSENTIAL SUBJECTS**

**E1 Bathymetry**

- E1.1 Underwater Acoustic**
- E1.1(a) Acoustic fundamentals
  - E1.1(b) Generation of Acoustic Waves
  - E1.1(c) Transmission of acoustic waves
  - E1.1(d) Sound speed and refraction
  - E1.1(e) Reflection and scattering of acoustic waves
  - E1.1(f) Acoustic noise and the directivity index
  - E1.1(g) Reception of acoustic waves and system performance
  - E1.1(h) Acoustic devices

- E1.2 Single-beam echo-sounders (SBES)**
- E1.2(a) Transducers
  - E1.2(b) Data recording
  - E1.2(c) Sounder calibration
  - E1.2(d) Sounding reduction
  - E1.2(e) Sounding accuracy
  - E1.2(f) Acoustic sweeps
  - E1.2(g) System selection



**E1.3**                    **Side Scan Sonar (SSS)**  
E1.3(a)                Side Scan systems  
E1.3(b)                Side scan data interpretation

**E1.4**                    **Multibeam and swath echo sounders (MBES)**  
E1.4(a)                Multibeam echo sounding systems  
E1.4(b)                Multibeam transducers and signal processing  
E1.4(c)                Coverage and accuracy  
E1.4(d)                Object detection  
E1.4(e)                Backscatter  
E1.4(f)                Integration and calibration  
E1.4(g)                Reference surface

**E1.5**                    **Phase Differencing Bathymetry (Interferometry)**  
E1.5(a)                Phase differencing systems  
E1.5(b)                Deployment and mounting

**E1.6**                    **Non-acoustic bathymetric techniques**  
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E1.6(b)                Other remote sensing bathymetry  
E1.6(c)                Mechanical techniques  
E1.6(d)                Inspection techniques

## **E2 Water levels and flow**

E2.1                    Tidal fundamentals  
E2.2                    Tidal measurements  
E2.3                    Tidal streams and currents  
E2.4                    Tidal analysis and prediction

**E2.5**                    **Tidal information**  
E2.5(a)                Use of tide tables  
E2.5(b)                Cotidal charts  
E2.5(c)                Use of numerical tidal models

E2.6                    Non-tidal water level variations

## **E3 Positioning**

**E3.1**                    **Geodesy**  
E3.1(a)                Introduction to Geodesy  
E3.1(b)                Coordinate systems for positioning  
E3.1(c)                Satellite positioning  
E3.1(d)                Map projections  
E3.1(e)                Geodetic computations  
E3.1(f)                Approximation and estimation

**E3.2**                    **Horizontal positioning**  
E3.2(a)                Horizontal positioning fundamentals  
E3.2(b)                Angular measurements  
E3.2(c)                Distance measurement  
E3.2(d)                Electromagnetic positioning  
E3.2(e)                Satellite positioning  
E3.2(f)                Acoustic positioning concepts  
E3.2(g)                Sources of error  
E3.2(h)                Deployment

<b>E3.3</b>	<b><i>Vertical positioning</i></b>
E3.3(a)	Vertical positioning fundamentals
E3.3(b)	Datums
E3.3(c)	Elevation measurements & computations
E3.3(d)	Heave
E3.4	Orientation
E3.5	Three-dimensional Geodesy

## **E4 Hydrographic practice**

<b>E4.1</b>	<b><i>Types of hydrographic surveys</i></b>
E4.1(a)	Nautical charting surveys
E4.1(b)	Surveys in support of port management and coastal engineering
E4.1(c)	Offshore industrial surveys
<b>E4.2</b>	<b><i>Hydrographic specifications</i></b>
E4.2(a)	Instrumentation
E4.2(b)	Operations
E4.2(c)	Products
<b>E4.3</b>	<b><i>Routing</i></b>
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E4.3(b)	Line Keeping
<b>E4.4</b>	<b><i>Data telemetry links</i></b>
E4.4(a)	Radio data telemetry links
E4.4(b)	Acoustic data telemetry
E4.5	Digital signal processing

## **E5 Hydrographic data management**

E5.1	Real-time data acquisition and control
E5.2	Analogue data capture
<b>E5.3</b>	<b><i>Data management, processing and analysis</i></b>
E5.3(a)	Approximation and estimation
E5.3(b)	Spatial data processing & analysis
E5.3(c)	Marine GIS
<b>E5.4</b>	<b><i>Data presentation</i></b>
E5.4(a)	Visualization and presentation
E5.4(b)	Marine Cartography
<b>E5.5</b>	<b><i>Hydrography for Nautical Charting</i></b>
E5.5(a)	Chart compilation
E5.5(b)	Correction of Charts
E5.5(c)	Electronic Charts

## **E6 Environmental Science**

### ***E6.1***

#### ***Meteorology***

- E6.1(a) The atmosphere
- E6.1(b) Meteorological elements
- E6.1(c) Winds
- E6.1(d) Climatology
- E6.1(e) Weather systems
- E6.1(f) Weather observing and recording
- E6.1(g) Weather forecasting
- E6.1(h) International Marine Meteorological Service System (IMMSS)

### ***E6.2***

#### ***Oceanography***

- E6.2(a) Physical properties of sea water
- E6.2(b) Marine circulation dynamics
- E6.2(c) General circulation of the oceans
- E6.2(d) Wind-waves and swell
- E6.2(e) Wave propagation
- E6.2(f) Oceanographic measurements
- E6.2(g) Oceanographic instruments

### ***E6.3***

#### ***Marine geology and geophysics***

- E6.3(a) Marine geology
- E6.3(b) Geomorphology
- E6.3(c) Earth's magnetic field
- E6.3(d) Earth's internal structure
- E6.3(e) Seismic profiling
- E6.3(g) Geotechnical sampling
- E6.3(h) Deposition and erosion

- E6.4 Environmental impact

## **E7 Legal Aspects**

- E7.1 Product Liability
- E7.2 Contracts

### ***E7.3***

#### ***Law of the Sea***

- E7.3(a) Development
- E7.3(b) Delimitation zones
- E7.3(c) Marine Law

## OPTIONAL UNITS

### **O1 Nautical Charting Hydrography**

- O1.1 Coastal topography
- O1.2 Siting of aids
- O1.3 Publications
- O1.4 Chart Reproduction
- O1.5 Correction of charts
- O1.6 Chart Compilation
- O1.7 Geographic Information Systems (GIS)
- O1.8 ENC – ECDIS Concepts
- O1.9 International Standards
- O1.10 ENC Production

### **O2 Hydrography to support Port Management and Coastal Engineering**

- O2.1 Surveys for Dredging Operations
- O2.2 Hydraulic surveys
- O2.3 Surveys for pollution monitoring
- O2.4 Channel Marking
- O2.5 Controlling sedimentation
- O2.6 Remote Sensing in the Coastal Zone
- O2.7 GIS
- O2.8 Warnings

### **O3 Offshore Seismic Surveying**

- O3.1 Geomagnetic surveys
- O3.2 Gravity surveys
- O3.3 Digital seismic techniques
- O3.4 Digital seismic data acquisition
- O3.5 Digital seismic data processing
- O3.6 Analogue equipment
- O3.7 Analogue Applications
- O3.8 Deep Water Surveys

### **O4 Offshore Construction Hydrography**

- O4.1 Drilling terminology
- O4.2 Mobile rig positioning
- O4.3 Fixed offshore platforms
- O4.4 Structure emplacement
- O4.5 Pipeline operations
- O4.6 Cable operations
- O4.7 ROV operations
- O4.8 ROV positioning
- O4.9 ROV equipment
- O4.10 ROV Surveying

## **O5 Remote Sensing**

- O5.1 Coastline delineation
- O5.2 Ice mapping
- O5.3 Water surface mapping
- O5.4 Bathymetric remote sensing
- O5.5 Water column properties

## **O6 Military Hydrography**

- O6.1 Anti-submarine
- O6.2 Mine Countermeasures
- O6.3 *Amphibious Operations***
  - O6.3(a) Beach reconnaissance
  - O6.3(b) Obstructions
  - O6.3(c) Surveying in the surf zone
  - O6.3(d) Vertical datum
  - O6.3(e) Horizontal positioning
  - O6.3(f) Depth measurement
  - O6.3(g) Products
- O6.4 Rapid Environmental Assessment (REA)
- O6.5 Electronic Chart – Military aspect

## **O7 Inland Waters Hydrography**

- O7.1 Hydraulic engineering
- O7.2 Elevation models
- O7.3 Flood plane mapping
- O7.4 Erosion and sedimentation
- O7.5 Vertical references
- O7.6 Buoyage