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Journal of the Canadian Hydrographic Association Revue de l'Association Canadienne d'Hydrographie

contents contenu

Lighthouse

Edition/Édition 58 • Fall/Automne 2000

regular features/chroniques

Every edition also receives much assistance from the Central Branch Lighthouse Committee and other CHA volunteers.

Chaque édition est réalisée grâce à la collaboration du comité Lighthouse de la section Centrale et d'autres volontaires de l'ACH.

Views expressed in articles appearing in this publication are those of the authors and not necessarily those of the Canadian Hydrographic Association.

Les opinions exprimées dans les articles de cette revue ne sont pas nécessairement celles de l'Association canadienne d'hydrographie.

LIGHTHOUSE is published twice yearly by the Canadian Hydrographic Association and is distributed free to its members. A membership application form can be found on page 5 of this issue. Yearly subscription rates for non-members are $20 for Canadian residents, and $25 for non-residents. Please make cheque or money order payable in Canadian funds to the Canadian Hydrographic Association.

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Back issues/Éditions antériures

Back issues of Lighthouse, Editions 24 through 57 are available at a price of $10 per copy. Please write to the Editor.

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For a rate card and mechanical specifications see the rate card printed on page 60 of this issue.

Pour les tarifs et les spécifications publicitaires, se référer à la page 60 de cette édition.

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notes mots

Message from the National President
Mot du Président national

As this issue goes to press it is Fall. The field work for most in the Northern Hemisphere where the water gets hard, is over. Now is the time for data reduction, data output and reflection. The Canadian Hydrographic Association continues to foster the development of Hydrography. In Canada, the Central Branch of CHA has a loan library of videos collected during in-house courses for the Canadian Hydrographic Service (CHS). In Malaysia, CHA works with the Canadian International Development Agency (CIDA) and the University of Technology in Johor Bahru, Malaysia to provide a Category A training course in Hydrography. The CHS and CHA receive inquiries for Hydrographic training for developing countries. The CHA journal Lighthouse is one means to provide the dissemination of hydrographic information. In subsequent issues, different lighthouse pictures will be displayed on the cover. This is a chance to go through old photographs for pictures of lighthouses. These pictures should be submitted to the Editorial Board. Just as the lighthouse guided ships over the ages, the Journal Lighthouse can guide the information exchange with Hydrographers, young and old.

Ken McMillan

Editor's Note
Note de la redactrice

Here is Edition 58 at last. There are four papers included in addition to an interesting piece on the effect of winter storms on the water levels on the Great Lakes. The CHA News section features some of the activities the branches have undertaken in the last two years. It is great to see the Association is active and undertaking these projects.

The next edition will feature a new Lighthouse on the cover as we retire the existing cover negative, which is showing its age, and produce a digital cover. The lighthouse on the cover may change from time to time as we feature different lighthouses from across the country and include a brief history to accompany the photo. If you have a photo suitable for the cover send it to the Editor along with a brief description.

Contributions to Lighthouse are always welcome. In order to make production more efficient please ensure items are available in digital form and graphics, including tables, photos, figures and graphs are submitted (minimum 300dpi) in their original format or as .pdf (preferable) or .tif as separate files from the text.

Terese Herron

directors directeurs

Announcements

KIS2001

The International Symposium on Kinematic Systems in Geodesy, Geomatics and Navigation will be held in Banff, Canada, during the period June 5-8, 2001. The symposium is organized by the University of Calgary and The Institute of Navigation. The Convenors are Dr. Gérard Lachapelle (lachapel@geomatics.ucalgary.ca). and Dr. M. Elizabeth Cannon (cannon@geomatics.ucalgary.ca).
Website: www.geomatics.ucalgary.ca/KIS2001

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Survey Navigation and Positioning Guidelines for 3D Marine Seismic Survey Specifications

Lignes directrices pour le positionnement et la navigation des levés 3D séismiques marins

by/par Bruce Calderbank

Guidelines for readily achievable survey navigation and positioning specifications for 3D marine seismic surveys are provided in a checklist type format detailing the survey and configuration parameters; the type, quantity and criteria for the equipment; checks, verifications and calibrations; rejection and termination criteria; and deliverables. Each system or component required is described together within these topics. These guidelines could be considered the minimum standards of performance, required proofs, and quality control criteria for the acceptance of the survey, navigation and positioning for 3D marine seismic surveys.

Des lignes directrices sur les spécifications pour le positionnement et la navigation des levés 3D séismiques marins sont données dans un format de type liste de contrôle et détaillent les paramètres des levés et de configuration; le type, la quantité et les critères pour l'équipement; les contrôles, les vérifications et les calibrations; les critères de rejet et de fin; ainsi que les livrables. L'ensemble des composantes de chaque système est décrit pour chacun des sujets ci-haut mentionnés. Ces lignes directrices pourraient être considérées comme étant les normes minimales pour les critères de performance, de preuve tangible et de contrôle de qualité pour l'acceptation du positionnement et de la navigation des levés 3D séismiques marins.

Comparaison de l'altitude GPS d'un navire avec des données marémétriques

Comparison of the GPS altitude of a ship with tide gauge data

par/by Stéphanie Michaud, Rock Santerre et Alfonso Condal

Dans cet article, des profils verticaux d'un navire obtenus du positionnement GPS-OTF sont comparés aux données marémétriques du réseau SINECO. Afin d'effectuer ces comparaisons, on a tenu compte de la conversion entre les surfaces de référence verticales, de l'interpolation spatiale et temporelle des données SINECO afin de correspondre aux observations GPS, et de la réduction de la hauteur de l'antenne GPS du navire à sa ligne de flottaison. Cette dernière réduction inclut également la modélisation de l'effet du squat du navire. Pour les 12 heures de données analysées, dans 2 secteurs de la voie navigable du fleuve Saint-Laurent, l'écart-type des différences est d'au plus ±7 cm lorsqu'il n'y a pas de phénomènes hydrodynamiques (non mesurés par les marémètres situés près des rives) importants. Lorsque de tels phénomènes se produisent, des différences pouvant atteindre -20 cm ont été détectées. Dans ce cas, le profil vertical GPS du navire est alors plus représentatif du niveau réel de l'eau que celui obtenu des marémètres.

This paper deals with the comparison of vertical profiles of a ship obtained from GPS-OTF positioning with COWLIS tidal data. To perform this comparison, we have taken into account the reduction between vertical reference surfaces, the spatial and temporal interpolations of tidal data to correspond to GPS observations, and the height difference between the GPS antenna of the ship and her waterline. This last reduction also includes squat modelling. For the 12 hour data analysed in 2 sectors of the St.Lawrence river, the differences have typically an rms value of ±7 cm, whenever there are no large hydrodynamic phenomena (undetectable by tide gauges close to the shore). When such phenomena are present, discrepancies as large as -20 cm have been detected. In this situation, the true water level is more realistically described by GPS vertical profiles of the ship than tide gauge data.

Determination of Mean Sea Level with GPS on the Vessel

Détermination du niveau moyen des mers avec le GPS sur un navire

by/par Reha Metin Alkan and H. Mustafa Palancioglu

Changes to the water level should be determined in order to reduce the depth measurements to the reference surface. For this purpose, instruments called 'Tide Gauges' of many types such as staff gauges, float gauges or self-recording gauges are used. However, GPS improvements have shifted positioning surveying to satellite methods. Because of the advantages they provide these methods are being densely used for both terrestrial and hydrographic surveys. It is now possible to obtain the 3D coordinates of the dynamic objects with the use of kinematic tecniques of the GPS method. Especially, with the Kinematic On the Fly (KOF) method, the positions and the heights of the mobile objects can be determined by the carrier phase measurements with an accuracy below 1 dm and in most cases, just a few centimeters. Besides having such a high accuracy, the most important advantage that it provides is to define the initial integer ambiguity of the vehicle in motion. This method is known as Precision

Differential GPS (PDGPS) because of the accuracy it provides.

In this study, a new 'Mean Sea Level (MSL)' determining model based on PDGPS method is introduced. The MSL is determined both by this new method and a conventional staff tide gauge with two separate studies realised in Haliç (Golden Horn) Inlet and the results are compared. As a result of these studies, it is seen that the height of the mean sea level can be determined by the new method. This method is a powerful alternative to the conventional tide gauge methods.

Les variations du niveau de l'eau servent à réduire les mesures de profondeur à une surface de référence. Dans ce but, les instruments appelés "marégraphes" de type planche à marée, à flotteurs ou auto-enregistreurs sont utilisés. Cependant, les améliorations du GPS ont fait en sorte que les méthodes de positionnement traditionnelles ont été remplacées par les méthodes satellitaires. À cause des avantages qu'elles procurent, ces méthodes sont grandement utilisées pour les levés terrestres et hydrographiques. Il est maintenant possible d'obtenir des positions tridimensionnelles d'objets en mouvement avec l'usage du GPS avec les techniques cinématiques. En particulier, par la méthode cinématique "On the Fly (OTF)", les positions et les altitudes des mobiles peuvent être déterminées par la mesure de phase de l'onde porteuse avec une précision du décimètre ou de quelques centimètres dans la majorité des cas. En plus du haut niveau de précision, l'avantage majeure qu'il procure est de définir l'ambiguïté initiale d'un véhicule en mouvement. Cette méthode se nomme la précision différentielle du GPS (PDGPS) à cause de la précision qu'elle procure.

Dans cette étude, un nouveau modèle pour déterminer le niveau moyen des mers (NMM) basé sur la méthode du PDGPS est introduit. Le NMM est déterminé par cette nouvelle méthode et par la méthode conventionnelle des marégraphes pour la région de Halic (Golden Horn) Inlet et les résultats sont comparés. Le résultat de ces études démontre que le niveau moyen des mers peut être déterminé par la nouvelle méthode. Cette méthode est une alternative puissante à la méthode conventionnelle des marégraphes.

Ten Years of a Canadian in Monaco

Les 10 années d'un canadien à Monaco

by/par Adam J. Kerr

Adam Kerr, former Central & Arctic Regional Director of Hydrography, was recently moved to look back on his 10 years as the only Canadian to be a member of the Directing Committee of the International Hydrographic Bureau (IHB) at Monaco.

The Bureau (after 1972, the IHO and IHB,) originally founded in 1921 and located at the Principality of Monaco due to the generosity of Prince Albert I, was involved in significant progress in hydrography during the years 1987 to 1997, during Mr. Kerr's tenure. This progress was largely due to the development of such industry standards as S-52 and S-57 for Electronic Chart technology and S-44 for hydrographic surveys and their adoption by the member states.

Other major areas of responsibility for the IHO include providing technical assistance to developing countries. This is especially in the area of hydrographic training, advice on the establishment of hydrographic offices (a major task in Africa and parts of Asia) and the delimitation of boundaries within the Law of the Sea. The IHB also oversaw the production of GEBCO (General Bathymetric Chart of the Oceans).

The international hydrographic community keeps abreast of the many developments in the industry by way of the IHB's publications, including the International Hydrographic Review and the monthly bulletins.

Adam Kerr, ancien directeur de l'hydrographie de la région Centrale et Arctique, fait une revue de ses 10 dernières années en tant que seul canadien à être membre du Comité directeur du Bureau hydrographique international à Monaco.

Le Bureau (après 1972, l'OHI et le BHI), fondé en 1921 et situé dans la principauté de Monaco grâce à la générosité du Prince de Monaco Albert I, a été impliqué dans l'essor important de l'hydrographie pendant le mandat de monsieur Kerr de 1987 à 1997. Cet essor a été grandement dû au développement de normes telles S-52 et S-57 pour la technologie des cartes électroniques et S-44 pour les levés hydrographiques et leur adoption par les pays membres.

Les responsabilités de l'OHI incluent, entre autres, de fournir une assistance technique aux pays en voie de développement. Cela se traduit par la formation hydrographique, des avis sur l'établissement de bureaux hydrographiques (une tâche importante en Afrique et en Asie) et la délimitation des frontières selon les politiques du Droit de la mer. Le BHI a supervisé la carte GEBCO (Carte générale bathymétrique des océans).

La communauté hydrographique internationale se tient au courant des développements de l'industrie par les publications du BHI, incluant la Revue hydrographique internationale et les bulletins mensuels.

Survey, Navigation and Positioning Guidelines for 3D Marine Seismic Survey Specifications

Bruce Calderbank

Originally published in The Hydrographic Journal, No. 90, October 1998, pages 11 to 20. Reprinted with permission of the author.

Introduction

During the author's career as a Client Navigation Representative, he has had to implement a variety of contracts and specifications for 3D marine seismic surveys, with respect to survey, navigation and positioning. Some of these have omitted details, which were critical to or would have significantly improved the quality of the survey.

As part of the author's procedures a list of survey, navigation and positioning criteria was complied which went through a number of style and content revisions. The end results are the tables below which could be used as a check list. The various equipment required and the expected performance of that equipment are described. Most of the values and other criteria suggested have been compared under actual survey conditions and found to be acceptable.

Not every table is complete. Some information will be supplied by the company, and other information will be supplied and negotiated with the contractor. However, the majority of the information provided below should not have to be altered, as the specifications detailed should suit most 3D marine seismic surveys. A tabular format is used to highlight the values and criteria suggested so as not to become buried in extensive explanations. Consequently, only brief comments follow some of the tables where applicable.

The reader is encouraged to use these tables for reference and guidance. The values adopted by a company for any item must meet the survey objectives of the company, and be negotiated with the contractor. Both should ensure that the vessel to be used is capable of meeting the criteria set out in the subsequent contract. The company may be required to accept a lower standard due to time or budget constraints.

3D marine seismic survey operations have been described in various articles, some of which are listed in the references. These and other articles should be referred to if the reader is uncertain of the relevance of some of the topics listed.

1. General Information	
Client	
Client Contract Number	
Contractor Reference Number	
Location	
Type of Survey	3D
Project Naming Convention	
Total Planned Line Kilometres (excluding run-outs)	kms
Total Planned Area	km2
Total Number of 3D Lines	
Average Planned Line Length	
Shooting Directions	
Estimated Start Date	
Estimated Duration	days
Vessel Name	

2. Configuration	
Number of Streamers	
Number of Sources	
Number of Gun Sub-Arrays per Source	

The contractor should supply a cable and source positioning system integrating at least the vessel(s) positioning; actively positioned source sub array(s), front (gun) float(s), and tailbuoy(s); laser positioning; front and tail (and middle if used) acoustic network(s); streamer compasses; and gyro compass(es). The contractor should use an integrated navigation system and a post-processing system that output compatible results (for example, the software should be based on the same processing models and algorithms).

These guidelines cover the use of all of the above although it is possible that a system may not used, such as laser positioning, or a front (gun) float(s) is not deployed. If that is the case then reference to the affected item(s) which follows can be disregarded.

3. Expected *a posterior* Positioning Accuracy Relative to the Vessel					
	Semi Major Axis of Standard (1σ) Error Ellipse (39.4 % Confidence Level for Multivariate Case)		Semi Major Axis Estimated Correlation (1σ)	Semi Major Axis Maximum Error Ellipse (1σ)	95 % Horizontal Error Ellipse of Two Dimensional Position
	In-Line (σ_x)	Cross Line (σ_y)	(σ_{xy})	(σ_{max})	2.447 * (σ_{max})
Source(s)	± 2 metres	± 3 metres	± 3 metres	± 3.2 metres	± 7.9 metres
Front (Gun) Float(s)	± 3 metres	± 3 metres	± 3 metres	± 3.5 metres	± 8.5 metres
First Trace	± 3 metres	± 3 metres	± 3 metres	± 3.5 metres	± 8.5 metres
Mid Trace	± 3 metres	± 4 metres	± 4 metres	± 4.1 metres	± 10.0 metres
Far Trace	± 3 metres	± 3 metres	± 4.5 metres	± 3.7 metres	± 9.0 metres
Tailbuoy(s)	± 3 metres	± 3 metres	± 4.5 metres	± 3.7 metres	± 9.0 metres

The above accuracies should be achievable for each source; for the front (gun) float(s); for the first, middle and last trace on each streamer; and for each tailbuoy. Sufficient redundancy should be incorporated in the network(s) design, to be able to achieve these results throughout the survey.

The effect of any permanent failure(s) on the accuracy of the network(s) should be demonstrated by the contractor on a MOVE® (or similar) package, and should ensure that the positioning of any node should not be greater than ± 1.5 metres when compared to the previous network analysis. Realistic *a priori* standard deviations (1σ) should be used which should be approved by the company.

The corresponding horizontal mid point (HMP) accuracy would be 2.8 metres for the first and last common mid point (CMP), and 3.1 metres for the middle CMP for each streamer.

The above calculations are based on the bivariate probability of a point lying with in an error ellipse drawn with semi-major and semi-minor axes of σ_{max} and σ_{min}. The correlation between the in-line and cross-line errors has been estimated.

Range of Variate	1σ	2σ	2.447σ	3σ
Confidence	39.4 %	86.5 %	95 %	98.9%

Using the error estimates for the in-line (σ_x) and cross line (σ_y) directions then σ_{max} and σ_{min} can be computed assuming a realistic value for the correlation (σ_{xy}). The correlation values are included to ensure all possible errors were considered instead of being assumed not to apply. The formula are:

$$\sigma^2_{max} = \tfrac{1}{2}\{\sigma_x^2 + \sigma_y^2 + [(\sigma_x^2 - \sigma_y^2)^2 + 4\sigma_{xy}^2]^{1/2}\}$$
$$\sigma^2_{min} = \tfrac{1}{2}\{\sigma_x^2 + \sigma_y^2 - [(\sigma_x^2 - \sigma_y^2)^2 + 4\sigma_{xy}^2]^{1/2}\}$$

The derived σ_{max} can then be used to calculate 95 % ($2.447\sigma_{max}$).

4. Streamer Parameters	
Streamer Type and Manufacturer	
Active Streamer Length (Nominal)	metres
Number of Channels per Group Interval	
Group Interval (Nominal)	metres
Group Length (Actual)	metres
Stretch Factor: Stretch Sections	
Stretch Factor: Active Sections	
Depth Indicators, type	
Depth Indicators, number	per streamer
Depth Controllers, type	
Depth Controllers, number	per streamer
Maximum Wing Angle for Balanced Streamers	± 3 degrees (excluding first 2 streamer compasses)
Maximum Feather Angle (any streamer)*	

* The maximum feather angle will depend on the geophysical objectives. All available tidal and current information should be utilized to predict the expected feather angles.

Streamer compasses are specified below under Navigation and Positioning Systems.

5. Source and Streamer Geometry			
For each line or part of a line	Objective	Allowance	Instantaneous ∇
Separations between:	**Cross-Line**		
Adjacent Front Streamers	metres	± 5%	± 10%
External Front Streamers	metres	± 5%	± 10%
Centre Sources	metres	± 5%	± 10%
Source Sub-Arrays	metres	± 15%	± 30%
Adjacent Tail Streamers*	metres	± 30%	± 40%
Minimum Offsets to Near Traces:	**Inline**		
Inline Offset from Centre Source to Inner Streamers Δ	metres	± 5%	± 10%
Inline Offset from Centre Source to External Streamers	metres	± 5%	± 10%
Front Streamer Shape (select)	flat / smile		
Minimum Depth Offsets:	**Depths**		
Streamer Depth	metres	± 1 metre	
Streamer Depth: Difference between extremes		± 1.5 metres	
Source Depth	metres	± 0.5 metre	
Source Depth: Difference between extremes		± 1 metre	

* Larger adjacent tail streamer separations caused by currents and sea conditions may be acceptable if approved by the company.

Δ The minimum offset from the centre source to the inner streamers will be at least the minimum safe distance.

∇ Instantaneous variations could occur due to sea conditions and should be for not more than 20 shot points.

6. 3D Coverage Parameters		
Shot Point Interval per shot	metres	
Interval for each Source in Flip Flop mode	metres	
Sub-Surface Line Spacing	metres	
Surface (sail line) Spacing	metres	
Acquisition Bin	Fixed rectangle	
CDP Column Spacing	metres	
Size of Bins: In-Line	metres	
Size of Bins: Cross Line	metres	
Nominal Fold per CMP		
Nominal Fold per Bin		
Offset Monitored	non-duplicate offset ranges for each segment	
Bin Expansion: On Line	None	
Bin Expansion: Off Line - Type (select)	block movement / linear taper	
Bin Expansion: Off Line - Definition (select)	either side of the bin / total cross line distance	
Bin Expansion: Off Line - Percentage	% Nears to % Fars	
Bin Expansion: at Near Trace	± metres	
Bin Expansion: at Mid Trace	± metres	
Bin Expansion: at Far Trace*	± metres	
Group(s) to be Maximized for Coverage		
Binning Specification: Nears	% of nominal	number of hits
Binning Specification: Mids	% of nominal	number of hits
Binning Specification: Fars*	% of nominal	number of hits
Survey Grid Rotation	degrees Grid	
Survey Grid Origin (centre of bin): Northing	metres	
Survey Grid Origin (centre of bin): Easting	metres	
Shot Point Number at Origin		
Line Number at Origin		

6. 3D Coverage Parameters - *continued*	
Origin Convention	
Ship Survey Speed (over ground) Δ	knots
Run In: Minimum ∇	at least 1.5 times the streamer length
Run Out	

* The streamer(s) can be subdivided into various subsections, which can be equal in length, or whatever length is required.

Δ Maximum possible without creating seismic noise or strumming on any streamer(s).

∇ The run-in for any line or part of a line should allow the streamer compasses to stabilize, ensure the streamer(s) is straight for best coverage, and to ensure that the acoustic positioning system is operating satisfactorily, and the gyro compass(es) have stabilized to minimize any Schuler effects.

7. Binning Displays Required		
Select one appropriate method:	Non Flexed	Flexed
Unique Radial Offset		
Unique In-Line Offset		
Unique In-Line Offset for each streamer Independent of Other Streamers		

8. Line and Shot Point Numbering	
Line Name Prefix Format	
Line Name Suffix Format: Prime (Line Number nnnn, Sequence Number seq)*	nnnnPseq
Line Name Suffix Format: Reshoot	nnnnAseq; A then B, then C etc.
Line Name Suffix Format: Infill	nnnnFseq; F then G, then H etc. (to avoid using I)
First Shot Point Number: Prime	1001 (or some other 4 digit number)
Shot Point Number Increment: Reshoot Δ	+10000 for A, then +20000 for B, etc.
Shot Point Number Increment: Infill Δ	+5000 for F, then +15000 for G, etc.
Incrementing and Decrementing Shot Point Numbering (select)	Yes / No
Source Firing on Odd Shot Point Numbers (select)	Starboard / Port
Source Firing: Reset if Out of Sequence (select)	Yes / No

* Other conventions may be more appropriate to the particular needs of the company. The line naming convention should ensure that the seismic recording system does not truncate the line suffix number.

Δ The shot point renumbering suggested for reshoots and infill may not be required.

9. Local or National Datum	
Local Datum Name	
Spheroid	
Semi-major Axis (a)	metres
Semi-minor Axis (b)	metres
Inverse Flattening (1/f)	
Eccentricity Squared (e^2)	
Units	International metres

10. Alternate Datum	
Alternate Datum Name	WGS-84
Spheroid	WGS-84
Semi-major Axis (a)	6 378 137.000 metres
Semi-minor Axis (b)	6 356 752.314 metres
Inverse Flattening (1/f)	298.257 223 563
Eccentricity Squared (e^2)	0.006 694 379 9
Units	International metres

11. Datum Shift Parameters from WGS-84 to Local Datum	
dX	metres
dY	metres
dZ	metres
X Rotation (rX)	arc seconds
Y Rotation (rY)	arc seconds
Z Rotation (rZ)	arc seconds
Scale Correction	ppm

The multiple regression shift parameters may be specified instead of the seven parameter transformation above, if the information is available for the area in which the 3D survey will be carried out.

12. Geoidal Height	
Model Used for Geoidal Height Calculation	
Geoid to Spheroid Separation	

13. Projection Parameters on Local Datum	
Projection Type	Universal Transverse Mercator (UTM)
UTM Zone (North or South)	
Longitude of Central Meridian (CM)	degrees
Latitude of Origin	0 degrees
Scale Factor along CM	0.9666
False Easting	500 000 metres
False Northing	0 metres (10 000 000 m for Southern Hemisphere)
Unit of Coordinates	International Metres

There are other grid projections, such as Transverse Mercator, Rectified Skew Orthomorphic, or Gauss-Krüger, which will have different parameters than UTM.

14. Example of Co-ordinate Conversion			
Local Datum			
Latitude		Easting	
Longitude		Northing	
Height		Height	
Alternate Datum			
Latitude		Easting	
Longitude		Northing	
Height		Height	

These are very useful to confirm the contractor's software agrees with the company's.

15. Prospect Boundary Points				
Datum Name				
Projection				
Boundary Point	Latitude	Longitude	Northing	Easting

Insert as many points as required to describe the prospect full fold area.

16. Block Boundary Points				
Datum Name				
Projection				
Boundary Point	Latitude	Longitude	Northing	Easting

Insert as many points as required to describe the block area. The block boundary should be shown on all maps, plans and aerial plots produced by the contractor.

17. Navigation and Positioning Systems - Type, Manufacturer, Software Version and Date	
Primary DGPS Positioning* (see also next table)	
Secondary DGPS Positioning* (see also next table)	
rGPS Positioning: Type and Manufacturer	
rGPS Positioning: Source(s)	1 per source
rGPS Positioning: Front (Gun) Float(s)	1 each
rGPS Positioning: Tailbuoys	at least the minimum number specified later in these guidelines (collocated with acoustic sensor)
Laser Positioning: Type and Manufacturer	
Laser Positioning: Capable of Tracking	minimum 6 targets
Acoustic Positioning: Type and Manufacturer $^{\Delta}$	
Acoustic Positioning: Vessel	at least 1, preferably rigidly mounted through a gate valve, and free of vibrations at operational speeds
Acoustic Positioning: Sources	each gun sub-array, and used in network solution (possibly collocated with an rGPS unit)
Acoustic Positioning: Front (Gun) Float(s)	1 each
Acoustic Positioning: Front	at least 2 per streamer, located as described below
Acoustic Positioning: Middle (for streamer exceeding 3 kilometres)	at least 1 per streamer, and used in network solution
Acoustic Positioning: Tail	at least 2 per streamer, located as described below
Acoustic Positioning: Tailbuoys	at least the minimum number specified later in these guidelines (collocated with an rGPS unit)

17. Navigation and Positioning Systems - Type, Manufacturer, Software Version and Date - *continued*	
Acoustic Positioning: Batteries	
Streamer Compasses: Type and Manufacturer $^{\nabla}$	
Streamer Compasses: Spacing	at least every 300 metres, front and tail as below
Streamer Compasses: Number per streamer	
Streamer Compasses: Batteries	
	Type and Manufacturer
Gyro Compass	
Back Up Gyro Compass	
Echo Sounder: Type and Manufacturer	
T/S Bridge or Seawater Sound Velocity Meter	
Marine Gravity (if applicable)	
Marine Magnetometer (if applicable)	
Speed Log (if applicable)	
Acoustic Doppler Current Profiler (if applicable)	
On Line Integrated Navigation System	
On Line Binning System	
Post Processing System	
Off Line Binning System	

*The single frequency GPS receivers should support P-code resolution on the CA-code measurement (L1) type technology, provide parallel tracking, and be all-in-view type GPS receivers. The components of the primary DGPS positioning system should utilize identical GPS and telemetry equipment, pseudo range correction (PRC) software and firmware versions. The components of the secondary DGPS positioning system should have the same characteristics but should be of a different type. (See next table.)

The number of rGPS units, acoustic sensors, and streamer compasses should meet at least the above minimum criteria and ensure that the resulting uncertainty in the front and tail network positioning of any node should not be greater than ±1.5 metres when compared to the previous network analysis.

$^{\Delta}$ The number of acoustic units should meet at least the above and the following minimum criteria:

- i The cable separations at the front and tail should be directly measured, by duplicate range measurements if possible.
- ii There should be at least 2 acoustic sensor units mounted approximately 100 metres apart, one on either side of the first live trace. The first acoustic sensor should be mounted within 15 metres of the first live trace.
- iii There should be at least 2 acoustic sensor units mounted approximately 100 metres apart, one on either side of the last live trace. The last acoustic sensor should be mounted within 15 metres of the last live trace.
- iv The network should have at least 30 % redundant acoustic range observations to enable biases to be determined, and to ensure there are no uncontrolled observations.

$^{\nabla}$ The number of streamer compasses should meet at least the above and the following minimum criteria:

- i There should be 2 compasses mounted approximately 100 metres apart, one on either side of the first live trace. The first compass should be mounted within 25 metres of the first live trace.
- ii There should be 2 compasses mounted approximately 100 metres apart, one on either side of the last live trace. The last compass should be mounted within 25 metres of the last live trace.
- iii The maximum distance from the last active streamer compass to the tailbuoy on each streamer should be less than 100 metres.

18. Minimum DGPS Equipment Requirements for Primary and Secondary Positioning	
	Each GPS receiver onboard, and at the DGPS Reference and Monitor Stations
Primary Positioning: Name and Supplier	
Secondary Positioning: Name and Supplier	
Minimum number of channels*	9 channels
Firmware Version	(best practice) same for each GPS receiver used
Firmware Version: Last Updated	latest possible or within 6 months of mobilization
PRC Software Version	(best practice) same for each GPS receiver used

18. Minimum DGPS Equipment Requirements for Primary and Secondary Positioning - *continued*		
PRC Software Version: Last Updated	latest possible or within 6 months of mobilization	
Minimum Number of DGPS Reference Stations	at least 2 or more (if operationally feasible) which should surround the prospect Δ	
Differential Correction Transmission Method: Primary Positioning		
Primary DGPS Positioning: Reference Stations ∇	Distance from Prospect	Azimuth from Prospect
(add rows as necessary)		
Differential Correction Transmission Method: Secondary Positioning	different to Primary DGPS	
Secondary DGPS Positioning Reference Stations ∇	Distance from Prospect	Azimuth from Prospect
(add rows as necessary)		
Obstruction at each DGPS reference Station: Elevation Mask	5 degrees	
DGPS Monitor Station (if used)	within 200 kilometres of prospect centre (if operationally feasible)	
	capable of altering users of any non conformance	
	alternatively a DGPS Network Control Centre	

* Twelve channel GPS receivers are preferred as these provide enhanced tracking capabilities, faster acquisition and re-acquisition times, better performance during high dynamic maneuvers, with an update rate of less than 1 second per cycle.

Δ The individual DGPS reference stations should be chosen so that they are equally spaced around the prospect to minimize distortions caused by ionospheric and tropospheric effects. As much as possible the following guidelines should be adhered to with respect to the maximum distance from each DGPS reference station to the prospect centre. The optimum locations should be chosen for the GPS antenna ashore and onboard to minimize electromagnetic interference, multipath effects, and any obstructions. GPS health (site) audits of the DGPS reference stations and the DGPS monitor station (if used) to check for multipath effects, electromagnetic interference, and obstructions should have been updated as specified later in these guidelines.

∇ Distances from the prospect to the individual DGPS reference stations should be kept to a minimum.

Transmission System	Maximum Distances	Comment
Satellite	750 kilometres	Preferred
Low Frequency	600 kilometres	Generally not encouraged
Medium Frequency	500 kilometres	Generally not encouraged
Ultra High Frequency	100 kilometres	Preferred backup method

19. Required Accuracy for DGPS Reference and Monitor Station Co-Ordinates	
International Earth Rotation Service (IERS) Terrestrial Reference Frame and Epoch (ITRF-yy)	
Absolute Accuracy (95 % confidence level or better)	± 1 metres
3 Dimensional Relative Accuracy for each Baseline (95 % confidence level or better)	5 centimetres + 5 ppm
Point Error Ellipsoid Dimensions (95 % confidence level or better) after final minimally constrained adjustment	semi-major axis (a) = less than 0.1 metres semi-minor axis (b) = less than 0.1 metres height = less than 0.2 metres

The GPS land survey observations to establish the geodetic control for the DGPS reference and monitor (if used) stations should meet the latest version of an approved national standard, such as the following:

i "Guidelines and Specifications for GPS Surveys", Natural Resources Canada, Geodetic Survey Division, Ottawa, Ontario, Canada, Edition 2.1, December 1992.

ii "Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques", Federal Geodetic Control Committee, National Geodetic Survey, NOAA, United States, Version 5.0, May 1988.

All DGPS reference and monitor stations should be tied (referenced) to the primary control network of the country in which the stations are located. The national control points to which the GPS land survey should be tied should be at least second (2nd) order accuracy (1 in 50,000) or better.

20. Required Offset Measurement Accuracies				
Offsets:	**In-Line**	**Cross Line**	**Radial**	**Height**
Static Offsets onboard Vessel	±0.1 m	±0.1 m	±0.2 m	±0.1 m
Static Offsets onboard Tailbuoys	±0.1 m	±0.1 m	±0.2 m	±0.1 m
Laser Prism(s) on source(s)	±0.2 m	±0.1 m	±0.2 m	±0.1 m
Towed Acoustic Sensors	±0.3 m	±0.4 m	±0.4 m	±0.3 m
Angle of Deflection for Towed Acoustic Sensors				45 to 60 degrees
Offsets:	**In-Line**			
Acoustic Sensors mounted on Streamer(s)	±0.2 m			
Streamer Compasses mounted on Streamer(s)	±0.2 m			
Laybacks:	In-Line			
Centre Source - Definition (select)	geometric/ gun volume			
Centre Source(s)	±2.0 m			
Centre Near or First Group	±3.0 m			

All static offsets should be accurately measured by land survey methods. All offsets and laybacks should be shown on an appropriate set of diagrams and the layout approved by the company. The angle of deflection for towed acoustic sensors would vary depending on their weight.

Contractor should endeavor to ensure that the offsets and laybacks are unchanged during the survey unless operational reasons justify change. Any changes should be re-measured and the network definition(s) and effected diagrams should be revised and approved by the company.

Any or all offsets and laybacks should be checked by contractor at each streamer deployment when required by the company.

All offsets of the in-sea units should be measured to the centre of the measurement sensor on each acoustic unit and streamer compass, and the centre of each individual gun or gun cluster. Allowance should be made for the stretch in the front and tail stretch sections.

When the shortest possible source and streamer geometry have been established allowing for operational and safety concerns, all towing wires and chains should be marked to ensure the geometry remains the same following each deployment.

21. DGPS and rGPS Positioning Criteria	
DGSP Accuracy (1σ)	± 5 metres
rGSP Accuracy: Tailbuoys (1σ)	± 5 metres
rGSP Accuracy: Front (Gun) Float(s) (1σ)	± 2 metres
UKOOA "Use of Differential GPS in Offshore Surveying" Guidelines	latest version
DGPS Height Aiding Approved (select)	Yes / No
DGPS Height Accuracy (to account for tides and sea conditions)	less than ± 5 metres (if on site a larger value has to be used Height Aiding should not be used)
DGPS Height Fixing Approved	No
DGPS Minimum Number of Acceptable Satellites*	5 (4 with Height Aiding)
DGPS Satellite Elevation Mask Δ	7 degrees
DGPS Age of Corrections	less than 10 seconds (stop if greater than 20 sec.)
DGPS Update Rate, including Monitor Station	less than 3 seconds corrected for any latency
DGPS Transmission Format	RTCM SC-104, version 2 or later
DGPS Data Link Performance to each Reference and Monitor Station	98% (or better) valid messages
DGPS HDOP	less than 3
DGPS PDOP	less than 4
DGPS VDOP	less than 4
rGPS Minimum Number of Acceptable Satellites*	4 (3 with Height Aiding)
rGPS Satellite Elevation Mask Δ	5 degrees
rGPS PDOP	less than 5
rGPS synchronization	1 second
rGPS Update Rate	less than 10 seconds (stop if greater than 20 sec.)

21. DGPS and rGPS Positioning Criteria - *continued*	
	Statistical Testing Values:
Probability of Test (β)	20 %
Power of the Test (1 - β)	80 %
Level of Significance (α) for the W-test	1 %
Level of Confidence (1 - α) for the W-test	99 %
Marginal Detectable Error (MDE) in any Corrected Pseudo-range	less than 15 metres

* Whenever possible, the maximum available number of healthy satellites that meet the minimum elevation criteria should be used in the positioning computation(s). Satellite prediction software with the latest updated almanac should be available throughout the survey. Such software should be used to identify any poor coverage windows and if possible plan operations accordingly.

Δ Provided the DGPS and rGPS software is capable of handling such low elevation satellites by the use of appropriate weighting. The weighting should be documented and approved by the company.

A continuous integrity check could be carried out during mobilization and the survey for each line or part of a line. If an integrity check is not possible then all DGPS positioning equipment should be verified in situ with the vessel(s) fast alongside prior to the commencement of seismic acquisition.

A re-radiation check of all rGPS positioning units could be carried out during mobilization, prior to deployment, and, as required, during the survey. If a re-radiation check is not possible then all rGPS positioning units should be verified in situ with the vessel(s) fast alongside prior to the commencement of seismic acquisition.

22. Active Tailbuoys – rGPS *and* Acoustic Positioning Acceptable	
Number of Streamers	Minimum Number of Active Tailbuoys Required
1	1
2	1
3	2
4	2
5	2
6	3
7	3
8	4
9	4
10	4
11	5
12	5

An active tailbuoy is defined as any tailbuoy with operational rGPS and acoustic positioning. With 3 or more streamers, acceptable active tailbuoys should not be adjacent to each other. The maximum number of active tailbuoys would be one for each tailbuoy.

The contractor should ensure that each tailbuoy unit has sufficient power to satisfy the requirements of the positioning system and data telemetry systems. Non-gassing batteries should be used.

23. Active Gun Sub Array(s) or Front (Gun) Float(s) – rGPS *and* Acoustic Positioning Acceptable	
Number of Sources	Minimum Number of Gun Sub-Arrays with rGPS positioning or Active Front (Gun) Float(s)
1	1
2	1
3	2
4	3

Active front (gun) floats(s) may not be required if adequate rGPS units are deployed on the source sub array(s). The maximum number of active rGPS and acoustic units would be one of each on each gun sub array.

24. Laser Positioning Criteria	
Distance Accuracy (1σ)	± 0.5 metres
Direction Accuracy (1σ)	± 0.1 degrees
Distance Resolution	0.5 metres
Direction Resolution	0.1 degrees
Orientation*	primary navigation gyro compass
Check Prism (if used) Δ	mounted to a fixed surveyed point

* Orientation from the navigation gyro compass, should be combined with the laser directions to derive the laser bearing in the integrated navigation system and the post-processing system.

Δ To allow direct comparisons to be made with the primary navigation gyro compass.

Laser positioning may be redundant with sufficient rGPS units deployed on the source arrays and front (gun) float(s). The prisms should be waterproofed to prevent water ingress. To prevent damage during deployment and recovery of a source sub-array, the prisms should be protected by a bracket or other strong feature, if operationally feasible. Repeated failed attempts to establish acceptable laser positioning to the source sub-arrays should require alternative arrangement(s) to be devised with company approval.

25. Acoustic Positioning Criteria	
Range Accuracy (1σ)	± 0.2 meters
Range Resolution	0.2 metres

The contractor should provide a medium or high frequency acoustic positioning system capable of providing acceptable data in the conditions expected during the survey. These conditions would include but not be limited to, the expected water depths, tides and currents, and the temperature and salinity changes. The acoustic positioning system should be designed such that the co-ordinate accuracy of the source(s) and streamer traces should be within the tolerance specified by the company.

A unique serial number should be clearly engraved or marked in some other durable manner on an easily visible portion of the acoustic sensor housing.

The redundancy and geometry of the observed acoustic ranges should meet good survey practices and standards, and should allow an effective, statistically adjusted network(s) to be computed. The survey network should contain sufficient redundant observations to enable biases to be detected. The redundancy should be evenly spread such that the network contains no uncontrolled observations. A well-controlled network will have the redundant observations in the design network. If the processing method is based on a phased adjustment of sub-networks, this redundancy requirement should apply to each sub-network. The company preferred testing method for all observables is by applying Baarda statistical testing for outliner detection using the testing values specified by the company.

The contractor should provide a MOVE® (or similar) analysis of the network(s) in order to be able to prove the network(s) meet the co-ordinate accuraccriteria, using the *a priori* values suggested by the company prior to mobilisation, as well as during the survey to determine the effect of any equipment failure.

Orientation along each streamer for the front acoustic network should be derived from the average of the first two active streamer compasses on the respective streamer. Orientation along each streamer for the tail acoustic network should be derived from the average of the last two active streamer compasses on the respective streamer, or from the rGPS positioning. Other appropriate procedures may be used with company approval.

The speed of sound in water at the streamer depth should be established and updated as specified by the company.

26. Streamer Compasses Criteria	
Direction Accuracy (1σ)	± 0.5 degrees
Resolution	0.35 degrees
Display	0.1 degrees
Internal Gimballing: Roll	360 degrees
Internal Gimballing: Pitch	at least 25 degrees
Acceptable On-Line Filtering:	sampled every second and averaged over 7 seconds

A unique serial number should be clearly engraved or marked in some other durable manner on an easily visible portion of the streamer compass housing.

The streamer compass configuration should be the same or very similar for each streamer. If operationally feasible, a given streamer compass should be mounted on the same streamer, at the same location, throughout the seismic acquisition.

The static biases for the streamer compasses which meet the specified tolerances set later in these guidelines, shall be set to zero (0) in the integrated navigation system and the post processing software, at the discretion of the company. The contractor should only use dynamic streamer compass verification values with the written approval of the company.

27. Streamer Depth Sensor Criteria	
Accuracy (1σ)	± 0.2 metres
Resolution	0.1 metres
Display	0.1 metres

28. Magnetic Variation for Streamer Compasses	
Model Used for Magnetic Variation Calculation	
Prospect Centre: Latitude	
Prospect Centre: Longitude	
Date Used for Computation	
Magnetic Variation Computed	degrees
Magnetic Secular Variation Computed	degrees
Agreement with most recent Admiralty Chart or other Independent Method	within 0.2 degrees
Magnetic Storm and Sun Spot Activity Reports	sent to vessel at least weekly, if significant

29. Gyro Compass(es) Criteria	
Accuracy (1σ): Static	± degrees
Accuracy (1σ): Dynamic	± degrees
Resolution	0.1 degrees
Display	0.1 degrees
Alignment with Vessel Centre Line (securely fastened)	± 0.2 degrees
Alignment: Repeaters	± 0.2 degrees
Orientation for Navigation System	primary gyro compass

30. Echo Sounder Criteria	
Depth	maximum water depth in prospect area
Accuracy	± 1 % of the water depth in area of operations
Units	metres
Graphic Resolution	0.2 metres
Digital Resolution	0.1 metres
Frequencies: at least 2	33 kHz and 210 kHz (or similar)
Recording Paper Speed and Scales	adjustable
Speed of Sound Setting	adjustable and continuously displayed
Transducer Draught Setting	adjustable
Event Mark	external and manual input
Output: Paper Record*	Yes (to be included with observer's log for each line)
Output: Digital	Yes
Heave Compensator$^{\Delta}$ (Optional)	± 0.5 centimetres or 5 % of measured range
Speed of Sound: Accuracy from T/S meter	± 1 metre per second
Speed of Sound in Water Column: Value Used (select)	standard / observed
Speed of Sound at Streamer Depth: Value Used $^{\nabla}$	observed
Draught: Value Used (select) $^{\nabla}$	standard / observed

* All analogue records should be clearly and legibly annotated to include at least the following minimum information at the start and end of each line: date, time, line number, shot point and scale used.

$^{\Delta}$ The heave compensator (if used) should be installed in close proximity to the echo sounder transducer and should be rigidly fixed. The installation and operation of the heave compensator should be in accordance with the manufacturer's specifications.

$^{\nabla}$ The velocity of sound in water for the water column and at the streamer depth and the draught of the vessel(s) should be observed and updated as specified later in these guidelines.

31. Marine Gravity Criteria	
Sample Rate for Gravity and Navigation	1 second
Synchronization with Navigation timing	1 second
Noise Envelope at 3 Minute Filter Horizontal Accelerations: Up to Force 4 or 25,000 mGal	± 0.5 mGal
Up to Force 5 or 50,000 mGal	± 1.0 mGal
Up to Force 6 or 75,000 mGal	± 2.0 mGal
Maximum Filtered Accelerometer Noise	4 level divisions
Heading Changes On Line	less than 1 degrees per minute, if operationally feasible
Speed Changes On Line	less than 1 knot per minute
Sensor Offset Position*	centre of vessel pitch, roll, and yaw axes

* The marine gravity meter should be in a position where it will not be exposed to extremes of temperature or be knocked or damaged, but will allow easy access for maintenance. The equipment should be mounted such that it is sufficiently dampened not to be affected by floor transmitted high frequency vibrations.

Data recording should commence 8 to 10 minutes before the start of a line or part of a line, and terminate at least 5 minutes after the end of the line or part of a line. Sufficient analogue data should be recorded to allow data recovery in the event of the failure of the digital data recording.

32. Marine Magnetometer Criteria	
Minimum Sensitivity Accuracy	± 1 nT (1 nT = 1 gamma which was old measure)
Sampling Rate	2 seconds
Synchronization with Navigation Timing	1 second
Noise Envelope	± 2 nT
Signal to Noise Ratio	25:1
Towed Astern	at least 3 times vessel length (if operationally feasible)

33. Speed Log and Acoustic Doppler Current Profiler Criteria	
Speed Log: Accuracy	± 0.1 metres per second on each axis
Speed Log: Update Rate	at least once per minute
Acoustic Doppler Current Profiler: Update Rate	at least once per minute
Acoustic Doppler Current Profiler: Accuracy	± 0.03 metres per second on each axis

For the marine gravity, marine magnetometer, and acoustic Doppler current profiler the contractor should provide visual outputs as well as digital and analogue records. All analogue records (if provided) should be clearly and legibly annotated to include at least the following minimum information at the start and end of each line: date, time, line number, and shot point.

34. Minimum Positioning Spares Recommended	
Primary DGPS Positioning onboard including GPS receiver, demodulator, antenna and cabling, computer hardware and software	Secondary DGPS Positioning onboard including GPS receiver, demodulator, antenna and cabling, computer hardware and software
DGPS at each reference station GPS receiver, demodulator,modem and relay capability, antenna and cabling, computer hardware and software	100% (in 'hot stand by mode')
Tailbuoy Vehicles including rGPS unit, telemetry link, power supply, antenna and cabling, computer hardware and software*	50 % of minimum number of active tailbuoys required (rounded up for odd numbers)
Acoustic Positioning Transponders/Responders*	25 %
Acoustic Positioning: Batteries	new at mobilization (replaced within manufacturer's expected duration)
Streamer Compasses*	50 %
Streamer Compasses: Batteries	new at mobilization (replaced within manufacturer's expected duration)
Streamer Depth Controllers*	50 %
Streamer Depth Controllers: Batteries	new at mobilization (replaced within manufacturer's expected duration)
Laser positioning unit	100 %
Gyro compass	100 %
Navigation Data Logging units	100 %
Repair of Equipment: Maximum Period of Navigation Downtime (if operationally feasible)	6 hours

* These suggested percentages of spares may not be required for multi streamer surveys where it could be possible to cannibalize a streamer(s) to allow production to continue. In such cases provisions for such a possibility should be included in the contract.

35. Pre Survey Checks, Verifications and Calibrations of Positioning Systems – Timing	
DGPS Positioning Verification - Primary	during mobilization
DGPS Positioning Verification - Secondary	during mobilization
Primary and Secondary DGPS Reference Stations - GPS Health (Site) Audits	within 6 months of mobilization

35. Pre Survey Checks, Verifications and Calibrations of Positioning Systems – Timing - *continued*	
rGPS Positioning Verification	all during mobilization
Laser Positioning Calibration	within 4 months of mobilization
Laser Positioning Calibration: Directions	both (same as for gyro compass(es))
Laser Positioning Calibration: Long Projects	repeated at 6 months from start of survey
Acoustic Positioning: Inspection of Hull mounted Transducer by Diver (to clear marine growth from transducer)	during mobilization (if not accessible through gate valve) or at discretion of company
Streamer Compasses: Manufacturer's Calibration	within 24 months of mobilization
Streamer Compasses: Verification by contractor	within 4 months of mobilization
Streamer Depth Controllers: Calibration	all during mobilization
Gyro Compass(es) Calibration	within 4 months of mobilization
Gyro Compass(es) Calibration: Directions	both
Gyro Compass(es) Calibration: Long Projects	repeated at 6 months from start of survey
Echo Sounder Transducer Check: Inspection by Diver (to clear marine growth from transducer)	during mobilization (if not accessible through gate valve) or at discretion of company
Echo Sounder Check: Lead Line Check	during mobilization or at discretion of company
Echo Sounder Check: Bar Check	prior to acquisition if operationally feasible
T/S Bridge or Seawater Sound Velocity Meter	within 12 months of mobilization
Speed of Sound in Water Column for Echo Sounder	at prospect centre and if operationally feasible, at corners of prospect prior to commencement
Speed of Sound in Water at Streamer Depth for Acoustic Positioning	in prospect prior to commencement
Marine Gravity (if applicable): As Required by Manufacturer	during mobilization, including alongside still reading
Marine Magnetometer (if applicable): As Required by Manufacturer	during mobilization
Speed Log (if applicable) Transducer Check: Inspection by Diver (to clear marine growth from transducer)	during mobilization (if not accessible through gate valve) or at discretion of company
Acoustic Doppler Current Profiler (if applicable) Transducer Check: Inspection by Diver (to clear marine growth from transducer)	during mobilization (if not accessible through gate valve) or at discretion of company
Results to be Available prior to commencement of seismic acquisition	within 12 hours of commencement

The company may request to be present at any or all of these checks, verifications and calibrations.

36. Checks, Verifications and Calibrations of Positioning Systems – During Acquisition	
DGPS Positioning	comparison of network solution with each DGPS Reference Station for each line or part of a line
DGPS Positioning - Primary versus Secondary	comparison for each line or part of a line
Laser Positioning Check: To Fixed Target onboard	daily or at discretion of company
Laser Positioning Check: via Post Processed Comparisons	weekly
Laser Positioning Distance Check versus rGPS	during deployment and recovery of streamer(s) within 200 metres of stern
Laser Positioning Position Check versus Acoustic Positioning	during deployment and recovery of streamer(s) within 200 metres of stern
Streamer Compasses: Dynamic Biases (for appropriate shot point interval consistent with the method of calculation)	for each line or part of a line
Streamer Depth Sensors: Calibration Check	all replacements to be checked before deployment
Gyro Compass(es): Check On Line	for each line or part of a line
Gyro Compass(es): Check by Transit Bearings, Sun Shots, or other methods	when appropriate
Speed of Sound in Water Column for Echo Sounder	weekly; changed when differs by 2 metre per second or sooner if changes in sea conditions warrant
Speed of Sound in Water at Streamer Depth for Acoustic Positioning	weekly; changed when differs by 2 metre per second or sooner if changes in sea conditions warrant
Vessel Draught	weekly during calm sea conditions; changed when differs by 0.5 metres.
Marine Gravity (if applicable): As Required by Manufacturer	daily checks, including still readings during any port calls

The company may request to be present at any or all of these checks, verifications and calibrations.

37. Post Survey Checks, Verifications and Calibrations of Positioning Systems – Timing	
DGPS Positioning Verification - Primary	at discretion of company
DGPS Positioning Verification - Secondary	at discretion of company
rGPS Positioning: Verification	at discretion of company
Laser Positioning: Calibration	period since previous verification greater than twice period stated above, or at discretion of company
Streamer Compasses: Verification by contractor	period since previous verification greater than twice period stated above, or at discretion of company
Streamer Depth Sensors: Calibration	at discretion of company
Gyro Compass(es): Calibration	period since previous verification greater than twice period stated above, or at discretion of company
Speed of Sound in Water Column for Echo Sounder	in prospect at end of survey
Echo Sounder: Lead Line Check	during demobilization or at discretion of company
Echo Sounder: Bar Check	during demobilization or at discretion of company
Marine Gravity (if applicable): As Required by Manufacturer	during demobilization
Marine Gravity (if applicable): Land Tie (select)	Yes / No
Preliminary Results to be available	prior to end of demobilization

The company may request to be present at any or all of these checks, verifications and calibrations.

38. Checks, Verifications and Calibrations of Positioning Systems – Acceptable Results	
DGPS Positioning Verification – Land Survey methods versus DGPS network solution (for the same instant in time)	less than 3 metres average radial difference, standard deviation less than 2 metres
DGPS Positioning Verification – Land Survey Methods versus each DGPS reference station position (for the same instant in time)	less than 3 metres average radial difference, standard deviation less than 2 metres
Accuracy of Known Points used for Land Survey Comparison on WGS84 datum (if used)	± 0.3 metres or better
Accuracy of Known Points used for Land Survey Comparison on Local Datum (if used)	± 0.3 metres or better
Accuracy of Land Survey Distance measurement	at least ± 0.2 metres
Accuracy of Land Survey Direction measurement	at least ± 0.02 degrees
DGPS Positioning Verification – Integrity Check Method versus DGPS network solution	less than 2 metres average radial difference, standard deviation less than 2 metres
DGPS Positioning Verification – Integrity Check Method versus DGPS network solution Scatter Plot	tight plot around mean position
Secondary DGPS Positioning Verification (alongside)	same as Primary, or average radial difference with Primary less than 3 metres
rGPS Positioning Verification – Land Survey Methods versus each rGPS position (for the same instant in time)	less than 3 metres average radial difference, standard deviation less than 2 metres
rGPS Positioning Verification – Re-radiation Method versus each rGPS unit	less than 1 metre average radial difference, standard deviation less than 1 metre
Laser Positioning Calibration: Distance (for the same instant in time)	less than 2 metres, standard deviation less than 0.5 metres; absolute difference between observations in 2 directions less than 0.7 metres
Laser Positioning Calibration: Direction (for the same instant in time)	less than 2 degrees, standard deviation less than 0.2 degrees; absolute difference between observations in 2 directions less than 0.6 degrees
Laser Positioning: Agreement with Previous Results	distance within 1.0 metres, direction within 0.4 degrees
Laser Positioning Check: To Fixed Target onboard	distance within 0.5 metres, direction within 0.2 degrees
Laser Positioning Check: via Post Processed Comparisons	distance within 0.7 metres, direction within 0.6 degrees
Laser Positioning: Distance Check versus rGPS during deployment and recovery	less than 2 metres average radial difference
Laser Positioning: Position Check versus Acoustic Positioning during deployment and recovery	less than 3 metres average radial difference
Streamer Compasses: Verification by contractor	manufacture's preset (A, B and C) values should be unaltered from the values derived during the most recent manufacturer's calibration
	each static bias less than 0.5 degrees of either sign, provided that for each compass the sign is the same
	each average static bias less than 0.5 degrees
	20% tested for roll at ± 5, ± 10, and ± 15 degrees and pitch at ± 5 and ± 10 degrees; each bias less than 0.85 degrees of either sign, provided that for each compass the sign is the same
Streamer Depth Sensors: Calibration on Deck	depth error less than 0.2 metres
Gyro Compass(es): Calibration*	standard deviation less than 0.1 degrees; absolute difference between observations in 2 directions less than 0.4 degrees
Accuracy of Azimuth Baseline used for Gyro Compass(es) Calibration	± 0.05 degrees

38. Checks, Verifications and Calibrations of Positioning Systems – Acceptable Results - *continued*	
Gyro Compass(es) Calibration: Agreement with Previous Results	within 0.6 degrees
Echo Sounder Check: Lead Line Check (taking into consideration possible debris alongside)	less than 0.5 metres between echo sounder and lead line check
Echo Sounder Check: Bar Check	less than 0.3 metres between bar and echo sounder
Marine Gravity (if applicable): Daily and Post Survey	as per manufacturers specifications
Marine Gravity (if applicable): Still Reading	similar results to previous, less than 1 mGal drift per month since last reading
Marine Magnetometer (if applicable): Connected to Test Module Sensor	less than ± 2 nT after at least 2 hours; readings should drift over time

* If the gyro compass correction is larger than 1.5 degrees of either sign, consideration could be given to slewing the gyro compass and repeating the observations.

39. Checks, Verifications and Calibrations of Positioning Systems – Acceptable On Line Results	
DGPS Positioning comparison of network solution with each DGPS Reference Station for each line or part of a line*	less than 3 metres average radial difference
	less than ± 2 metres difference in Eastings
	less than ± 2 metres difference in Northings
DGPS Positioning – Primary versus Secondary Δ	less than 3.5 metres average radial difference
Streamer Compasses: Dynamic Biases (for appropriate shot point interval consistent with the method of calculation)	less than 0.8 degree (1.2 degrees for front and tail compasses) of either sign
Gyro Compass(es): Check On Line*	absolute difference between each gyro compass for each line less than 1.0 degrees

* These checks could be used as quality control tools and not necessarily as rejection criteria.

Δ This should be a necessary condition when switching between the two systems when the primary DGPS temporarily fails. If this condition is not met, production should cease until the DGPS positioning improves, and an explanation is provided by the contractor to the satisfaction of the company.

40. Rejection Criteria – Acceptable Data for Each Line or Part of a Line	
DGPS Positioning: Primary or Secondary	100 %
Shot Point Interval: Nominal (over any 200 shot point sliding window)	± 1 % and not more than 7 consecutive shot points
Shot Point Interval: Mean*	nominal ± 0.02 metres
Shot Point Interval: Standard Deviation	less than 2.0 % of nominal
rGPS Positioning	95 % and not more than 20 consecutive shot points
Laser Positioning	95 % and not more than 20 consecutive shot points
Acoustic Positioning for One or More Streamers	loss for not more than 20 consecutive shot points
For each Front Acoustic Range	70 % of range data within a 3 metre window centered on nominal range
Reflected Acoustic Ranges	5 % of total number of acoustic ranges in each acoustic network
Streamer Compasses	95 % and not more than 20 consecutive shot points
For each Streamer Compass where one of the following derived from the time series plots or statistics may apply:	less than 0.8 degrees from best linear fit of data over 250 metres either side of the event
	average value less than 0.8 degrees from adjacent compasses on same streamer
	differences of the standard deviation (DSD or Dstd) between adjacent compasses on the same streamer less than 0.7 degrees
	calculated dynamic bias unacceptable for 5 or more lines or parts of lines in same direction
Streamer Depth Sensors	not more than 10 consecutive shot points rejected between any two adjacent sensors, **or** between the front and tail of any streamer
Echo Sounder: Operational Downtime	more than 1 hour
Source Depth	not more than 10 consecutive shot points rejected
Marine Gravity (if applicable) if either:	horizontal accelerations in excess of 60,000 mGal peak to peak on either axis
	cross coupling readings in excess of ± 20 mGal
Marine Magnetometer (if applicable)	greater than 10 nT peak to peak
Network Adjustment: Variance Covariance Matrix in Front Network	each attribute less than 5 metres for 95 % of shot points in line or part of a line
Near Trace Radial Offset: Variation	less than 2 metres, unless such variations are a result of tides and currents influencing the towing characteristics, or other physical causes

* Inline shot to shot spikes over 2.5 metres should correlate with shot point time interval spikes. Cross line spikes over 4 metres should be investigated to ensure filtering parameters are set up correctly for the data, or any other problems.

Post processed navigation data should be used in the acceptance or rejections of lines. This means that a line may be accepted in real time but subsequently rejected due to problems highlighted during processing.

41. Survey, Navigation and Positioning Misfire Criteria	
DGPS Positioning: Primary and Secondary	any loss or unacceptable DGPS for both systems simultaneously
Tailbuoy rGPS Positioning: Acceptable Number	falls below minimum
Sub Array rGPS or Front (Gun) Float rGPS Positioning: Acceptable Number	falls below minimum; rectified prior to start of next line
Laser Positioning*	no data available, if operationally feasible rectified prior to start of next line
Acoustic Positioning for One or More Streamers Δ	no data available
Streamer Compasses: Streamer Rejected	if on same streamer, 3 or more or any 2 adjacent streamer compasses rejected
Echo Sounder	exceeds minimum downtime criteria

* Missing laser positioning (if used) data caused by fog, rain and sea conditions should be considered beyond the control of the contractor. Redundancy in the front network should take this into consideration if the these conditions are expected regularly during the 3D survey.

Δ Missing acoustic positioning data may be interpolated provided the vessel was on a steady course, there were no significant feather changes (less than 2 degrees), and existing sea state allowed suitable interpolation to be carried out at discretion of the company.

Continuation could be allowed depending on performance of supporting systems and redundancy during the line and at discretion of the company. Acquisition could continue provided the following criteria are met for each system:

i Loss of tailbuoy rGPS positioning – all other acoustic ranges in the tail network {not including those to the unacceptable active tailbuoy(s)} should be acceptable.

ii Loss of sub array rGPS positioning or of front (gun) float – reliable and consistent laser and acoustic positioning data is available to position the affected centre of source(s).

iii Loss of acoustic positioning to sub array(s) – reliable and consistent rGPS and laser positioning data is available to position the affected centre of source(s).

iv Loss of laser positioning to the sub array(s) – reliable and consistent rGPS and acoustic positioning data is available to position the affected centre of source(s).

v Loss of acoustic positioning for one or more streamers – there were no variations in the streamer feather angle(s), and there were no sudden heading changes during the effected period.

42. Survey, Navigation and Positioning Line Termination Criteria

A line or part of a line should be terminated if the survey, navigation and positioning misfire criteria in the preceding tables are not met for any one of the following systems for the number of consecutive shot points given below, unless continuation is approved by the company.

DGPS Positioning: Primary and Secondary	not more than 5 consecutive shot points
Tailbuoy rGPS Positioning	not more than 20 consecutive shot points
Sub Array rGPS Positioning	not more than 20 consecutive shot points
Front (Gun) Float rGPS Positioning	not more than 20 consecutive shot points
Laser Positioning	not more than 20 consecutive shot points
Acoustic Positioning	not more than 12 consecutive shot points
Streamer Compasses	not more than 20 consecutive shot points
Gyro Compass	not more than 20 consecutive shot points
Echo Sounder	not more than 100 consecutive shot points
Binning: On-Line	not available for over 500 metres
Full Nominal Coverage	less than 85 %
Continuous Misfires (for same source)	8 or more of the shot points
Misfires Over Consecutive Shot Points	not more than 10 in 20 shot points
	not more than 20 in 100 shot points
Misfires for Any Line or Part of a Line	4 %
Misfires for Prospect	2 %

43. Interrupted Line Continuation		
Shot Point Overlap for Start and End of Reshoot	10 shot points (at no charge to company)	
Minimum Reshoot Length	active streamer length	
Number of Edits in Any Line or Part of a Line	maximum of 3 separate edits, cumulative total less than 25 % of the complete planned line	
Minimum Number of Segments per Line	less than 20 km 20 to 35 km 35 to 50 km greater than 50 km	2 3 4 at discretion of company

Reshoots should be acquired in the same direction as the original lines unless approved otherwise by the company. Infills should be also acquired in the same direction as the original lines, except at swathe boundaries, unless approved otherwise by the company.

44. Required Statistical Testing Values for Network Solution	
Probability of Test (β)	20 %
Power of the Test (1 - β)	80 %
Level of Significance (α) for the W-test	1 %
Level of Confidence (1 - α) for the W-test	99 %

The calculation of the source and receiver group co-ordinates should be based upon the least squares adjustment and include full statistical testing. The preferred testing method for all observables is by applying Baarda statistical testing for outliner detection. The preferred processing approach is an integrated adjustment whereby all observables are processed in one integral network adjustment per event. Alternatively, processing may be based on a sequential adjustment of partial networks.

45. Suggested *a priori* Standard Deviations (1σ)		
Vessel Offsets and Baselines	± 0.2 metres	
Towed Offsets and Baselines	± 0.5 metres	
Vessel DGPS Positioning: Easting	± 3.5 metres	
Vessel DGPS Positioning: Northing	± 3.5 metres	
rGPS Range to Front (Gun) Float(s)	± 2.0 metres	
rGPS Bearing to Front (Gun) Float(s)	± 0.5 degrees	
rGPS Range to Tailbuoy(s)	± 3.0 metres	(for 3000 m streamers, pro-rated for other configurations)
rGPS Bearing to Tailbuoy(s)	± 0.06 degrees	
Laser Range	± 0.8 metres	
Laser Bearing	± 1.0 degrees	
Streamer Compasses	± 0.8 degrees	
Streamer Compasses: First and Last	± 1.2 degrees	
Acoustic Ranges	± 1.0 metres + 1 % of the range	
Gyro Compass(es)	± 0.8 degrees	
Course Made Good (if used)	± 2.0 degrees	

The same or similar *a priori* values should be met, and should be used in order to achieve the a *posterior* values required. Different contractor's will use different values.

What is important is that the ërelativeí weighting between the observations should be correct. Based on the post processed results of the first 5 accepted lines, these parameters should be either confirmed or reviewed to better fit the actual data performance. The confirmed or updated parameters to be used for the post-processing of all lines acquired during the survey, should be agreed in writing by both the contractor and the company.

For each line or part of a line, the Unit Variance for each network should lie about a value of 1 ± 0.3. However, since the observables are filtered and possible correlations between them are disregarded, the Unit Variance may not be one. A pessimistic set of *a priori* values would reduce the Unit Variance value towards zero. It is preferable to concentrate on the consistency of the Unit Variance over the survey area, and over the line analyzed in particular. Peculiar variation(s) of the Unit Variance from the average for the prospect should be systematically investigated.

46. Acceptable Network Comparisons with Calculated Offset Positions		
Comparison between Network Solution and Positions Derived from Vessel Offsets, Laybacks, and Streamer Compasses for:	Tolerance	Acceptable Fixes For Each Line or Part of a Line
Sources and Front Acoustic Sensors	± 3 metres (radial)	95 %
Tail Acoustic Sensors	± 7 metres (cross-line)	95 %
Tail Acoustic Sensors	± 2 metres (in-line)	95 %

For each streamer, the tailbuoy misclosure angle should not be greater than 0.5 degrees. The tailbuoy misclosure angle is the derived angle from the head of each streamer between the positioning solution for the streamer tailbuoy (whether actively positioned or not) derived from offsets and the streamer compasses, and the tailbuoy rGPS position. The results for each streamer should be sorted by line direction, and for averages over 0.3 degrees the magnetic variation should be further analyzed. Regardless of the line direction, the derived magnetic declination from the tailbuoy misclosure angles should be of the same algebraic sign, and should be consistent over a localized area (although some differences may be observed in large prospects over volcanic strata).

47. Acceptable Residuals		
rGPS Range to Front (Gun) Float(s)	less than 1 metres	
rGPS Bearing to Front (Gun) Float(s)	less than 0.2 degrees	
rGPS Range to Tailbuoy(s)	less than 1 m	(for 3000 m streamers, pro-rated for other configurations)
rGPS Bearing to Tailbuoy(s)	less than 0.3 degrees	
Tailbuoy In-Line Misclosure	less than 3.0 metres	
Laser Positioning (if used): Range	less than 0.7 metres	
Laser Positioning (if used): Direction	less than 0.6 degrees	
Acoustic Positioning: Ranges	less than 0.5 metres	
Gyro Compass(es)	less than 0.5 degrees	

48. Navigation Recording and Post Processing Parameters			
TIME to be used for all data logging and reporting			
STANDARD PORT with reference (for tidal information)			
Survey, Navigation and Positioning Statistical Data Format (select software version and specify media)	Microsoft Excel® / Lotus 1-2-3® Media:		
	Format:	**Media:**	**Copy to:**
Raw Navigation Data Format*	UKOOA P2/91		Client
Number of Acquired Lines per Tape			
Tape Naming Format: Raw Δ			
Final Post Processed Data Format	UKOOA P1/90		Client, Seismic Processing Contractor
Number of Post Processed Lines per Tape			
Tape Naming Format: Post Processed Δ			
Final Post Processed Data Available for On Line Binning Display	within 12 hours of completion of a line or part of a line		
Final Post Processed Data Format for Vessel Position Files ∇	UKOOA P1/90		Client
Final Post Processed Data Format for Vessel Position Files and Reduced Bathymetry (One header and all V and E records.)	UKOOA P1/90		Client
Final Post Processed Data Format for CMP data (Generally the position between centre source and the first record.)	UKOOA P1/90		Client
Marine Gravity Data (if applicable): Standard digital Lacoste-Romberg Format	Lotus 1-2-3® Compatible		Client, Gravity Processing Contractor
Marine Magnetometer (if applicable)			Client
Acoustic Doppler Current Profiler (if applicable)			Client

* Raw data only with no filtering or smoothing applied to the data.

Δ The contractor may have a standard tape naming format which may be suitable.

∇ Generally with one header and all V records, although may be required as all V records with individual headers.

The contractor should ensure that there are no discrepancies between the survey, navigation and positioning logging and records, and the seismic acquisition logging and records. All positioning data should be co-registered with all other data in both time and sequence number formats in order to permit unambiguous correlation with the seismic record data. The contractor should ensure that all positioning post-processing and co-registration with the seismic records is completed onboard, unless agreed otherwise in writing with the company.

All raw data should be recorded to disk or other medium for all survey, navigation and positioning systems. All records for one position fix should be referred to the same instant in time (generally gun firing). Deskewing to the time of gun firing should be carried out by means of extrapolation or interpolation from a consecutive number of samples. Proof of correct deskewing technique will be required by the company.

The most recent unfiltered time-tagged laser positioning data should be available to the integrated navigation system. Old readings should be clearly identified and rejected from the network adjustment.

The contractor should provide, for each line or part of a line, a log showing the status of the positioning systems; any irregularities, changes or failures should be noted as they occur. These logs and quality control logs and time series plots for every system and sensor used onboard should be included with the navigation data.

The company should be allowed to view all onscreen data and any hard copy outputs at any time. Copies of this information should be provided if requested by the company.

49. Navigation Post Processing for Third Party Quality Control

	Format:	Media:	Within:
Raw Navigation Data Format	UKOOA P2/91		5 hours
Final Post Processed Data Format	UKOOA P1/90		9 hours

Data should be available, if required, within the period specified, from the completion of a line or part of a line, otherwise acquisition should cease. The time period could also be specified relative to the expected acquisition time for the typical line length of the survey.

Access should be provided to a separate contractor's navigation work station to allow the company representatives to inspect the raw and post processed data for each line or part of a line at any time.

50. Survey, Navigation and Positioning Statistical Data Required for Each Line

Line Name	first and last shot point
Primary DGPS	maximum HDOP, maximum PDOP, average HDOP, average computed height, DGPS reference stations used
Secondary DGPS	maximum HDOP, maximum PDOP, average HDOP, average computed height, DGPS reference stations used
	average difference comparisons with primary in Easting and Northing (or Along and Across)
Laser positioning	unacceptable data that was not used for complete line
Acoustic positioning	unacceptable data that was not used for complete line
Streamer compasses	unacceptable data that was not used for complete line, or shot point range of any streamer compass data which was not accept able for more than 20 shot points compass(es) which failed the calculated dynamic bias test
Gyro Compass(es)	performance comment with regard to oscillations
	average difference comparisons with primary gyro compasses
Echo Sounder	speed of sound in water column used and observed
Fully Integrated	results of statistical testing for whole network
Networks	results of statistical testing for each observable or observation type
	average unit variance, average degrees of freedom, average residuals for each observable
	comparison of on-line and off-line results
	average separations for sub-arrays, and centre of sources
	average streamer front, middle (if used) and tail separations between each adjacent pair (e.g., between streamers 1 and 2, streamers 2 and 3, etc.)
	average angular tailbuoy misclosure (rotation) and average in-line and cross-line misclosures for each streamer
	average shot point interval, shot point interval test based on distance and time
	absolute error ellipses for selected CMP locations specified by the company
	effect of undetected errors in the observations, of the size of the MDE (marginal detectable error), for each observation on the CMP co-ordinates (e.g., external reliability)
Shot Points	all edits declared survey, navigation and positioning misfires, or seismic misfires, as well as any trace edits

Edits could be included in final P1/90 version provided that the procedure does not adversely effect the integration of the navigation and seismic data during seismic processing.

51. Final Navigation Deliverables

	Film	Paper	Scales	Copies	Within
Raw Navigation Data				1	2 weeks
Final Post Processed Navigation Data				2	2 weeks
Final Post Processed Data for Vessel Positions				1	2 weeks
Final Post Processed Data for CDP Positions				1	2 weeks
Shot Point Location Map (select)		Yes/No	1:25 000	4	2 weeks
Plotting and Labeling Intervals			10 and 100		
Shot Point Location Map (select)		Yes/No	1:50 000	4	2 weeks
Plotting and Labeling Intervals (metres)			50 and 500		
Large Scale Antenna Position Maps (select)		Yes/No	1:	4	2 weeks
Large Scale Coverage Maps (select)		Yes/No	1:	4	2 weeks

51. Final Navigation Deliverables - *continued*

	Film	Paper	Scales	Copies	Within
Water Depth Map(s) corrected for draught, speed of sound and tides (select)		Yes/No	1:	4	2 weeks
Water Depth Contour Map(s) (select)		Yes/No	1:	4	2 weeks
Water Depth Contour Interval (select)		Yes/No	10 metres		
Final Navigation Report (specify numbers of copies)	n/a	Yes	n/a		2 weeks
Copy of Report on diskette (select)		Word® / Word-perfect®			
Marine Gravity Data (if applicable)				2	1 month
Marine Magnetometer Data (if applicable)				1	2 weeks
Acoustic Doppler Current Profiler Data (if applicable)				1	2 weeks
Spatial Plots (see next Table)		Yes	A4 and A3	4	by demob
Field Navigation Tapes	kept until seismic processing completed				
Echo Sounder Trace Records	included with observers logs for each line or part of line				
On Line Navigation Printouts and Track Plots	kept until seismic processing completed				

Final deliverables should be provided within the period specified from the completion of the survey.

52. Required Spatial Plots

Different spatial plots are given under three separate topics.

Coverage	Seismic Acquisition	Positioning
Coverage plots without flexed binning	In-line misclosure for each Streamer	dN: Primary v Secondary DGPS
Coverage plots with flexed binning	Average rotation angle for all streamers	dE: Primary v Secondary DGPS
Count displays for all hits in each bin including any duplicates	Average feather angle for all streamers	Primary positioning sys tem height
Uniqueness offset coverage plots for each sub-line	Contoured water depth	Primary positioning PDOP
Centre source separation		Primary positioning HDOP
Adjacent front streamer separations		Secondary positioning PDOP

53. Required Navigation Personnel – Minimum Number and Minimum Experience

	Minimum Number	Minimum Experience
Chief Navigator	1	3 years
Shift Leader(s)	2	2 years
Navigator(s)	2	1 years
Navigation Data Processor(s) (if provided)	1	2 years

The numbers and experience of the navigation personnel will differ from contractor to contractor. Flexibility will be required by both the company and the contractor. The requirement being to ensure that the company is provided with competent contractor personnel, as well as the necessary opportunities are provided for the contractoris personnel to gain experience.

54. Navigation Data Shipments Details

	Addresses:
Raw Navigation Data Tapes	
Post Processed Navigation Data Tapes	
Maps and Reports	
Marine Gravity Processing Contractor	
Marine Magnetometer Processing Contractor	

Caveat

The above suggested survey, navigation and positioning guidelines for 3D marine seismic survey specifications are considered by the author to be practical or best practice values which should be achievable. As much as possible all of the multitude of parameters involved have been described, although that does not eliminate the possibility that something could have been overlooked. Also criteria which are relevant to particular contractor systems have not been described. New developments and technological improvements may make some of the above criteria redundant. Users of these guidelines may wish to vary any of the values and other criteria suggested due to commercial and operational considerations, and via negotiations to clarify or re-define possibly problematic criteria.

Acknowledgments

HSCIL has carried out 3D survey consulting assignments as the Client Navigation Representative for over 25 companies, while supervising a variety of contractors. This background and over 20 years of experience has allowed HSCIL to produce these guidelines. The author wishes to thank the personnel of several contractors, and other colleagues for their suggestions and comments.

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About the Author/À propos de l'auteur

__Bruce Calderbank__ has been involved in the offshore since 1978 after receiving his undergraduate degree in surveying from University of New South Wales. After obtaining a postgraduate Diploma in Hydrographic Surveying from Plymouth Polytechnic in 1980, Bruce worked for a couple of companies before returning to Canada and setting up Hydrographic Survey Consultants Intl. in 1983. He has worked in over 25 countries worldwide.

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E-mail ....

Employed by/*Employeur* ....

Present Position/*Post Occupé* ....

Citizenship/*Citoyenneté* .... Date ....

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Comparaison de l'altitude GPS d'un navire avec des données marémétriques

Stéphanie Michaud, Rock Santerre et Alfonso Condal

Introduction

Le système de positionnement GPS (Global Positioning System) et les nouveaux algorithmes de traitements de mesures de phase permettent d'atteindre des précisions centimétriques dans le positionnement tridimensionnel de navire, et ce même en mode cinématique et sur des distances de plusieurs dizaines de kilomètres. Les techniques de résolution d'ambiguïtés de phase OTF (On-The-Fly) sans initialisation sur des points géodésiques connus, et même lorsque le véhicule est en mouvement, permettent le positionnement précis de navires sans trop de difficultés techniques. Cette nouvelle approche permet de réaliser des travaux et des expérimentations à peine imaginable il y a quelques années. Une de ces expérimentations est la comparaison de l'altitude d'un navire, déterminée avec la technique GPS-OTF, avec des données du niveau de l'eau mesuré par des marémètres. Cette étude est réalisable puisque la précision du positionnement GPS est maintenant comparable à celle des données marémétriques.

Plus spécifiquement, les profils verticaux d'un navire de sondage de la Garde côtière canadienne ont été comparés aux données de marées provenant de marémètres du réseau SINECO (Système d'Information sur les Niveaux des Eaux Côtières et Océaniques) déployé le long du fleuve Saint-Laurent. Pour qu'une telle comparaison soit valide, plusieurs facteurs doivent être pris en considération. À savoir, la conversion entre les surfaces de référence verticales, l'interpolation spatiale et temporelle des données des marémètres afin de correspondre aux temps et aux positions GPS, la réduction de la hauteur de l'antenne GPS du navire à la hauteur de la ligne de flottaison (dans laquelle intervient l'effet du *squat*). Cependant, les phénomènes hydrodynamiques particuliers causés par exemple par des rapides (fortes pentes de la surface de l'eau) ou par la dépression du niveau de l'eau (particulièrement lors de la marée baissante) dans un chenal étroit et profond soumis à de forts courants, ne sont pas perceptibles par les marémètres habituellement installés près des rives (hors des chenaux de navigation). Ce qui fait en sorte que même les méthodes d'interpolation spatiale les plus sophistiquées ne peuvent révéler ces phénomènes. Il en sera également discuté dans cet article.

Plus en détails, la section 2 décrit les secteurs de sondage où les comparaisons ont été effectuées, de même que les données GPS et marémétriques utilisées. La section 3 présente la démarche scientifique utilisée afin de réaliser la comparaison des données GPS et marémétriques. Enfin, les résultats tirés de la comparaison sont présentés et analysés à la section 4.

Description des données utilisées et de secteurs des tests (2)

Données GPS

Les données GPS proviennent d'une étude de l'approche GPS-OTF réalisée pour la Garde côtière canadienne (GCC). Celle-ci est décrite plus en détail dans Marceau et al. [1996]. Les essais effectués sur le fleuve St-Laurent se sont déroulés sur trois jours et dans deux secteurs différents, soit à Trois-Rivières les 17 et 18 octobre 1995 et près de Neuville le 19 octobre 1995 (correspondant aux jours 290 à 292 de l'année 1995). Seules les données correspondant aux 17 et 19 octobre 1995 ont été utilisées pour cet article. La station de référence GPS associée à chaque secteur était placée sur un point géodésique préexistant et situé à moins de 5 km des levés bathymétriques. Pour chaque jour, des données GPS ont été recueillies pendant environ six heures et demie avec un taux d'échantillonnage d'une seconde. Avec l'approche OTF, la précision obtenue en planimétrie était meilleure que 5 cm, typiquement les valeurs oscillaient de ±2 à ±3 cm. En altimétrie, la précision était meilleure que 10 cm, typiquement les valeurs étaient de ±5 cm, après le lissage des altitudes avec un polynôme d'ordre 4 sur une période de 2 minutes afin d'amoindrir le bruit. L'équipement déployé de même que les étapes de calculs et les algorithmes OTF utilisés sont décrits dans Marceau et al. [1996].

Un bateau de sondage de la GCC, le GC03, faisait de courts allers-retours dans le même secteur. Ce bateau, de type catamaran, mesure environ 18 m de longueur, 6 m de largeur, et son tirant d'eau est d'environ 1,5 m (figure 4). La longueur des lignes de sondage était d'environ 1,5 km dans le secteur de Trois-Rivières et d'environ 3 km dans celui de Neuville, et la largeur des deux secteurs était d'environ 100 m. On peut voir à la figure 1, entre autres, l'emplacement des secteurs de sondage et des stations de référence GPS. Le fait que l'antenne GPS soit sur un bateau en marche complique l'analyse, comparativement à une antenne fixée sur une bouée [DeLoach et al. 1995]. En effet, il faut tenir compte de facteurs supplémentaires comme le *squat* (enfoncement du navire principalement fonction de sa vitesse), l'imprécision de la distance verticale entre l'antenne qui est fixée sur le mât et la ligne de flottaison lorsque le bateau est au repos, et l'enfoncement (variable) du bateau en fonction de son poids (la réserve de carburant et le chargement sont deux paramètres qui provoquent cette variation). À noter que l'enfoncement du GC03 peut varier de 6 cm si le réservoir de carburant est plein ou vide. Lors des journées des tests, la surface du fleuve était calme de sorte qu'il y avait peu ou pas de houle et que le roulis et le tangage du bateau étaient aussi négligeables.

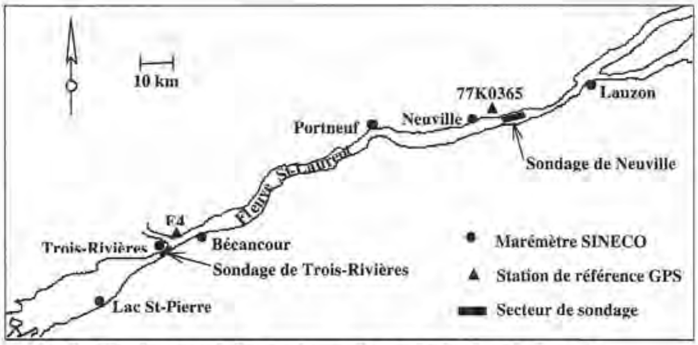


Figure 1 : Emplacement des secteurs de sondage, des stations de référence GPS et des marémètres SINECO utilisés.

Plusieurs raisons expliquent le choix de ces deux secteurs par la GCC. Les caractéristiques particulières des deux sites sont, d'abord, qu'ils sont tous les deux situés dans la voie navigable du fleuve Saint-Laurent. Ensuite, le site de Trois-Rivières est propice à l'analyse du *squat* car la marée y est négligeable, la pente de la surface du fleuve y est faible, et il ne s'y produit pas de phénomène hydrodynamique particulier. Quant au site de Neuville, il est sujet à une grande marée, le chenal y est étroit, et la pente de la surface du fleuve et les courants y sont particulièrement forts. Les figures 2 et 3 montrent la position planimétrique du bateau en fonction du temps (les levés ont une durée de plus de 6 heures) pour chacun des 2 sites de sondage. On peut facilement y apprécier la multitude d'allers-retours effectués dans chacun des secteurs, de même que les quelques irrégularités dans la trajectoire. Les temps ajoutés aux extrémités des allers et retours représentent les époques où le bateau effectue un virage (changement d'azimut et réduction de la vitesse du bateau).

Données SINECO

Les données de marées qui sont comparées aux profils verticaux GPS du navire proviennent de marémètres qui composent le réseau SINECO (Système d'Information sur les Niveaux des Eaux Côtières et Océaniques). Ce réseau est géré par le Service hydrographique du Canada (SHC). On peut consulter le document du SHC [1994] pour plus de détails. Le réseau est composé de 16 marémètres numériques (stations permanentes) de type TMS-1000 qui ont été implantés graduellement depuis 1991 le long du fleuve St-Laurent. Ils fournissent de l'information sur les marées, ce qui permet notamment de connaître le niveau d'eau périodiquement à l'emplacement d'un marémètre. Un marémètre permet l'enregistrement simultané et de façon indépendante d'un niveau d'eau par chacun de ses trois capteurs, à intervalles de 15 minutes, et de certaines caractéristiques physiques du milieu (par exemple la salinité, la température de l'eau, la pression). Toutes ces données enregistrées entrent dans le calcul de la hauteur du niveau d'eau. La précision que l'on peut atteindre, dans des conditions idéales, sur la mesure du niveau d'eau est d'environ ±3 cm. Parmi les aspects opérationnels et facteurs naturels qui viennent dégrader cette précision, on peut mentionner le processus d'intégration du niveau d'eau qui a pour effet d'éliminer partiellement l'effet des vagues, et la non-homogénéité de la température de la colonne d'eau.

Le niveau d'eau enregistré est ensuite rapporté au zéro des cartes, surface de référence à partir de laquelle les cotes bathymétriques sont établies. Pour ce faire, on détermine les paramètres de réduction du niveau d'eau au zéro des cartes d'un marémètre en utilisant les repères de nivellement situés à proximité de la station et dont l'altitude est connue par rapport au zéro des cartes et au niveau moyen des mers.

Pour effectuer la comparaison des altitudes GPS et des hauteurs de marée des stations SINECO, la méthode d'interpolation spatiale Voronoi (section Interpolation temporelle des données SINECO) a été utilisée. Cette méthode requiert un minimum de 3 stations SINECO, englobant chaque secteur de sondage. De préférence, les caractéristiques maréales des sites des marémètres doivent être homogènes et représentatives de celles du secteur où l'interpolation sera effectuée. De fait, les stations Bécancour, Trois-Rivières, et Lac St-Pierre ont été retenues pour la comparaison dans le secteur de Trois-Rivières, et les stations Lauzon, Neuville, et Portneuf pour celle du secteur de Neuville. Ces stations SINECO sont aussi représentées à la figure 1.

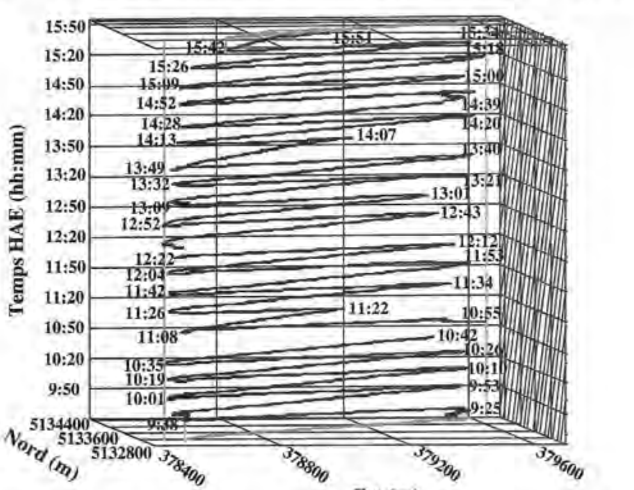


Figure 2 : Position du bateau en coordonnées MTM zone 8 en fonction du temps (secteur de Trois-Rivières).

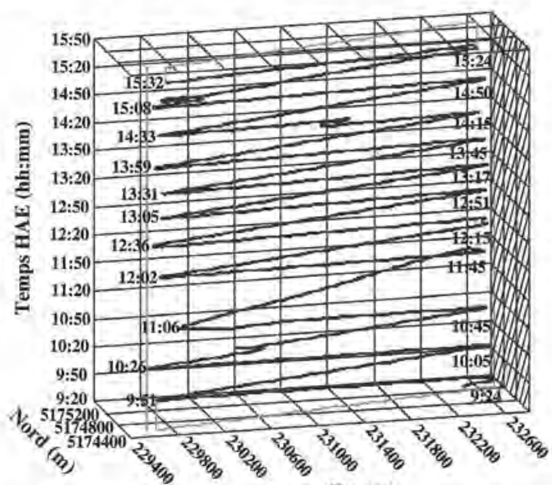


Figure 3 : Position du bateau en coordonnées MTM zone 7 en fonction du temps (secteur de Neuville).

Description de la méthodologie (3)

Comme mentionné précédemment, le but de l'étude est de comparer les altitudes GPS d'un navire avec les hauteurs de la marée obtenues de marémètres du réseau SINECO. Cependant, on possède des données GPS à chaque seconde et des données de marée à chaque 15 minutes pour chaque station SINECO. En premier lieu, les données marémétriques ont été interpolées temporellement à toutes les minutes. Ensuite, les données GPS dont le temps coïncide avec les données interpolées, c'est-à-dire les altitudes GPS à la minute juste et les coordonnées planimétriques qui y correspondent, ont été extraites. Un intervalle d'une minute a été adopté car il permet d'avoir une bonne quantité de données à comparer avec les altitudes GPS et que la marée varie peu à l'intérieur d'une minute. De ces altitudes de l'antenne GPS du navire, il faut soustraire une constante de 11,27 mètres (connue à ±5 cm) qui correspond à la différence de hauteur entre l'antenne GPS et la ligne de flottaison du bateau quand il est au repos (figure 4). De plus, lorsque le bateau se déplace, cette différence de hauteur diminue à cause du *squat* (dont il sera discuté à la section Effect du *squat* du navire). À la suite de cette opération, le niveau d'eau mesuré par le récepteur GPS par rapport à l'ellipsoïde de référence WGS-84 (qui est à toutes fins pratiques compatible avec le NAD-83) est obtenu. Pour connaître le niveau d'eau aux stations SINECO par rapport à la même surface de référence verticale que les altitudes GPS, il faut les réduire du zéro des cartes au géoïde, puis à l'ellipsoïde de référence. Ensuite, puisque les données de marée sont prises à des endroits spécifiques le long des rives, il faut interpoler la hauteur de la marée à chaque position planimétrique du navire. Finalement, pour fin de comparaison, les différences entre les altitudes GPS et les hauteurs de la marée interpolées spatialement et temporellement à chaque minute sont calculées.

Figure 4 : Navire GC03 utilisé lors des sondages (la différence de hauteur entre l'antenne GPS et la ligne de flottaison du bateau est de 11,27 m). Photographie: courtoisie de la Garde côtière canadienne-Région des Laurentides.

Interpolation temporelle des données SINECO

Puisque des données étaient manquantes à certaines époques (aux 15 minutes) pour les stations SINECO de Trois-Rivières et du Lac St-Pierre, il a d'abord fallu interpoler ces valeurs manquantes. En effet, celles-ci ne pouvaient être remplacées par les prédictions ou les prévisions du Service hydrographique du Canada car elles étaient aussi manquantes dans les fichiers qui étaient à notre disposition. L'interpolation temporelle a été effectuée en utilisant une régression polynômiale des points représentant la courbe de niveau d'eau (par rapport au zéro des cartes) de chaque station. Dans le cas présent, il a été possible d'utiliser un polynôme parce qu'il s'agit d'une petite section dans le temps (1 à 2 heures) de la marée relativement facile à modéliser. Chaque station a été analysée de façon indépendante, et quelques polynômes d'ordres différents (1 à 6) ont été comparés. Les résiduelles étaient calculées en soustrayant les données SINECO de celles obtenues avec le polynôme. Le polynôme retenu était celui dont la somme des carrés des résiduelles était la plus faible et dont la valeur des résiduelles autour des points manquants était la plus près de zéro pour une somme des carrés des résiduelles semblable. Il est important de souligner que seules les valeurs manquantes déterminées avec chaque polynôme retenu ont été ajoutées aux valeurs existantes, et que les résiduelles calculées étaient toujours meilleures que ±1 cm, donc à l'intérieur de la précision des données SINECO.

Il était ensuite possible de faire l'interpolation à chaque minute pour chaque station. Cette interpolation s'est effectuée en estimant chaque courbe de marée par une spline cubique. En fait, quand on utilise cette méthode d'interpolation, c'est comme si la courbe était divisée en plusieurs parties et qu'on utilisait un polynôme distinct d'ordre trois pour estimer chaque partie. La fonction qui décrit la courbe est donc composée d'autant de polynômes qu'il y a de sous-intervalles créés. Un des avantages reliés à l'utilisation de cette méthode est que les données utilisées pour l'interpolation sont conservées intégralement, contrairement à ce qui se passe avec la régression polynômiale mentionnée précédemment. La précision de cette interpolation par spline cubique est estimée à ±1 cm.

Interpolation spatiale des données SINECO

La méthode d'interpolation utilisée est celle de Voronoi. Il s'agit d'une méthode géométrique orientée-objet et simple d'utilisation. Elle est bien décrite dans Gold [1989]. En résumé, on peut dire que cette méthode se base sur la structure de données Voronoi (structure matricielle) qui est composée de tuiles irrégulières associées chacune à un objet de l'espace, ici la grandeur de la marée à une station SINECO à une époque donnée. La tuile associée à un objet est la partie de l'espace qui est située le plus près de cet objet que de tout autre. Cette structure se construit en effectuant d'abord, à partir d'un ensemble de points-échantillon dont la caractéristique qui nous intéresse est connue, une triangulation qui utilise l'algorithme de Delaunay, puis en traçant les médiatrices de chacun des côtés et en les coupant aux intersections. Le point dont on veut interpoler la caractéristique est le point-requête. Lorsque celui-ci est inséré dans la structure, il vole une partie de l'aire des tuiles voisines déjà existantes afin d'avoir sa propre tuile. La valeur de la caractéristique interpolée sera calculée comme une moyenne pondérée dont le poids associé à chaque point-échantillon est fonction de l'aire volée par la nouvelle tuile à chaque tuile voisine par rapport à l'aire totale volée par son insertion dans la structure. La somme des poids sera donc égale à 1. Les points-échantillon mentionnés sont en fait les stations SINECO dont la hauteur de la marée est connue par rapport à l'ellipsoïde, et les positions planimétriques GPS auxquelles les données de marée doivent être interpolées constituent les points-requête puisque l'on cherche à connaître la hauteur de la marée à ces positions. La méthode d'interpolation Voronoi est une méthode exacte car elle conserve la valeur des données de départ. Elle ne possède par contre pas de moyen intrinsèque pour être validée, ce qui constitue son principal inconvénient. Les moyens qui ont été employés pour la valider sont décrits plus loin. Le programme informatique Voronoi utilisé a été modifié pour nos besoins.

L'interpolation Voronoi a été faite avec des valeurs de marées rapportées à l'ellipsoïde de référence. La raison pour laquelle cette surface de référence a été utilisée est qu'il s'agit d'une surface décrite mathématiquement qui sera adoptée dans le futur comme surface de référence verticale continue (Seamless Vertical Reference Surface) pour tous les travaux hydrographiques [O'Reilly et al., 1996]. De plus, il s'agit de la surface de référence du positionnement GPS. Pour y réduire les données marémétriques SINECO, dont la surface de référence était initialement le zéro des cartes (ZC), il a d'abord fallu les réduire au géoïde (qui correspond à toutes fins pratiques au niveau moyen des mers NMM) à l'aide des altitudes de repères altimétriques situés à proximité des stations SINECO et connues par rapport à ces deux surfaces [Labrecque, 1997]. Ensuite, la réduction à l'ellipsoïde s'est faite en interpolant la valeur d'ondulation du géoïde (N) à partir de la table des ondulations du géoïde MtlQue96 (Montréal-Québec 1996) calculée par les Levés géodésiques du Canada. La précision de la conversion entre ces surfaces de référence verticales est estimée à environ ±3 cm, dans les 2 secteurs de sondage de cette étude. Les valeurs utilisées pour ces réductions sont rapportées au tableau 1.

Pour valider l'interpolation spatiale, une méthode différente a été appliquée pour chaque secteur de sondage. Pour celui de Trois-Rivières, les données interpolées ont été comparées directement avec les données du marémètre de Trois-Rivières, et aucune différence significative n'a été notée. On pouvait procéder ainsi car le secteur de sondage était situé juste en face du port de Trois-Rivières, à moins de 1 km. En ce qui concerne le secteur de sondage de Neuville, il était impossible de comparer directement les hauteurs de marée interpolées avec celles mesurées à la station SINECO de Neuville car la hauteur de marée est différente à ces deux endroits au même moment vu la distance qui les sépare (de 7 à 10 km) et l'amplitude de la marée dans ce secteur. L'interpolation Voronoi a été utilisée pour interpoler la hauteur de la marée à la station SINECO de Québec (située sur la rive opposée de la station de Lauzon) à partir des données des stations de Lauzon, de Neuville, et de Portneuf. Ces valeurs ont ensuite été soustraites aux données SINECO de la station de Québec. La moyenne des différences était de 6,0 cm avec un écart-type de ±2,7 cm. Il a été assumé (voir tableau 2) que l'erreur d'interpolation dans le secteur de Neuville est sensiblement la même que celle évaluée à la station de Québec.

Tableau 1 : Différence d'altitude des repères de nivellement (RN) entre le zéro des cartes (ZC) et le niveau moyen des mers (NMM), situés à proximité des stations SINECO, et ondulations du géoïde (N) aux positions des repères de nivellement.

Station SINECO		RN de référence		ZC - NMM	N (MtlQue96)
Numéro	Nom	Nom	Matricule	(m)	(m)
3353	Bécancour	BECAN-1972	7223041	2,59	-30,16
3360	Trois-Rivières	3RIV-3-1958	58L9043	2,97	-30,46
15975	Lac St-Pierre		87L9000	3,40	-31,13
3250	Lauzon	3162	59L3162	-1,96	-27,99
3280	Neuville	NEUV-1-1958	58L9048	-1,38	-28,61
3300	Portneuf		79L006	-1,13	-28,99

Effet du *squat* du navire

Le *squat*, cet enfoncement supplémentaire du bateau en fonction de sa vitesse par rapport à la surface de l'eau (vitesse surface), de la profondeur du chenal et de plusieurs autres facteurs (tels que la largeur du chenal, la largeur et la forme de la coque du navire), a été modélisé approximativement afin que son effet soit en grande partie éliminé dans la comparaison. Dans le cas présent, le facteur déterminant était la vitesse surface du navire. Puisque seul le vecteur vitesse par rapport au sol (vitesse fond) était mesuré avec le GPS, le vecteur vitesse surface a été obtenu en calculant la différence vectorielle entre la vitesse fond et la vitesse du courant pour chaque secteur de sondage. La direction et la magnitude de la vitesse du courant ont été extraites de *l'Atlas des courants de marée - Estuaire du Saint-Laurent, du cap de Bon-Désir à Trois-Rivières* [1997], après avoir décomposé chaque jour de sondage en plusieurs plages de temps qui correspondent à celles qui se trouvent dans l'Atlas. La précision de la vitesse surface est estimée à ±0,7 m/s, cette valeur étant principalement influencée par l'imprécision du vecteur vitesse du courant.

Normalement, le *squat* est proportionnel au carré de la vitesse surface [Morse et al., 1996]. Les autres facteurs étant considérés comme constants pour les deux jours de levés, ils ont pu être regroupés dans le même coefficient à estimer. Pour les raisons mentionnées dans la description des données GPS, ce sont les données reliées au secteur de Trois-Rivières qui ont servi à la modélisation du squat. La relation suivante a été modélisée à partir des différences entre les altitudes GPS et la marée interpolée en fonction de la vitesse surface du bateau:

$$S = 0{,}0024 \times V^2 \qquad (1)$$

Tableau 2: Ordre de grandeur des différentes erreurs influençant la précision de la comparaison des altitudes GPS et des données marémétriques.

Facteurs	Ordre de grandeur de l'imprécision (cm)
Données altimétriques GPS	±5
Données SINECO	±3
Interpolation temporelle	±1
Interpolation spatiale	Trois-Rivières: négligeable Neuville: ±6
Évaluation du *squat*	±3
Attitude du bateau et houle	négligeable lors des tests
Distance verticale antenne-ligne de flottaison	±5
Enfoncement supplémentaire du bateau dû à son poids	±3
Conversion entre surfaces de référence verticales	±3
Total	Trois-Rivières: ±9 Neuville: ±11

où S est le *squat* en mètres et V est la vitesse surface du bateau en mètres par seconde. Par exemple, le *squat* est d'environ 14 cm quand la vitesse surface est de 7,5 m/s, de 2 cm à 3 m/s, et nul quand la vitesse surface est nulle. En tenant compte de la précision du coefficient estimé (±0,0001 s^2/m) et de celle de la vitesse surface, il a été possible de déterminer la précision de l'évaluation du *squat* lorsque la vitesse surface du bateau est de 7,5 m/s (vitesse surface maximale qui a été atteinte), soit ±3 cm. Par la suite, le modèle de l'équation (1) a été appliqué aux différences entre les altitudes GPS et la marée interpolée pour éliminer l'effet du *squat*, et ce pour les 2 secteurs de sondage. L'élimination du *squat* permet de considérer que la distance verticale entre l'antenne GPS et la ligne de flottaison du bateau en mouvement est la même que lorsque le bateau est au repos.

Résumé des erreurs influençant la précision de la comparaison

Le résumé et l'ordre de grandeur des différentes erreurs influençant la précision de la comparaison entre les altitudes GPS du navire et les données marémétriques sont présentés au tableau 2. À noter que ces précisions sont spécifiques aux données, au bateau, et à la méthodologie utilisés dans ce projet.

L'erreur totale est d'environ ±10 cm pour les 2 secteurs. Si l'ordre de grandeur de ces erreurs est réaliste, les différences de la comparaison (de la section 4) entre les profils verticaux du navire mesurés par GPS et le niveau de l'eau obtenu des données SINECO ne devraient pas excéder la magnitude de l'erreur totale. À noter que ce budget d'erreur ne tient pas compte de l'influence des phénomènes hydrodynamiques particuliers au secteur de Neuville.

Comparaison de l'altitude GPS avec les données marémétriques (4)

Secteur de Trois-Rivières

Comme mentionné précédemment, ce secteur est caractérisé par une marée très faible (variation d'à peine 15 cm lors du sondage), la pente de la surface du fleuve n'y est pas très accentuée et aucun phénomène hydrodynamique ne s'y produit. La figure 5 montre l'altitude de l'antenne GPS rapportée à la ligne de flottaison du bateau et les données de marée de la station SINECO de Trois-Rivières rapportées à l'ellipsoïde de référence. Les données des autres stations SINECO (Bécancour et Lac St-Pierre) ont très peu contribué à l'interpolation spatiale. On peut voir à la figure 6 les deux courbes de différences entre les altitudes GPS et les hauteurs de marée de la station SINECO de Trois-Rivières, soit avant (avec *squat*) et après (sans *squat*) que le *squat* eut été éliminé (avec le modèle de l'équation 1), de même que la vitesse surface à laquelle le bateau se déplaçait.

Figure 5 : Comparaison, par rapport à l'ellipsoïde, des altitudes GPS et des hauteurs de marée de la station SINECO de Trois-Rivières (secteur de Trois-Rivières).

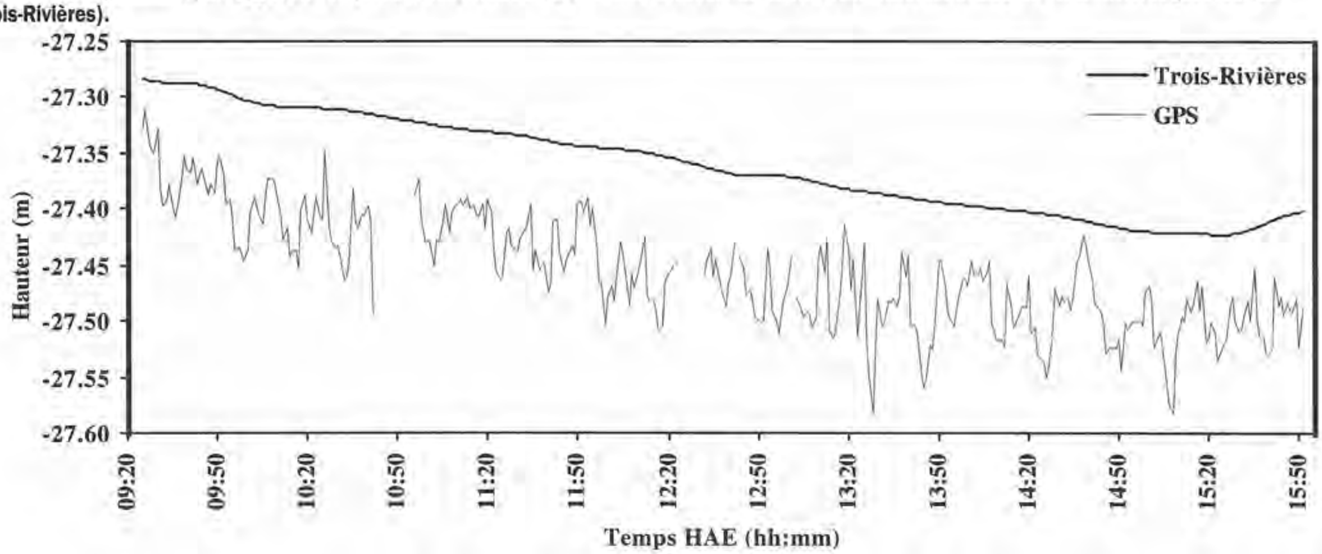


Figure 6 : Différence entre les altitudes GPS et les hauteurs de marée de la station SINECO de Trois-Rivières, avec et sans squat, et vitesse surface du bateau (secteur de Trois-Rivières).

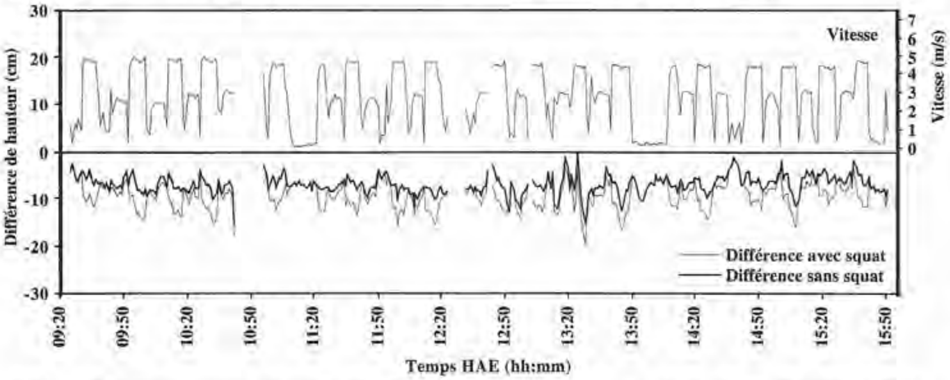


Tableau 3 : Différence entre les altitudes GPS et les hauteurs de marée de la station SINECO de Trois-Rivières (secteur de Trois-Rivières).

Différence GPS - marée		
	Moyenne (cm)	-9,4
avec *squat*	Écart-type par rapport à la moyenne (cm)	±2,9
	Écart-type par rapport à zéro (cm)	±9,9
	Moyenne (cm	-7,0
sans *squat*	Écart-type par rapport à la moyenne (cm)	±2,2
	Écart-type par rapport à zéro (cm	±7,3

Figure 7 : Comparaison, par rapport à l'ellipsoïde, des altitudes GPS et des hauteurs de marée aux stations SINECO, et de celles interpolées avec Voronoi (secteur de Neuville).

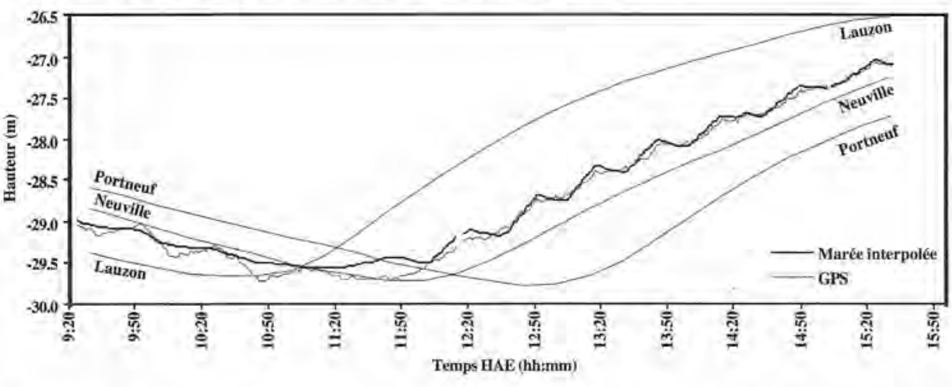
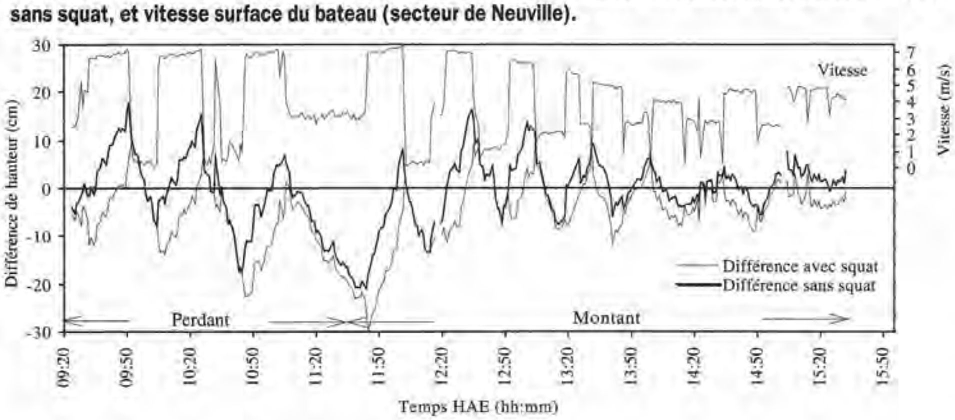


Figure 8 : Différence entre les altitudes GPS et les hauteurs de marée interpolées avec Voronoi, avec et sans squat, et vitesse surface du bateau (secteur de Neuville).



Le tableau 3 résume les résultats tirés des deux courbes de différences.

On peut voir que le fait d'éliminer le *squat* des données a abaissé la moyenne de près de 2,5 cm, de même que l'écart-type qui est passé de ±2,9 cm à ±2,2 cm. Par contre, une erreur systématique de -7 cm est présente dans les résultats. Celle-ci pourrait être reliée entre autres à la détermination de la distance verticale entre l'antenne GPS et la ligne de flottaison du bateau, de même qu'à la réduction entre les surfaces de référence verticales. Malgré tout, les écarts demeurent à l'intérieur du budget d'erreur totale rapportée au tableau 2.

Secteur de Neuville

Le secteur de Neuville possède des caractéristiques particulières déjà mentionnées dans la description des sites (section Données GPS): l'amplitude de la marée y est assez grande (variation d'environ 2,5 m lors du sondage, voir figure 7), la pente de la surface du fleuve y est très accentuée (35 cm sur 3000 m [Marceau et al., 1996]), le chenal est plutôt étroit (environ 250 m [SHC, 1997]) et peu profond (10,7 m), et les courants sont plus forts dans le chenal (jusqu'à 3-4 noeuds [SHC, 1997]) que hors du chenal. La figure 7 montre l'altitude de l'antenne GPS rapportée à la ligne de flottaison du bateau, les données de marée des trois stations SINECO qui ont contribué à l'interpolation spatiale, et les résultats de l'interpolation Voronoi. L'interpolation Voronoi a été significativement efficace. Comme on peut le constater, les valeurs interpolées épousent extrêmement mieux les données GPS que les données SINECO recueillies à chacun des trois sites les plus près du secteur de sondage. De plus, en comparant les temps avec la figure 3, on peut constater que les paliers réguliers formés par le profil des altitudes GPS correspondent aux allers et retours que le bateau a effectués.

Les différences calculées avec et sans le *squat*, de même que la vitesse surface de déplacement du bateau, sont présentées à la figure 8.

Tableau 4: Différence entre les altitudes GPS et les hauteurs de marée interpolées avec Voronoi (secteur de Neuville).

Différence GPS-marée interpolée		Total	Perdant	Montant
	Moyenne (cm)	-5,6	-9,1	-3,1
avec *squat*	Écart-type par rapport à la moyenne (cm)	±7,1	±8,5	±4,5
	Écart-type par rapport à zéro (cm)	±9,1	±12,5	±5,5
	Moyenne (cm)	-0,5	-2,6	1,1
sans *squat*	Écart-type par rapport à la moyenne (cm)	±7,3	±9,2	±5,2
	Écart-type par rapport à zéro (cm)	±7,4	±9,5	±5,3

Les courbes de différences ont été analysées dans leur ensemble, puis en séparant les données qui coïncident avec le temps où la marée baisse (perdant) d'avec celles où la marée monte (montant). On peut observer à la figure 8 que la correction de l'effet du squat a été plus grande dans la partie du levé correspondant au perdant et au début du montant de la marée, quand le bateau se déplace à contre-courant, car la vitesse surface y est plus grande. En sens inverse, le courant est assez fort pour déplacer seul le bateau, donc la vitesse surface est presque nulle. On peut également voir que la direction de déplacement où il y des corrections pour l'effet du squat est inversée en même temps que le courant est inversé, soit dans la deuxième partie du montant. De plus, la vitesse surface maximale est plus faible car elle varie en fonction du courant qui est aussi plus faible. Le tableau 4 résume les résultats tirés des deux courbes de différences.

Comme espéré, l'élimination du *squat* a abaissé la valeur absolue de la moyenne des différences et la fait tendre vers zéro. Cependant, l'écart-type par rapport à la moyenne est resté sensiblement le même, soit environ ±7 cm. La valeur moyenne des différences (sans *squat*) pour l'ensemble des données (colonne: Total), -0,5 cm, est un hasard, puisque les différences positives et négatives se sont annulées presque tout au long de la courbe. L'écart-type par rapport à la moyenne de l'ensemble des données (sans *squat*) est de ±7,3 cm, une valeur 3 fois plus élevée que celle obtenue dans le secteur de Trois-Rivières. Cette plus grande valeur provient essentiellement des différences plus élevées au perdant et au début du montant (avant que le courant soit totalement inversé). Comme illustré à la figure 8, ces différences peuvent atteindre une valeur de -20 cm. Ceci s'explique par le fait que la méthode d'interpolation qui s'appuie sur les mesures des marémètres situés près des rives (hors du chenal) ne peut pas bien modéliser la marée, surtout à la fin du perdant, à cause de phénomènes hydrodynamiques particulièrement importants dans le secteur de Neuville. En effet, à cet endroit la pente de la surface du fleuve et le courant y sont forts, de plus, au perdant, l'eau se retire plus rapidement dans le chenal, ce qui cause une dépression de la surface de l'eau par rapport aux rives. Dans la partie des données correspondant au montant, les différences maximales dépassent légèrement 10 cm. Finalement, notons que les pics positifs des différences de hauteur (figure 8) se produisent lorsque le navire atteint l'extrémité ouest des lignes de sondage (figure 3) et que les pics négatifs des différences de hauteur se produisent lorsque le navire atteint l'extrémité est des lignes. Ceci pourrait être explicable par l'erreur d'interpolation spatiale ou la décorrélation spatiale de l'effet de phénomènes hydrodynamiques. Des tests et des études supplémentaires devront être effectués afin de confirmer ou d'infirmer cette hypothèse.

Conclusions

La précision centimétrique du positionnement GPS avec la méthode OTF rend maintenant réalisable la comparaison des profils verticaux d'un navire avec des données marémétriques. Afin que la comparaison soit valable, une méthodologie appropriée doit tenir compte de la conversion entre les surfaces de référence verticales, de l'interpolation spatiale et temporelle des données des marémètres afin de correspondre aux temps et aux positions GPS, et de la réduction de la hauteur de l'antenne GPS du navire à la hauteur de la ligne de flottaison (dans laquelle intervient l'effet du *squat*). Par exemple, pour la vitesse surface moyenne du navire de 5 m/s, lors des tests présentés dans cet article, l'effet du squat a une valeur d'environ 6 cm.

L'écart-type par rapport à zéro des différences entre la hauteur du niveau de l'eau mesurée par des marémètres et celle obtenue de profils verticaux GPS d'un navire (sans squat) était d'au plus ±7 cm, pour le secteur de Trois-Rivières et le secteur de Neuville lors du montant de la marée, c'est-à-dire aux endroits et aux moments où aucun phénomème hydrodynamique particulier ne se produit. Dans cette situation, l'erreur totale théorique (budget d'erreur) avait été estimée à environ ±10 cm.

Cependant, lorsque des phénomènes hydrodynamiques se produisent, et puisqu'ils ne peuvent pas être mesurés par les marémètres localisés près des rives, des différences jusqu'à -20 cm ont été atteintes. Dans cette situation, la hauteur réelle du niveau de l'eau est mieux décrite par le profil vertical GPS d'un navire (ou d'une bouée) que par les données marémétriques recueillies près des rives. On pourrait d'ailleurs utiliser le positionnement GPS-OTF afin de mesurer ces phénomènes hydrodynamiques dans le but de les étudier et de les modéliser.

D'un autre point de vue, dans les secteurs où il n'y a pas de phénomènes hydrodynamiques très forts, les données SINECO interpolées spatialement pourraient être utilisées pour valider les solutions OTF (afin de s'assurer que les ambiguïtés de phase GPS sont correctement fixées), lorsque le navire est très éloigné (D > 50 km) de la station de référence

GPS. Pour une validation de la solution OTF en temps réel, les données SINECO devraient être également disponibles en temps réel.

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Determination of Mean Sea Level with GPS on Vessel

Reha Metin Alkan and Haci Mustafa Palancioglu

Since the writing of this paper the United States Air Force has turned off Selective Availability (SA) thus improving positional accuracy.

(This paper was presented at the *ION GPS Meeting*, Nashville, USA, 14-17 September 1999)

Introduction

The depth in hydrographic surveys can be measured from the water level during the survey interval. In order to reduce the depth measurements on to a vertical datum, the changes of the water level should be determined. According to the requirements of the particular survey, the measured depths will be reduced to one of two datum lines [Bannister and Raymond, 1991].

i-) The Land-Levelling Datum (TLLD): This datum, also known as geoid, is the equipotential surface with zero height which is accepted as passing through the 'Mean Sea Level' and continued under the Earth surface. TLLD is used in both hydrographic surveys and terrestrial surveys.

ii-) The Tidal Datum: This is generally used for navigation purposes. The usual level adopted is that level of the water surface below which the tide rarely falls. This is named 'Lowest Astronomical Tide' (LAT). The latest trend is the use of the LAT as vertical datum for hydrographic (nautical) charts [Kumar, 1997].

The water in oceans, seas and lakes moves for a variety of reasons, a number of them coming into play at the same time. Movement can be horizontal or vertical, undirectional or circular, and occasional or cyclical [Ingham, 1992]. These changes in the water can be seasonal, monthly, and daily according to the region of the water environments. In general, the effects which change the water surface can be grouped as Meteorologic Effects, Oceanographic Events, Vertical Earth Crust Movements (isostatic and tectonic movements), and Astronomic Tides [Hekimoglu and Sanli, 1993]. The most important effects among them that change the water surface are tides and winds. Tides can reach up to 4-5 m height at some North European Seas whereas it is 15-20 cm height in Turkey [Alpar, 1993].

Measurements of Sea Level Changes

In order to determine the changes in the water level at certain time intervals and 'Mean Sea Level' (MSL), tide gauges built on the shore are used. The water level used for the determination of the nation's vertical datum and for hydrographic surveys differs from each other based on equipment, time, and evaluation methods. For the determination of the nation's vertical datum, MSL is calculated from long-period observations by using precision tide gauges. On the other hand, basic tide gauges with short-period observations are sufficient for hydrographic surveys. 'Staff Tide Gauges' are the most commonly used in conventional hydrographic surveys with an accuracy of ±(1-5) cm approximately. The 'Float Gauge' is developed for more precise measurements in which the effects of wave movements are minimized. These are more expensive than the 'Staff Tide Gauges' and their accuracy is between ±(0.1-1) cm. On the other hand, ±(0.1-0.5) mm accuracy can be achieved by using 'Recordable Tide Gauges'. 'Space Radar Altimetry' which is used for the determination of the global water level in ocean and seas and 'Pressure Tide Gauge' which uses some measurements of water parameters to generate results are the other systems [Ingham, 1992].

GPS Measuring

Today, it is possible to acquire the positioning accuracy of 50 m in horizontal, 78 m in vertical, and 93m in both as 3D with the help of single-receiver using C/A-Code measurements [Hurn, 1993]. On the other hand, authorized (military) users will have access to the Precise Positioning Service, which can achieve a greater degree of accuracy using P-Code [Leick, 1995]. However, carrier phase measurements are used for geodetic purposes. There are a few methods that use carrier phase measurements for positioning; static, fast static, reoccupation, and kinematic measurements.

Kinematic Measurement Method

In 1985, Dr. Benjamin Remondi, of U.S.A. National Geodetic Survey, found that initial integer ambiguity can be determined by data received from a mobile receiver [DeLoach et al, 1995]. Today, positioning the mobile objects can be performed with less than decimetre accuracy by using kinematic methods.

The vectors from reference station to rover point can be calculated by the evaluation of reference station and rover point measurements simultaneously. The accuracy changes depend on the usage of codes and carrier phases in calculations. The method where code measurements are used is called 'Differential GPS' (DGPS) method whereas the usage of Carrier Phase Measurements is called 'Precision Kinematic GPS' (PDGPS) method.

Table 1. The Summary of the GPS Error Source

Error Source	Stand-alone GPS (m)	DGPS (m)
Satellite Clocks	3.0	0.0
Orbit Errors	2.7	0.0
Ionosphere	8.2	0.4
Troposphere	1.8	0.2
Receiver Noise	0.3	0.3
Multipath	0.6	0.6
SA	30.0	0.0
User Equivalent Range Error	31.4	0.9

DGPS works by cancelling out most of the natural and man-made errors that creep into normal GPS measurements. The summary of the GPS error source is given in table 1 [Holloway, 1997].

The positions and heights of the mobile objects can be determined by carrier phase measurements with accuracy of less than 1 decimetre, often a few centimetres. For this reason, this method is called 'Precision Differential GPS' (PDGPS) [Heimberg and Seeber, 1994]. This method often exceeds the accuracy requirements of private geodetic applications, precise hydrographic surveys, and engineering applications in shallow water.

The integer ambiguity value must be determined using methods such as Antenna Swapping, Known Base, Static Initialization etc. while surveying with kinematic method. However, these methods have disadvantages especially in hydrographic applications. For example, a static initialisation is not feasible or possible every time, in a hydrographic survey where the antenna is installed on the mast of a survey vessel, it cannot be kept steady for several minutes. Another disadvantage is that during the measurements, data cannot be received for some reason from one or more satellites that was received at the beginning from the same satellites [Cannon et al, 1993]. In this case, measurements are stopped and start after re-initialisation.

A new method has been developed which eliminates these disadvantages and provides opportunities to determine the positions of mobile objects with high accuracy. This method is called On The Fly (OTF) or On The Way (OTW). OTF measurements provide the trajectory of a moving sensor without the necessity of a static initialisation.

The success of the initial integer ambiguity calculation with the OTF method and finding the coordinates of the mobile receiver depends on;

i-) *Number of available satellites and their geometry,*

ii-) *Type (Code/Phase) and the quality of the data that is going to be used,*

iii-) *Distance between reference station and mobile receiver,*

iv-) *Differential orbits and atmospheric errors [Lachapelle et al, 1993].*

The most important effect on the OTF method which reduces its solution performance is the multipath effect [Abidin, 1994]. The distance between reference and mobile receivers should ideally be no greater than 7 to 10 km for dependable OTF solutions.

Determination Of Mean Sea Level By GPS Method

By using the properties of the Kinematic OTF method mentioned in the previous section, it is found that the GPS method can be used for the determination of 'Mean Sea Level' (MSL). The geometry of the problem can be seen in Figure 1.

The height of the 'Mean Sea Level' obtained from tide gauge reading can be calculated with the equation below (Fig. 1);

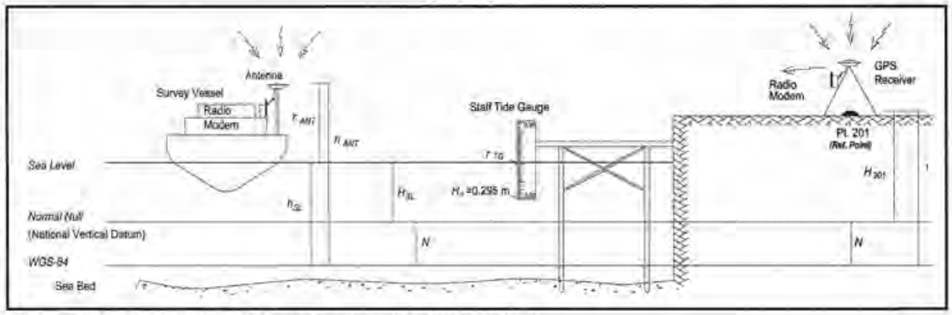

Figure 1. Determination of Mean Sea Level by GPS Method

(1) $H_{SL}^{TG} = H_0 + r_{TG}$

Where, H_0; the height of the zero point of the staff tide gauge in the 'National Vertical Datum' and r_{TG}; staff reading. It is enough to use the average of the readings, which is obtained for each 30 or 60-minute interval to acquire a r_{TG} value. On the other hand, H_0 can be obtained from the benchmark by any levelling technique.

On the other hand, MSL can also be expressed by means of ellipsoidal heights that are obtained by GPS observations (Fig. 1);

(2) $H_{SL}^{GPS} = (h_{ANT} - r_{ANT}) - N = h_{SL} - N$

Where, h_{ANT}; the antenna height from WGS-84 ellipsoid, r_{ANT}; the antenna height between sea level to top of the antenna, N; geoid undulation.

A Case Study

For the solution of the above mentioned problem, two applications for two different dates were conducted in Haliç (know as Golden Horn), Istanbul, Turkey shown in Figure 2. Golden Horn is a very old inlet in the European side of the Bosphorus strait to the South entrance.

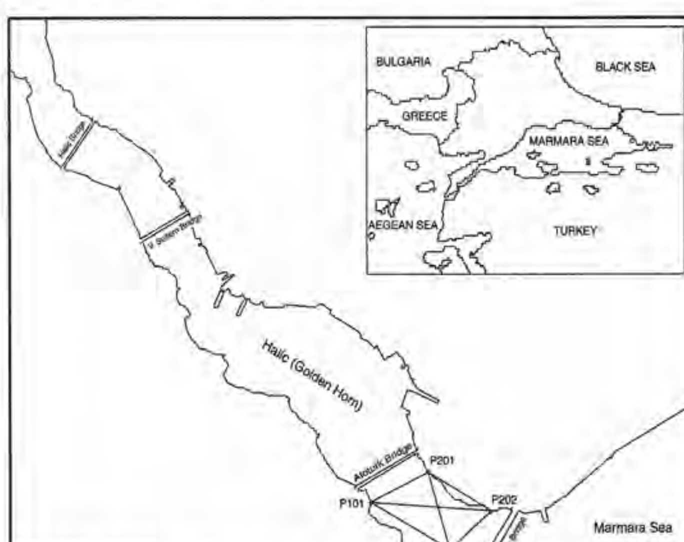

Figure 2. The Application Area

The following steps were used for the application:

i-) Geodetic reference points established: 4 control points (101, 102, 201, 202) were established which covered the study area.

ii-) Determination of geodetic points' heights: *'Spirit Levelling'* method was used to obtain heights using the benchmarks in the study area. *'Valley Cross Levelling'* and *'Trigonometric Levelling'* were used to tie the geodetic points to each other and to create a closed network (Fig. 2).

iii-) Determination of the coordinates of the geodetic points: Geodetic points were coo dinated by GPS method. During the appl cation, two *Wild-Leica System 300* receivers were used. Static GPS method was carried out for each point to get measurement data from 6 to 7 satellites for every 5 seconds. Post-processing of the raw data and adjustment were accomplished with *Wild-Leica, SKI v.2.1* software. Cartesian coordinates that resulted from a free adjustment were converted to 'Transverse Mercator Plane Coordinate System' according to central meridian of 30 degrees with a 3 degree zone width as shown in Table 2.

iv-) Calculation of the relative undulation value in the study area: The undulation value 'N' can be calculated with following equation.

(3) $N_1 = h_1 - H_1$

Where, H_1; the height of any point in 'National Vertical Datum' system, h_1; ellipsoidal height for the same point. Previously calculated and adjusted heights are used in order to calculate the *relative undulation* value in the study area shown in Table 3.

The established network could not be connected to global GPS network. So, the coordinates obtained are not absolute WGS-84 coordinates. Instead they are defined according to the datum at the time of measurements. Therefore, the undulation that we obtained is called *'relative'*.

Table 2. Free Adjusted Geodetic Coordinates of the Reference Points

Pn. No.	Ellipsoidal Coordinates
000101	φ: 41° 01' 20".616490 N λ: 28° 57' 48".834269 E *h*: 19.426 m
000102	φ: 41° 01' 10".507281 N λ: 28° 58' 10".562309 E *h*: 19.577 m
000201	φ: 41° 01' 27".217256 N λ: 28° 58' 4".762309 E *h*: 20.022 m
000202	φ: 41° 01' 18".593341 N λ: 28° 58' 21".884254 E *h*: 21.200 m

Table 3. The Calculation of the Relative Undulation Value in the Study Area

Pn. N.	H_1 (m)	h_1 (m)	$N_1 = h_1 - H_1$ (m)	N_{Avr} (m)
101	1.040	19.426	18.386	18.3848
102	1.189	19.577	18.388	
201	1.631	20.022	18.391	
202	2.826	21.200	18.374	

v-) Determination of Mean Sea Level height:

a-) With Staff Tide Gauge: For this study, an enamelled staff with the dimensions of 90 cm length and 12 cm width was used. The height of the staff's zero point was obtained from #201 geodetic control point using spirit levelling. Staff readings () were repeated at 15 minute intervals for both sessions.

(4) $H_{SL}^{TG} = H_0 + h_{TG}^{Avr}$

Staff Tide Gauge readings are given in Figure 3 and 4.

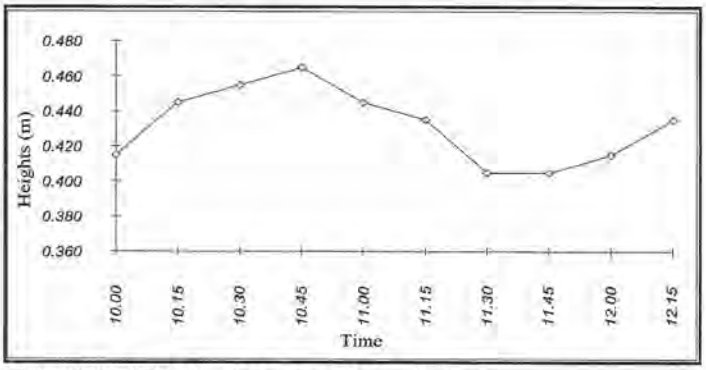

Figure 3. Staff Tide Gauge Readings *(1st application)*

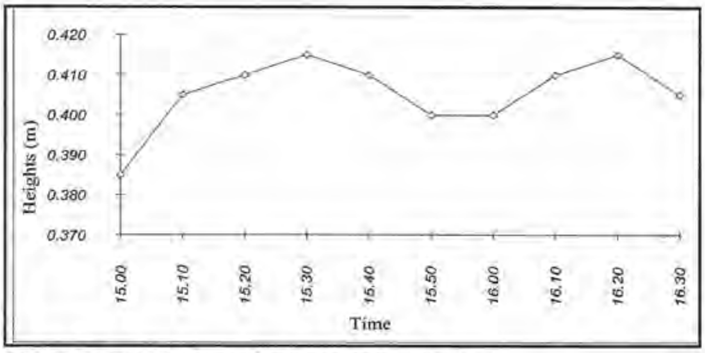

Figure 4. Staff Tide Gauge Readings *(2nd application)*

b-) With PDGPS Method: In this procedure, it was necessary to calculate the h_{AVT} or H_{SL} values which are given in equation 2. For this purpose, a geodetic control point was chosen and one GPS receiver and a radio-modem unit were set up. Adjusted ellipsoidal coordinates of points previously calculated are used (Table 2). Another GPS receiver and radio-modem unit were set up on the survey vessel that was treated as a tide gauge station. The survey vessel was taken to a place in the study area, characterised by calm water, and measurements were carried out by the PDGPS method. Data were recorded into the receivers' control unit for post processing. In the first application, data was obtained with a data rate of 1 second for 6 minutes which is approximately 360 measurements whereas during the second application data were obtained for approximately 30 minutes which was approximately 1700 measurements. All experimental data were logged in only a few hours and borrowed equipment returned to its owners immediately. For this reason it was not possible to make longer measurements. *SKI v.2.1* software was used for post-processing to obtain (φ;λ;*h*;) values for each epoch. Averages of the obtained h values were used to calculate h_{SL} values for each application. However during the process stage, a statistical analysis was applied to eliminate outliers instead of a basic arithmetic average. To do this, a best-fit curve was determined that provides the condition that the sum of the squares of the corrections of the observations will be least, according to the below equation;

$$\textbf{(5)}\quad h_n + v_n = a_0 + a_1 t_n + a_2 t_n^2$$

Where, $h_i\ (i = 1,2,\ldots,n)$; ellipsoidal height for each movement, $v_i\ (i = 1,2,\ldots,n)$; residuals of measurements, a_0, a_1, a_2 and a_3 ; coefficient of the adjusting curve, $t_i\ (i = 1,2,\ldots,n)$; record order of the measurements. By using the last equation, the coefficient of the best-fit curve can be calculated by following these steps;

$$\textbf{(6)}\quad \underline{v} = \underline{A}x - \underline{l}$$

$$\textbf{(7)}\quad \begin{bmatrix} v_1 \\ v_2 \\ \cdot \\ \cdot \\ v_n \end{bmatrix} = \begin{bmatrix} 1 & t_1 & t_1^2 & t_1^3 \\ 1 & t_2 & t_2^2 & t_2^3 \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ 1 & t_n & t_n^2 & t_n^3 \end{bmatrix} \begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ a_n \end{bmatrix} - \begin{bmatrix} h_1 \\ h_2 \\ \cdot \\ \cdot \\ h_n \end{bmatrix}$$

$$\textbf{(8)}\quad \underline{x} = (\underline{A}^T \underline{P} \underline{A})^{-1} \underline{A}^T \underline{P}\, \underline{l} = \begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ a_n \end{bmatrix}$$

Where, $\underline{A}$; design matrix, $\underline{P}$; weight matrix. Adjusted measurements and standard deviation are obtained by using the equations below.

$$\textbf{(9)}\quad \bar{\underline{h}}_i = \underline{h}_i + \underline{v}_i$$

$$\textbf{(10)}\quad \sigma_0 \sqrt{\frac{[Pvv]}{n-1}}$$

As a result of the calculations, the adjustment process was re-done by eliminating only the measurements' residuals, which is 3 times bigger than the standard deviation calculated from equation 10. This process was realised with 2 iterations for the first application and with 3 iterations for the second application. As a result, by taking the arithmetic average of the $\bar{h}_i$ values, h_{SL} values are obtained as 18.870 m (2.65 cm, and 18.750 m (2.06 cm. The best-fit curves that result from these processes are given in Appendix II. The result of the above mentioned applications can be seen in Table 4.

Table 4. The Comparison of Mean Sea Level Values that is Obtained by PDGPS and Tide Gauge Readings

	Period	H_{SL}^{GPS}	H_{SL}^{TG}	Diff.
1st application	6'	0.485 m	0.432 m	5.3 cm
2nd application	30'	0.365 m	0.406 m	-4.1 cm

Conclusions And Recommendations

As can be seen from Table 4, '*Mean Sea Level*' values, obtained from each method are very close. It could be said that, the height of the water level can be determined by a GPS aided vessel. This new method is a powerful alternative to the conventional staff tide gauges, especially for surveys that are away from the shore.

This method does not require the measurements of the water parameters such as salinity and temperature that are necessary for measurements using the '*Pressure Tide Gauges*'. Furthermore, it is also a very useful tool when the '*Box Tide Gauge*' can not be installed due to the reasons such as water depth and sea traffic. However some limitations must be kept in mind.

The most important factor, which effects the precision of the results, is the accuracy of the measurements of the distance between the antenna on the surveying vessel and sea level. Therefore, the distance should be measured as accurately as possible with a steel tape or other geodetic methods. It is important to avoid loading additional equipment or persons into the surveying vessel, which will change the previously measured distance. As a summary, the equilibrium position at which the distance is measured should be kept as similar as possible.

The most obvious disadvantage of the new method is determining the geoid undulation N. It is necessary to determine the N value in order to convert the ellipsoidal heights that are obtained by GPS measurements to the orthometric heights. The determination problem of the N value has been solved by most of the countries that have defined their N values and made them available for practical use. If the N value is unavailable in this manner, the previously mentioned method and equation 3 could be used to calculate it. But, the calculated undulation value that was determined according to the datum that we chose does not represent the value of real undulation. However, Cartesian coordinates, which were obtained at the beginning of the study after the free adjustment process was used for all of the measurements. So, all of the measurements were carried out with this mentioned datum. Therefore, the calculation approach of the undulation value does not create a problem.

One of the negative aspects of the method is that the distance between the reference station and the mobile receiver should not exceed a certain limit. Otherwise, the result will be unsuccessful due to not being able to determine the initial integer ambiguity.

By keeping the study area conditions (tide, wind etc.,) in mind, the MSL values could be determined several times by additional GPS measurements with certain intervals (for example every 4 or 6 hours) if necessary. In this way, the changes (rise and fall) that occur in the sea level during the day that are caused by tide or other effects will be factored in if necessary.

By considering the above mentioned negative factors, the height of water level can be determined with an accuracy of the order of a few centimetres by PDGPS method and survey vessels can be used as a tide gauge platform.

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Appendix II. Best Fitting Curves

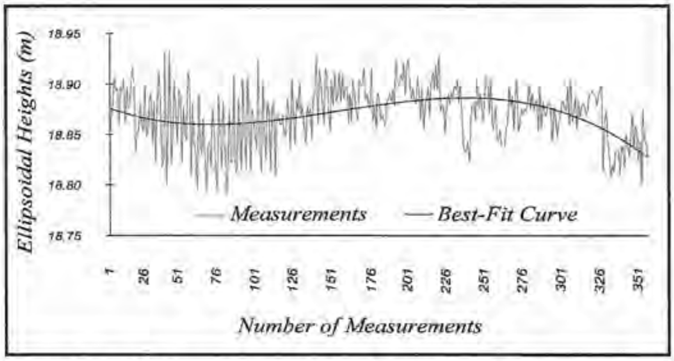

Figure A. Best-Fit Curve belongs to the 1st application

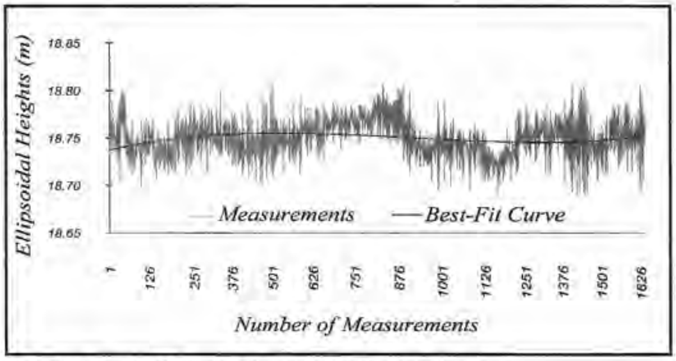

Figure B. Best-Fit Curve belongs to the 2nd application

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Lighthouse puzzler

	Barry	Ken	Sheila	Tim	Marina	Range-lights	Rocks awash	Stadia	On-foot	Helicopter	Launch	Truck
Andrew												
Bernard												
Dave												
James												
On-foot												
Helicopter												
Launch												
Truck												
Marina												
Range lights												
Rocks awash												
Stadia												

Lighthouse Puzzler # 18

The Revisory Survey had several distinguished visitors one day this year at a time when there were several jobs needing to be done. So Revisory pressed the visitors into service and sent out four teams of two.

Things went well and all the work was done in an exemplary manner. From what you heard over a beer that evening, can you report on the teams and their activities?

The clues:

1. The two with the helicopter left after Bernard and Sheila, who were not together.
2. Andrew did the stadia work but did not work with Ken or use the truck.
3. Dave and his partner (who did not visit the marina) went farther than the two with the truck but not as far as Tim or the two who checked out the rocks awash.
4. James discovered (but not with the launch) that the "rocks awash" were actually an overturned paddleboat.
5. Sheila, Ken and James fueled up on their way home and all arrived back at different times.

Solution to Puzzler #17 (Edition 56)

Fred, Sheila and Tim are not from Sarnia [Clues 1, 2, 5] so it must be Ed. Jack is not from Winnipeg or Burlington or [clues 3,4] nor is he with Ed [clue 4] so he must be from Ottawa with Tim. Which means John is from Sarnia and Joel is from Burlington.

By elimination, Jim's team, from Winnipeg, must be on Cost Analysis. Joel is on Personnel Problems [clue 6] so John, from Sarnia, is on QA [clue 1] and Jack and Tim, from Ottawa, must be the team working on Deadlines.

Ten Years of a Canadian In Monaco

Adam J. Kerr

The Beginnings

Having just read Tom McCulloch's excellent article 'Thirty Years of Turmoil, Stress and Achievement', in the 55th Edition of this journal, I have been tempted also to look back. This, a luxury that should only be taken up by someone of 'mature' years, as a younger man should surely be looking always to the future! However, as I have enjoyed the unique privilege of being so far the one and only Canadian to have been a member of the Directing Committee of the International Hydrographic Bureau (IHB) at Monaco, I thought the readers may find it interesting if I shared this experience with them. It is possible that some who know me will say that I am not a Canadian, having been born in the United Kingdom. But having spent thirty years of my life in Canada and some of that time working in such desirable regions as Ellef Ringnes Island and Quirpon, Newfoundland, not to mention that city of all power – Ottawa! I suppose I do have some credentials! However, my intent in this article is not autobiography but to describe first hand, what goes on in the secretariat of the International Hydrographic Office (IHO) and what I believe we have achieved, both in the secretariat and by the Organization at large, during the last ten years.

In April 1987 I found myself, due to the encouragement of Steve MacPhee, the Dominion Hydrographer and others of his senior staff, elected as a member of the three-person Directing Committee of the Bureau. My fellow Directors, elected at the same time, were Rear Admiral Sir David Haslam, retired Hydrographer of the United Kingdom, and Rear Admiral Alfredo Civetta, retired Director of the Italian Hydrographic Institute. The process of election is to first elect the three members of the committee and then from them to elect the President and chairman of the committee, who on this instance turned out to be the broadly experienced Sir David Haslam. Later, in 1992, I was re-elected for a further five years, this time to share the load with Rear Admiral Christian Andreasen (USA) as President and Rear Admiral Giuseppe Angrisano (Italy) as a co-Director.

The Organization

The Bureau is not large, with, at that time, a staff of eighteen and the three Members of the Directing Committee, making a total of twenty one. Since writing this there have been several changes made to reduce the total manpower and undertake a greater level of contracting out. Of the eighteen staff four are termed Professional Assistants and these are normally selected from the Member States' Hydrographic Offices (HOs). Like the Directors themselves, they are selected with a geographic spread in mind and at present they originate from France, Germany and Spain, although during my term we had Professional Assistants from the UK and from Pakistan. Typically, the PAs, with the exception of the PA for Finance, are middle-level hydrographers.

It is necessary to explain the difference between the IHO and the IHB. When the Organization was founded in 1921 it was called the International Hydrographic Bureau but in 1972, when its formal Convention entered into force, the Organization became the IHO and the Secretariat became the IHB. It is located in Monaco due to the generosity of Prince Albert I of the Principality, who was an enthusiastic amateur oceanographer and encouraged the development of all matters concerning the scientific studies of the sea. He built the Musée Océanographique, well known to the general public due to its association with the late Jacques Cousteau. Less well known is the fact that he arranged for premises for the IHB, which were opened in 1926 in a fine building beside the port of Monaco. Recently, in 1996, the Bureau was moved to modern but equally magnificent quarters on the other side of the port.

The IHO is an intergovernmental organization, with at present 69 member states as signatories to its convention with another 13 countries waiting to join. (Several States are expecting to join soon and this figure is subject to change). It is not a member of the United Nations group of organizations, although in the years prior to the last world war it was a member of the League of Nations. Its budget, which is primarily associated with the salaries for the Directors and staff, is approximately US$ 2 million. These funds are available through contributions from the Member States, which are paid on a variable scale depending on the country's shipping tonnage. Typically countries with large tonnage, such as Greece, Japan and the USA pay about US$ 100,000 and the smaller countries pay about US$ 10,000 per annum.

The objectives of the IHO are stated in its Convention and may be summarized as: the coordination of the activities of national hydrographic offices; achieving the greatest possible uniformity in nautical charts and documents; encouraging the adoption of new technology by HOs; and the development of the sciences of field hydrography and techniques used in descriptive oceanography. In fact it is the first two of these that get the most attention, as the others are in truth more national matters. These objectives have, over the years, resolved into several programme activities. One of these is standard-setting in hydrography, which in recent years has moved with the technology from setting standards for paper products to digital products.

Another programme area has been the encouragement of the individual HOs to join forces in global activities, which lead to internationally standardized products and services available to shipping. This finds shape in the development of an international chart folio and more recently in the Worldwide Electronic Navigational Chart Data Base (WEND), a matter that will be discussed more further on.

The third programme that may be identified is that of the General Bathymetric Chart of the Oceans (GEBCO). This has historic origins and stems from Prince Albert's interest in setting up a system to gather up all the known bathymetric data and to publish it as a series of bathymetric charts, mainly intended for scientific use. Shortly after the Bureau was formed it was proposed that this activity may be passed to it and since then the IHO, with various other scientific bodies, including the Intergovernmental Oceanographic Commission (IOC), have maintained this important series of charts and scientific data base. Canada in fact has played a large part in the GEBCO programme and during the 1980s did all the drafting and printing of eighteen sheets of the 5th Edition. It is now likely that all future editions will be in digital form.

Having set out the background of the Organization, let me now turn to what I believe we have achieved during the ten years that I was on the Directing Committee and what we would perhaps like to achieve in the future.

1987 - 1997 Years of Progress

The Directing Committee partitions the responsibilities of its three members by administrative and technical matters and by geographical areas. With regard to the latter, during my first term of five years, I was responsible for our contacts and activities in northwestern Europe and America and in the last term I have been responsible for north eastern Europe, Asia and Australasia. This has put me into contact with a number of interesting people working in the hydrographic field, many of whom have become good friends. It is in fact one of the decided benefits of the work at the IHB to be deeply involved in the close association of the rather limited field of hydrography. The regional responsibilities of a Director of the IHB involve a very considerable amount of travel that has taken me to many interesting places.

Technically and administratively I have been involved throughout with the very significant development of Electronic Chart Display and Information System (ECDIS) and the standards and specifications that we have developed in cooperation with the International Maritime Organization (IMO) and other international organizations. In 1986 the IHO formed its Committee on ECDIS (COE), under the chairmanship of Jim Ayres (USA) and this was passed to me on taking office. In the same year the IHO formed forces with IMO to form the Harmonization Group on ECDIS (HGE). During the last ten years, activities under these two groups have proliferated into a network of internal committees and working groups and into many new and different arenas. These include other international standard-setting bodies, such as the International Standards Organization (ISO) and the International Electrotechnical Commission (IEC).

The successes that have been achieved in establishing these standards have been largely due to the many technical specialists from many countries that have participated in the work. At the IHB the main effort has been to harness and coordinate this work. This is totally in line with the objective of the IHO to seek uniformity in hydrographic products and to a lesser extent to coordinate the activities of hydrographic offices. The major goals that have been reached were the adoption of the Performance Standards for ECDIS by the General Assembly of IMO in 1995 and the release of the 3rd Edition of the Digital Data Exchange Standard S-57 in November 1996. These are just the main standards and within them there are many more that contribute to the whole and in the end will make ECDIS a viable and safe navigation tool. Canada, it may be said, has been a major contributor to these activities, being one of the first in the field with digital data creation and use and in such tireless efforts as those of Mike Eaton in developing standards for Colours and Symbols for ECDIS. Canada has also been a leader in creating harmonious working relationships between government and industry, something that must clearly become an international goal for the future.

So much for the establishment of ECDIS data standards. With these coming on stream another urgent activity has been the development of a world-wide digital data base and updating service for ECDIS. In this task Norway, under the encouragement of Øyvind Stene, took an early lead but at a symposium, held at the Bureau in 1991, it became clear that the Member States of the IHO felt that this should be a jointly shared activity. Thus following the second objective of the IHO, namely the coordination of the activities of hydrographic offices, the IHO moved to set up an organization to develop a worldwide electronic navigational chart data base, termed the WEND. The idea was that all HOs would digitize their charts as ENCs (Electronic Navigation Charts), these would be in vector format following the specifications of S57 of the IHO. Regional Electronic Chart Coordinating Centres, known as RENCs would be established. These RENCs would then take on the responsibility of integrating the data into regional data bases plus the integration of updates and provide these as a service to shipping. The practice has proven to be more difficult than the theory and the system is moving into implementation rather later than had been planned. Nevertheless it was hoped that in 1998 the first part of this service, providing coverage for northern Europe, would come into being. (This service was formally established in 1999 as PRIMAR).

"put me into contact with a number of interested people"

The difficulties referred to above have been for several reasons. Standards have been much more difficult to develop than originally anticipated. Technology has been changing so rapidly that it has been difficult to decide on the right level of technology to use in matters of computing and telecommunications. There can be no denying that HOs are very conservative, and working in a much more businesslike environment has proved difficult. Added to all this, the entry of commercial companies into areas of hydrography that were previously the exclusive domain of government HOs has been an interesting challenge.

Moving to other areas of the work, the IHO has since the early seventies been involved in technical assistance to developing countries. Its budget for this activity has been rather small and to get the most for its money it has decided upon training as the best vehicle. Even here it has not had the resources to fund the training courses itself but working with the Fédèration Internationale de Géometrique on hydrographic courses, providing training to a common agreed standard all around the world. This is achieved through the FIG/IHO Advisory Board on Training of Hydrographers. Many years ago I participated with Alan Ingham, Admiral Kapoor and others in the formation of this system and the Board and served for a while as the Board's chairman. This programme of the IHO and FIG has now reached a state of some maturity and nearly thirty courses (this number is continually increasing) have now been approved as meeting the standards. At present the IHB provides the Secretarial services to the Board and the Canadian representative is Dave Wells, well known in hydrographic circles.

The work of the FIG/IHO Advisory Board has encouraged the development of particular institutions offering hydrographic course. A success story in that direction was the formation of the International Maritime Academy (IMA) at Trieste, Italy. This institution offers several courses and amongst them is one on hydrography, which is offered free to students, primarily from developing countries. Guest lecturers to this course are invited from countries with expertise, including Canada. A need is seen for courses in modern digital data management and it had been hoped that the International Institute for Aerospace Survey and Earth Sciences (ITC) in Enschede, Netherlands might have provided such a course. Unfortunately this did not materialize but the course is now being offered at the IMA at Trieste.

More directly associated with the provision of technical assistance to developing countries have been the visits to those countries to advise them on how to establish HOs. While the effort has been there and Directors have visited such unusual places as Ougadougou in Africa in the course of their business, it has been extremely difficult to bring promises into actions. This has been particularly the case in Africa, where apart from South Africa , some Mediterranean countries and recently the development of the Mozambican Hydrographic Institute, the situation is unsatisfactory. Numerous visits have taken place to both West and East Africa and plans made for Regional Centres, for Hydrographic Committees and projects, there has been some limited progress to date. The incoming President, Rear Admiral Giuseppe Angrisano, has been particularly active in recent years and has tried hard also to seek funds through organizations such as the European Commission. One must hope that matters will improve, because undoubtedly, the lack of modern charts will stifle the free movement of shipping and hence the economies of African nations.

Ten Years of a Canadian In Monaco

I myself have been involved in East Asia, where fortunately for the most part the status of hydrography and charting is generally better than that of Africa. Our concern there has been mainly directed at the South China Sea where the state of hydrography and the charts are extremely bad. This background is faced with the onslaught of an ever increasing movement of larger and faster ships and it seems a matter of time before some disastrous accident occurs. We have sought the recognition of IMO and the assistance of the United Nations Development Programme but to date no financial help has materialized. We have encouraged the coastal states surrounding the area to make joint surveys but also this has not taken place. Apart from the general difficulty of bringing focus to bear on apparently distant maritime soft spots a major problem is the political problem that is involved in the sovereignty of several small islands. This has resulted in the coastal states surrounding the South China Sea to be unable to jointly tackle the problem. However, there has been some success in collecting bathymetric data from the numerous oil companies working in the area.

"there has been some success in collecting bathymetric data"

A brighter spot in East Asia has been in Indonesia where we have been able to participate in a minor way in encouraging a major Norwegian survey to be carried out under contract to the Indonesian government. Our part was very small in advocating the use of international standards in this work but we are pleased to see this activity in place which will rapidly improve the quality of the hydrography and charts along the proposed sea lanes and along the continental shelf of Indonesia. We hope that the next country to be approached in this form of bilateral programme will be Vietnam, which is now a centre of major oil company activity. It has approached several countries, including France and Norway, seeking assistance in setting up hydrographic capabilities and we look forward to seeing these materialize. At the moment it is understood that there is no action in this country on these plans.

It is clear that bilateral arrangements between developed and developing countries are easier to achieve than multi-lateral assistance. Several cases can be seen around the world of very satisfactory projects that are supported by the US HY-COOP program, the Japanese International Co-operation Agency (JICA), the French NAVCO and various other national technical assistance bodies. I have been very impressed by the way the Norwegian Government tackles these matters through its embassies, Export Council and its general promotion of both Norwegian aid and industry. Canada could do well to take a leaf from that book.

Yet another of one of the more disparate activities of the IHO has been in its activities associated with the technical delimitation of boundaries within the Law of the Sea. Hydrographers have long been involved as technical experts in maritime boundary delimitation. Specialists have written many articles on these matters. In about 1995 Rear Admiral Fraser, a previous President of the IHB, decided to develop a manual to inform hydrographers about the subject. When I took office in 1987 we formed a Technical Assistance in Law of the Sea (TALOS) committee and subsequently produced a manual. In this work, we were joined by the International Association of Geodesy, which provided geodetic expertise. The most recent activity in this area are plans to prepare a book on the Continental Shelf to give guidance for those countries which plan to make claims to a continental shelf extending beyond 200 nautical miles offshore. This work will be carried out jointly between the IHO and the IOC. This book has now been published by the Oxford University Press: Continental Shelf Limits: The Scientific and Legal Interface.

It was noted earlier that the GEBCO programme of bathymetric mapping was a major interest of the IHO. In recent years considerable attention has been given to digitizing the information and the National Environment Research Council of the UK has produced a GEBCO Digital Atlas. In this, all the bathymetric contours and other information from the original paper sheets have been digitized and produced as a compact disc. The latest idea is to produce the GEBCO information in a gridded form and this matter is being studied at present. An offshoot from GEBCO activities are the Regional Bathymetric projects. These are in reality the responsibility of IOC but IHO participates in this work. In these projects bathymetric sheets have been published at I: I million, compared with GEBCO's published scale of 1:10 million. Associated with the GEBCO programme is a sub-committee on place names that has developed a Gazetteer of Undersea Features. Due to more and more information being gathered on the undersea topography and more features being identified, the work on dealing with undersea feature names has grown significantly.

Returning to the more conventional side of hydrography, several activities deserve mention. Work has continued recently on a publication 'Specifications for Hydrographic Surveys', designated S-

44. This has proven to be a very contentious matter as it appears that many people have very strong views on survey accuracy. This work was finished in 1997. Tides and datums are other areas that have had attention. Canada maintains, on behalf of the IHO, a tidal constituent data bank. Policies concerning the use of this data by commercial companies wishing to produce tidal prediction programs had to be worked out. The datum to which soundings should be referenced on charts had for many years been designated rather generally to 'a level so low that the tide would but seldom fall below it.' Recently, following a study, it has been agreed that a more quantitative definition as the Lowest Astronomical Tide (LAT) should be used. Horizontal datums are a particular concern as the introduction and use of satellite systems, referenced to the World Geodetic System 1984 (WGS 84), has introduced anew the need for a single world wide common datum. Unfortunately many different datums are used on charts throughout the world and in some cases there is no datum used. The IHO has produced a technical resolution urging Member States to use WGS 84 on all new charts, and on other charts to provide a statement allowing the navigator to make an adjustment between WGS 84 and the local datum. It seems likely that the need for greater attention to the use of WGS 84 will become evident.

The Bureau produces a number of publications. The most familiar of these may be the International Hydrographic Review, which has been published since the organization was formed. [Ed. The International Hydrographic Review has been discontinued in the year 2000 and has been replaced with The New International Hydrographic Review available on the Internet]. The Bureau also produces a monthly Bulletin, describing activities and events of the Bureau and the IHO at large. These publications require ongoing attention. A continual search must go on to find suitable articles for the Review, which presents an ongoing history of the progress of hydrography. Once a year the Yearbook must be updated. This includes the addresses and contacts of all Hydrographic Offices, both those that are representatives of Member States and non-Member States.

An Annual Report is produced in two volumes, to describe the events of the organization during the previous year. Volume I provides general information and Volume II provides the financial information. There are numerous publications dealing with the technical specifications and standards discussed earlier. These must all be maintained up-to-date. Details of all publications, which are provided free to Member States and sold to others, are included in the Catalogue of Publications that is produced annually and is available free of charge. In recent years ordering by credit card has been introduced and some publications are now available on CD ROM. A Bulletin Board system that is accessible to all Member States was introduced in 1992. A major effort was made recently to re-design the Bureau's set of publications with emphasis on availability through the Internet Selected publications are provided in printed form and all others are now available on CD ROM or over the internet There is a home page (http://www.iho.shom.fr) for the organization and the website includes the Catalogue of Publications.

The IHO has now been in place for 75 years and at the XVth Conference it was decided to form a Strategic Planning Committee to see if its organization and work should be adjusted in order to meet the future more effectively.

In summary, for me this was an interesting ten years, working with a small dynamic organization, that is as yet not greatly encumbered by bureaucracy. While much of the western world has been trying to reduce the size of government the IHO has been steadily growing in membership and the need for its services appears to be growing daily. Certainly, like all other organizations, it must alter its ways to satisfy new requirements but it is my belief that this is an efficient and productive body that must be maintained at least at its present strength.

NOTE: *This paper was written in 1999. Some comments have been added to update the reader on some matters that have since changed. Overall the Directing Committee, in place since 1997, has overseen a number of changes. These have included actions proposed by the Strategic Planning Committee that were approved at an Extraordinary IH Conference in March 2000.*

About the Author / À propos de l'auteur

Adam J. Kerr *spent nearly thirty years with the Canadian Hydrographic Service, in many capacities, including Director of both Central and Atlantic Regions. He then spent ten years as a member of the Directing Committee of the International Hydrographic Bureau at Monaco. Since 1997 he has been retired and lives in the UK but continues to do consulting on hydrographic matters.*

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Winter Storms on the Great Lakes

Ron Solvason and Carol Robinson

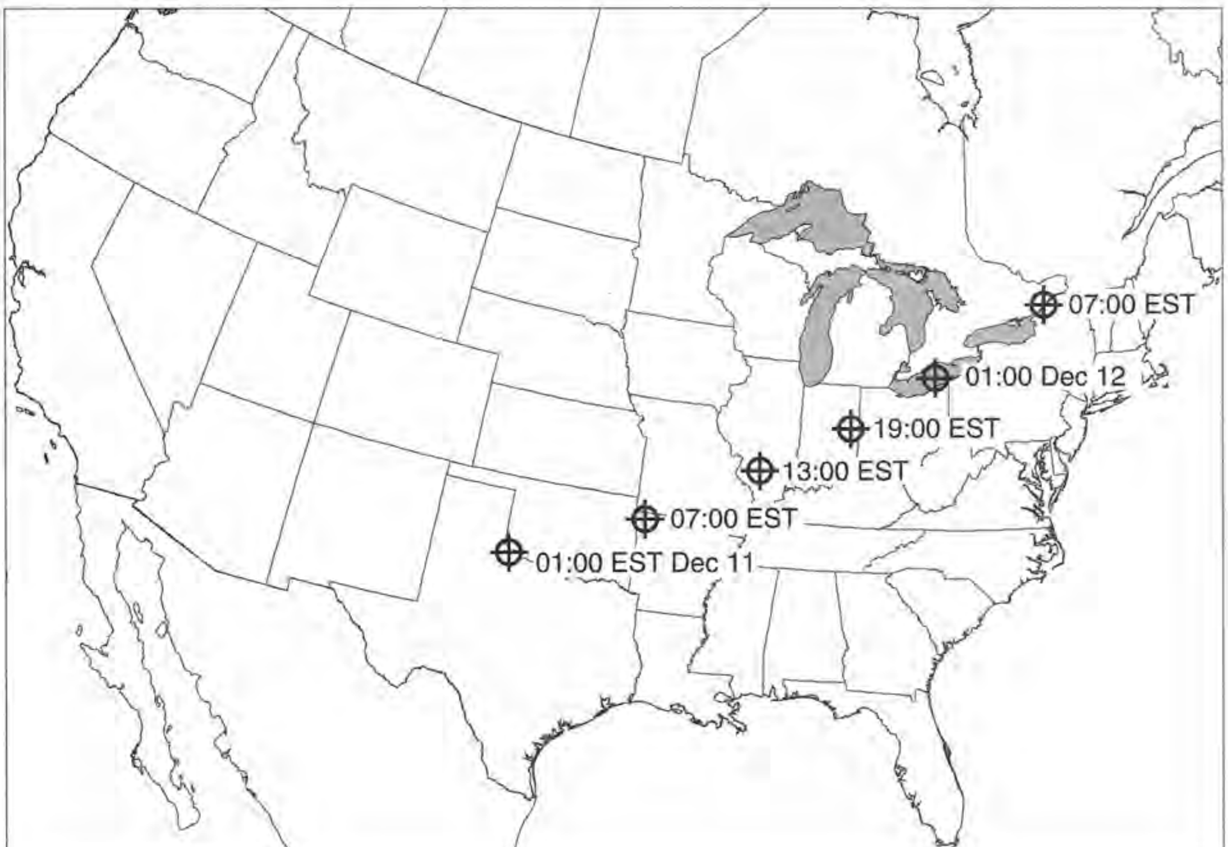
Canadian Hydrographic Service, Central and Arctic Region

A water level surge resulting from strong winds associated with a storm is a major factor contributing to flooding in shoreline areas. Lake Erie experiences some of the highest wind setup or storm surges in the Great Lakes region. There are two major factors which make Lake Erie susceptible to these storm surges. One is the fact that Lake Erie is a relatively shallow body of water and the other is that the major axis of the lake is oriented in roughly the same direction as the prevailing winds and major storm events.

On December 11 and 12, 2000 the first major storm of the winter 2000-2001 season passed through Southern Ontario. The path of this storm as tracked by Environment Canada's Regional Centre Thunder Bay began in the American southwest and moved in a northeasterly direction towards the Great Lakes. (Figure 1) As it approached Lake Erie, rapidly dropping pressure intensified the storms voracity. The centre of low arrived at the western end of Lake Erie at about 2200 hours EST on December 11th and tracked over the central portion of the lake reaching the eastern end of the Lake at about 0300 hours EST on December 12th.

In advance of the centre of the storm, strong winds from the southwest, in excess of 60 knots pushed water to the eastern end of the Lake. This generated a storm surge that reached a height of approximately 2.1 metres above the static water level at Port Colborne

Figure 1



Map of Storm Track December 2000

Ontario. (Figure 2) At Buffalo New York the surge was even higher, reaching a height of nearly 2.8 metres above the static water level. (Figure 3) Although the surge lasted for only a couple of hours, it caused flows in the Niagara River to nearly double from the previous day. The surge occurred at approximately 0600 EST on December 12th, which was nearly 3 hours after the centre of low pressure passed.

At the same time, the storm caused the water levels at the western end of the lake to fall as the water was forced to the east. At Bar Point water levels dropped by approximately 1 metre from the static level. At Toledo Ohio the water level fell as much as 1.3 metres from its static level. In fact for a period of almost 12 hours in the early hours of December 12 the western end of Lake Erie and the entrance to the Detroit River was more than 0.5 metres below Chart Datum (the level to which depths on navigation charts are referenced).

Although there were reports of some minor flooding of roads and a park in Ontario, Buffalo experienced more extensive flooding and property damage. It was fortunate that this storm occurred during a time when Lake Erie is at a level below its all-time average. A similar storm in 1985 produced a slightly smaller surge but it occurred when Lake Erie was at a level above its all-time average and caused damage in the tens of millions of dollars in Ontario and New York.

News reports of these storm events generally focus on the flooding and associated property damage that can be considerable. However, the effects of the draw-down on water levels also pose considerable risk to navigation and water intake facilities. As can be seen on the two graphs above there was a period of at least 12 hours when the water level at the western end of the lake was more than 0.5 metres below Chart Datum. If mariners are not aware of this they run considerable risk of grounding and possible foundering. At the very least, shipping schedules are severely affected while ships wait until water levels return to a safe height.

Figure 2

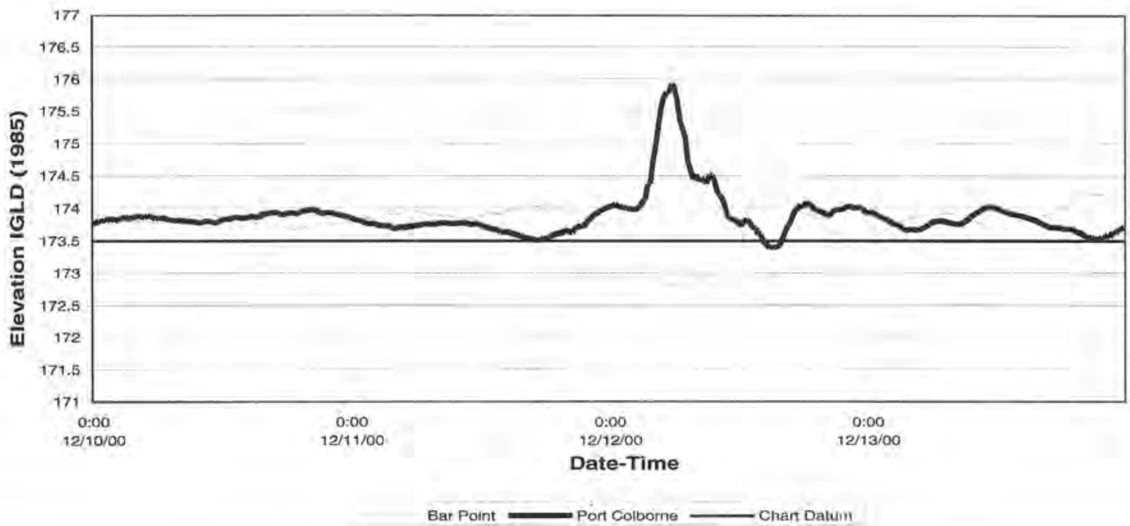
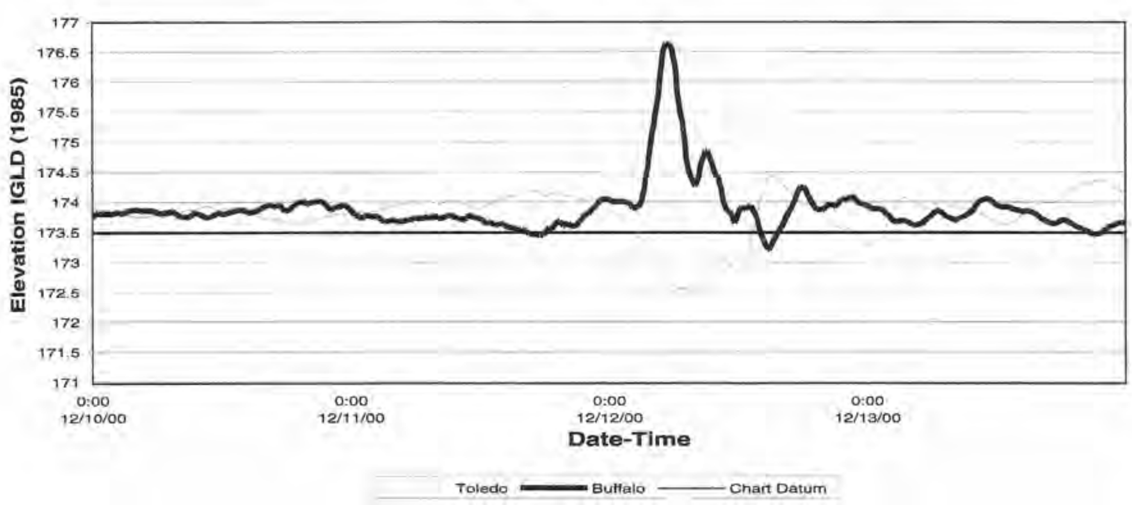


Figure 3



SUSTAINING MEMBERS / MEMBRES DE SOUTIEN

Sustaining membership allows companies closely linked with the hydrographic field to become more involved with the activities of the CHA and to maintain closer contact with users of their products. Through LIGHTHOUSE these Sustaining Members are also able to reach a world-wide hydrographic audience. The benefits of Sustaining Membership include:

- a certificate suitable for framing;
- three copies of each issue of Lighthouse;
- copies of the local Branch newsletters, where available;
- an invitation to participate in CHA seminars;
- an annual listing in Lighthouse;
- an annual 250 word description in Lighthouse; and
- discounted advertising rates in Lighthouse.

Annual dues for CHA Sustaining Membership are $150.00 (Canadian). Current Sustaining Members are listed below.

Aanderaa Instruments Ltd.
100 - 4243 Glanford Avenue
Victoria, British Columbia
Canada V8Z 4B9 Fax: (250) 479-6588
contact: Gail Gabel (affiliation - CHA Pacific Branch)

Garde côtière canadienne
104 rue Dalhousie, Suite 311
Québec, Québec
Canada G1K 4B8 Téléc: (418) 648-4236
contact: Claude Duval (affiliation - ACH Section du Québec)

l'Institut maritime du Québec
53 St-Germain Ouest
Rimouski, Québec
Canada G5L 4B4 Téléc: (418) 724-0606
contact: Claude Jean (affiliation - ACH Section du Québec)

NovAtel Communications Ltd.
1120-68 Ave. N.E.
Calgary, Alberta
Canada T2E 8S5 Fax: (403) 295-0230
contact: Art Silver (affiliation - CHA Central Branch)

Kongsberg Simrad Mesotech Systems Ltd.
202 Brownlow Avenue
Dartmouth, Nova Scotia
Canada B3B 1T5 Fax: (902) 468-2217
contact: John Gillis (affiliation - CHA Central Branch)

Terra Remote Sensing
1962 Mills Road,
Sidney, British Columbia
Canada V8L 3S1 Fax: (250) 656-4604
contact: Rick Quinn (affiliation - CHA Pacific Branch)

Terra Remote Sensing

Terra Remote Sensing Inc. is a spatial data organization offering world class expertise and technology for digital aerial mapping, hydrographic charting and marine geophysical surveying. TRSI's headquarters is located in Sidney, British Columbia, Canada with an American representative office located in the state of Washington. Formerly a division of Terra Surveys Ltd., TRSI is now an independent employee-owned corporation offering decades of successful experience to its global clients.

TRSI provides unique digital mapping solutions for the linear engineering market through powerful, proprietary hardware and software packages. A new scanning laser (LIDAR) product, combined with TRSI's "VideoMap": software, provides rapid and cost-effective digital mapping to the utility, telecommunication, rail and resource sectors. This technology, combined with more traditional marine geophysical and hydrographic (acoustic) survey capability, gives TRSI a comprehensive tool kit from which a broad range of mapping solutions can be built on land or water. Marine solutions are particularly applicable to charting, search and salvage, outfall, port and harbour, submarine pipeline/cable, depth of burial, water inventory, marine habitat, and environmental assessments.

TRSI's solutions are in demand wherever organizations need timely and cost-effective access to comprehensive, high quality geospatial information. The captured data, providing geo-referenced aerial imagery to any scale, is then ported directly to computer-aided mapping systems and geographical information systems (GIS) for photo mosaics, planimetric maps, and/or digital terrain models used in routing evaluations and engineering designs. TRSI also performs GIS and geodetic/vertical control analysis, map preparation, merging and processing of independent data sets, and project management and training. The company has successful experience around the globe, including projects in the Caribbean, South America, Africa, the Middle East, Southeast Asia and United States.

Terra Remote Sensing Inc. is an employee-owned company, whose shareholders are the professional and technical staff who are directly involved in the firm's day-to-day operations. Senior management is comprised of a group of specialists with over a century of combined experience in photogrammetrics, hydrographics and consulting engineering. This diverse team of professional engineers, hydrographers, surveyors and geophysicists is supported by a technical staff of GIS specialists, cartographers, and programmers who are all permanent employees of the company.

News from Industry Nouvelles de l'industrie

Bytown Marine Limited
Nepean, Ontario, Canada

Bytown Marine Limited (BML) has been awarded a contract by Public Works and Government Services Canada for the supply of a High Accuracy Marine Survey System to be delivered to the Departmant of Fisheries and Oceans, Canadian Coast Guard at Quebec City.

BML will supply the Dessault Sercel Navigation and Positioning (DSNP) Aquarius Series 5002 L1/L2 Marine Survey System, UHF Repeater Station and associated software.

The DSNP Aquarius product line provides sub-metre positioning accuracy. The Series 5002 products offer 3D accuracies in the 2 to 5 cm range at distances of up to 50km and at longer ranges with the use of a repeater station.

Bytown Marine Limited has recently concluded an agreement with Dassault Sercel Navigation and Positioning, naming BML as the sole Canadian Sales and Service representative for the SAGITTA Marine Navigation and AQUARIUS Marine Survey Differential GPS product lines.

DSNP is the European leader and a major player in the world of Differential GPS and GNSS systems. Stemming from the original Sercel radio-navigation department, it has rich and long proven experience in the radio-navigation field. DSNP engineering teams were among the very first in the world to work on GPS receivers; the first European GPS receiver in 1985, as well as the first integrated differential GPS in 1989, were developed in its laboratories. Today, engineering know-how is the main asset of DSNP. As a subsidiary of Thomson-CSF, DSNP takes advantage of the groupís advanced industrial facilities, ensuring customers get best-of-breed products at all times.

Incorporated in 1976, BML is a Canadian company most widely recognized as a supplier of marine electronics, especially GPS receivers, Inmarsat satcom terminals and hydrographic survey systems. In 1984, the company expanded its capabilities beyond marine systems into the areas of military communications, satellite weather imagery, environmental monitoring, solar energy and industrial lasers. During the 1980ís and 1990ís BML played a leading role as a supplier of satellite navigation and communications systems in Canada, providing installation, commissioning and training services to the Canadian Navy and Canadian Coast Guard as fleet were equipped with satellite navigation receivers and Inmarsat satellite communication terminals.

For information contact:

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Bytown Marine Limited, Tel: (613)723-8424 Fax: (613)723-0212
Website: www.bml.ca

Kongsberg Simrad Mesotech
Port Coquitlam, British Columbia, Canada

Kongsberg Simrad Mesotech Ltd. (KSML) has delivered its first multi-role multibeam sonar capable of operating to a depth of 6,000 meters to the Woods Hole Oceanographic

Institution (WHOI) of Massachusetts. WHOI will use the SM 2000 sonar on its ROV (Remote Operated Vehicle), Jason, and its submersible, Alvin, for deep sea and ocean floor research.

The SM 2000 is highly versatile and can be used for forward looking obstacle avoidance and navigation roles with 20 degree vertical x 120 degree coverage, or may be reoriented on the vehicle to provide 1.5 x 1.5 degree bathymetry data, with up to 150 degree swath coverage. No changes to the system are required for these modes.

The multi-role SM 2000 sonar is ideal for research organizations whose sensor requirements vary from mission to mission. The flexible telemetry options available make installation simple on either tethered ROVs or free diving submersibles. Raw sonar echo data may also be logged for post mission analysis and research.

"This SM 2000 sonar system represents a continuation of our solid record of supplying deep water sonars, including systems rated to full ocean depth," said KSML president Hans Gray.

A similar KSML system has been used by WHOI to gather bathymetry data, provide real-time ROV navigation, and gather raw echo backscatter data from deep water 'smokers' for research.

Dedicated to quality and customer satisfaction, Kongsberg Simrad Mesotech Ltd. is a world leader in the high frequency acoustic imaging market. Its product line includes multibeam profilers, multibeam sonars, scanning sonars, side scan sonars, profilers and altimeters. Applications for KSML products span the military, fisheries, scientific, and offshore oil industries.

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Jane Thomas - Ullrich Schade and Associates Ltd.
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Saab Transponder Tech
Solna, Sweden

International Communications and Navigation (ICAN) Ltd.
St. John's, Newfoundland, Canada

Saab/ICAN team win major AIS contracts with Lockheed Martin Saab TransponderTech of Solna, Sweden and International Communications and Navigation Limited (ICAN) of St. John's, Newfoundland, Canada have been awarded contracts by Lockheed Martin Overseas Corporation to provide Automatic Identification System (AIS) solutions for Greece and Turkey. The AIS hardware and software will meet IMO performance standards, specifically the IMO Resolution MSC.74(69) Annex 3, for Universal Shipborne Automatic Identification Systems. Lockheed Martin chose the Saab/ICAN team after a lengthy, worldwide tendering process in search of an AIS technology partner for these and other projects.

AIS delivers vessel position and related information from ship to ship and from ship to shore. It is designed to provide collision avoidance capability on the ship's bridge and to augment vessel traffic management systems. Ships will carry a transponder that broadcasts the ship's identity, position, speed, course, and other information to all other AIS users within VHF Radio range. The International Maritime Organization (IMO) will require all SOLAS class ships built after July 2002 to carry one of these transponders and carriage requirements for all other ships in this category will be phased in over the subsequent six years.

The Hellenic Merchant Marine Ministry is undertaking a trial that includes shipboard AIS transponders and base stations. It is the first phase of a national Vessel Traffic Management Information System (VTMIS) for Greece that is being delivered by Lockheed Martin to its Greek Prime Contractor, INTRACOM.

In the Turkish Straits, Lockheed Martin's VTMIS infrastructure project is now underway. The AIS component of this project includes the installation of 6 Saab R30 Base Stations and 50 Saab Pilot Cases. Each Pilot Case consists of a watertight case, power supply, R3 transponder, notebook PC, and ICAN's Aldebaran II Electronic Charting System (ECS) with AIS Module.

Saab TransponderTech AB is the world's most advanced developer of AIS transponders, and has over 350 AIS transponders in service today including a system that covers the entire Swedish coastline. ICAN develops and integrates ECS software addressing the needs of maritime professionals for navigation, hydrographic surveying, buoy tending and radar overlay, as well as AIS. ICAN has over 120 Regulus and Aldebaran systems in service around the world. ICAN and Saab have been working together for over two years to develop the AIS market, and have delivered AIS technology for two Canadian Coast Guard trials. The Greek and Turkish projects represent a significant leap forward in the adoption of a technology aimed at increasing human safety and environmental protection.

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Website: www.ican.nf.net

Terra Remote Sensing Inc.

The shareholders of Terra Remote Sensing Inc. (TRSI) are pleased to announce the creation of TRSI as an independent corporation under the B.C. Companies Act.

TRSI has long been known as the West Coast Office of Terra Surveys Ltd., established in 1984. It specialises in the hydrographic, photogrammetric, orthophoto, and digital mapping fields, and with the rapid adoption of Geographical Information System (GIS) applications over the past decade has integrated its entire array of products and services with GIS.

Terra Surveys was purchased by a subsidiary of the Orbital Sciences Corporation (USA) in 1999, and the employees of Terraís west coast operation saw an opportunity to exploit the specialised technologies and expertise of the Sidney office via an employee-led buyout. They were convinced that their specialities ó hydrography utilizing both conventional sonar and proprietary scanning laser technologies, marine geophysics, and geo-referenced mapping using digital video and cameras — could be more effectively employed and further developed independently.

TRSI purchased the assets and technologies of Terra Surveyís West Coast Office, including a new rapid pulse (10 KHz) scanning laser under development for the utility, fiber optic and pipeline construction/maintenance, last month. The existing employees are now the shareholders of TRSI, and include professional hydrographers, geophysicists, land surveyors, software developers, and cartographers. Many have been with Terra since the opening of the west coast office in 1984, and are the very foundation of the success of the new company.

TRSI looks forward to continuing to effectively serve its worldwide client base from its headquarters in Sidney, British Columbia. It remains an innovative mapping and terrain modelling corporation that provides unique and cost-effective solutions to geographic information challenges.

For information contact:

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Canadian Hydrographic Service News
Nouvelles de l'association canadienne d'hydrographie

Pacific Region

Hydrographic Surveys 1999

* The Pender was in the Fair Harbour/Kyuquot Sound area and completed 50% of the new surveys required to produce the proposed new chart 3677. After the survey, CCG MNS group used the Pender on the Central Coast as a base for Light reconstruction projects. This resulted in a demobilization from Fair Harbour, instead of a tow back to IOS.

* The Revisor surveyed Race Rocks and Gabriola Passage Pilot Marine Protected Areas in February and March of 1999. She was attached to the Pender to assist with the Fair Harbour/Kyuquot Sound surveys for July and August.

* Other projects: Sidney Harbour, Victoria Harbour, Esquimalt Harbour, and Revisory in Vancouver Harbour and the Strait of Georgia. A survey of Chilko Lake (interior BC) was done for the Habitat Enhancement Branch of DFO.

* The R.B. Young has a new EM1002 MBES and acceptance trials were conducted in December of 1999.

* Tidal surveys were occupied with instrumentation upgrades and Y2K testing on the Pacific Tsunami Warning Gauges and the Permanent Water Level Network.

In 1998 the Barge Pender Hydrographic staff erected, "The Bent Propeller Monument", at Oliver Cove, British Columbia. The Prop is from one of the Bertram Survey Launches, after an argument with a rock. This monument is a visible reminder to all who navigate the British Columbia coast of the many unknown dangers that lurk below the surface. It also pays tribute to the men and women of the Canadian Hydrographic Service who attempt to find and chart these hazards.

Hydrographic Surveys 2000

* The PENDER (July & August) concluded the surveys required for the Kyuqout Sound/Checleset Bay New Chart 3677. A single beam Bertram launch will be used, with RT-2 GPS for Heave Compensation. The area is strewn with rocks and is know for large ground swells (I'm getting sick just writing this!)

* The REVISOR with the EM3000 will assist the PENDER, in addition to several local projects (Including Victoria & Sidney) and various Revisory Surveys. A Revisory Survey has recently been completed in the Desolation Sound area for the cruising atlas 3312.

* The R.B. YOUNG with the EM1002 will have numerous collaborative projects covering the entrie coast with Oceans Directorate, NRCAN, DND and private sector partners.

Second Narrows (Vancouver Harbour) Project

CHS, Vancouver Port Corporation, Sultran, and CN Rail are co-operating to install an acoustic system to measure water flows and heights, to improve knowledge of key transit times so as to better schedule ships and trains (CN operate a lift bridge). Many individuals and companies are involved:

* in CHS, the primary individuals are

Terry Curran (project manager), Bill Hinds (project electronic supervisor), Al Thorn (project mechanical engineer), Al Thomson (project electronics), and surveyors who measure the sound speed from time to time, (and level in calibration benchmarks)

* Depot mechanical personnel did an amazing job of constructing the massive support hardware

* ASL Environmental Sciences are providing the flow measuring system, and integrating the water measuring system

* DFO legal people have spent many hours putting in place three collaborative agreements with VPC, CN Rail, and Sultran

* Financially, PERD has been a major supporter, as well as the collaborators. CHS has contributed salary money.

Environmental Data Set

Sherman Oraas and Terry Curran have been assembling a dataset for environmental uses - not for navigation. They have been extracting the low water shoreline (1.5 million values) and spot soundings (350,000 values) from charts, plus some elevations. This has been supplemented with data from offshore surveys at coarse line spacing. The product is intended for the many users that need to place their information on a base map. The product would be sold through Nautical Data International.

There is a lot of interest regionally, spearheaded by Dick Carson of the Oceans branch. CHS appears to have the responsibility. The product would be positioned in quality below the chart data, and possibly sell for about $1000.

Presently, two copies of the dataset are in evaluation by Alpha site users, with responses expected by the end of March. Early comments are that the shoreline points may need to be connected to be useful for some purposes.

There is great concern about data piracy, such that the data gets into circulation and version control is lost. The result could be a dataset that no one maintains, and whose quality is unknown.

Nautical Publications

The focus of our efforts over the past several months has been production of six New Charts, Nanaimo Harbour and five charts in the Hakai Passage area. Maintenance of existing charts also played a major role in our plans.

New Charts

Chart 3447, the New Chart of Nanaimo Harbour and Departure Bay incorporates EM3000 multibeam surveys and provides additional large scale coverage of the HMCS Saskatchewan dive site and the new BC Ferry terminal at Duke Pt.

Of the five Hakai Passage area charts, one, Chart 3935, is currently at press. Two others are in the final stages of production and are scheduled for printing in the near future. The remaining two are scheduled for completion later in the year.

Maintenance

Our maintenance program was highlighted with the completion of several New Editions including Chart 3962, which incorporated new survey data in the previously unsurveyed Griffin Passage area on the central coast. A chart amendment patch was also prepared for Chart 3738 to incorporate this new survey data.

Chart 3668, Pacific Region's first chart produced utilizing Raster editing tools was another significant milestone. Production was a frustrating learning process but the experience gained will serve us well on several other charts planned for the near future.

Numerous other New Editions, Reprints, Chart Amendment Patches and Overprints were also completed to address chart maintenance requirements.

Unfortunately, cutbacks in funding impacted production, forcing the cancellation of work on Chart 3312, the popular cruising atlas of the Desolation Sound area.

Electronic Charts

Production of S-57 ENC files are in the final stages of a three year CHS-CCG co-operative project. Emphasis has been to provide coverage along major routes and to commercial ports along the BC coast. This has been accomplished with the exception of Hecate Strait where existing charts do not allow for conversion to ENCs without extensive re-surveying and re-charting.

Development and implementation of ECDIS systems has been very slow so no feedback of existing ENC files has been received. This is expected to change as system manufacturers start to deliver systems to CCG this year. User feedback is an important consideration for future production and maintenance plans of ENCs and Pacific is taking a wait and see approach before further expansion of coverage is undertaken.

Many of the smaller scale offshore charts will not be converted to S-57 files at this time. With the ability of most systems to use the "dual fuel" approach, raster charts will be utilized for offshore charting, allowing CHS to concentrate its S-57 production on approach and harbour charts.

* Current Pacific releases 127
* ENC released in 2000 13
* Files at HQ for final check 23
* New charts in production 4

Staff Assignments

In addition to their charting assignments, Nautical Publications staff also participated in Advanced CARIS and CARIS for Windows training, hosted Power and Sail Squadron tours and took part in career development rotational assignments in Field Hydrography and Geomatics. Of particular interest was the Pacific/Laurentian Region exchange of staff members Brian Wingerter (Pacific) and Estelle Poirier (Laurentian). All reports indicate that this was a very successful and productive exchange.

Future Plans

Production will continue on the remaining four New Charts in the Hakai Passage area.

Other New Charting plans include the two-sided printing of Chart 3479. This chart will consist of a 1:15,000 approach chart of the extremely popular recreational boating area around Sidney. The back will contain a 1:8,000 inset of the Sidney / Tsheum Harbour area surrounded by useful recreational boating and diving information.

Multibeam surveys and planning continue on Chart 3412, the reformatted, larger scale chart of Victoria Harbour and Approaches.

A New Edition is also planned for Chart 3419, Esquimalt Harbour, to incorporate multibeam and revisory survey data.

Work on the documentation for ISO 9000 certification will require significant resources in the coming months.

Central and Arctic Region

Work continues in Central and Arctic Region (C&AR) under the direction of Julian Goodyear.

Surveys in 2000

Hydrographic surveys for 2000 were again reduced over previous years. This was a bit of a "learning" year as all single beam launches were upgraded with the recently acquired, PC-driven, Hypack Max data acquisition systems, and all hydrographic data processing moved to PC-based, CARIS NT Hydrographic Information Processing System (HIPS) software.

John Medendorp served as Hydrographer-In-Charge (HIC) for the continuing hydrographic surveys on the eastern side of Georgian Bay. The Canadian Coast Guard Ship (CCGS) Griffon was used as the base of operations for staff and four launches, for approximately one month.

A joint scientific/hydrographic program in the western Arctic, was again carried out aboard the CCGS Sir Wilfrid Laurier with Andrew Leyzack as HIC. The Laurier and one launch were used for data collection.

Bob Covey led the Revisory Survey as HIC, once again, in collecting data from various areas in the region. These data, mainly soundings, shoreline information and navigational aids and conspicuous objects positioning, are to be used in updating charts and other products.

Several harbour surveys were conducted using the Simrad EM3000 multibeam system. Part way through the season, the system was transferred to a newly built, 30 foot, aluminum survey launch.

A new survey of Hamilton Harbour was done to update the chart of this major port. This survey gave us an opportunity to train staff to use the new data acquisition software, Hypack Max, the HIPS data processing software on NT, as well as the multibeam system and processing.

A small survey party led by HIC Jon Biggar, aboard the CCGS Radisson in the Eastern Arctic, collected hydrographic information in areas requested by the Government of Nunavut.

Charting

The production of S-57 Electronic Navigation Charts (ENCs) continues, as does the increase in demand for these products. Production techniques and quality control procedures have constantly evolved to create a better product.

The Canadian Coast Guard's "Aids Modernization Program" has resulted in a large number of changes to the navigational aids system in the region. A great deal of effort has been expended incorporating these changes into CHS products.

The recently assumed responsibility for western Arctic charting by Central and Arctic Region (C&AR) continues to present a significant workload.

Five/Six (?? Terese: Several other new editions coming, what cut off date do you want to use, or should we refer to only new charts) charts were released this year: New Chart 2241, Port Severn to Christian Island, New Chart 5629, Marble Island to Rankin Inlet, New Chart 5641, Arviat and Approaches, a New Edition of Chart 2085,Toronto Harbour, and New Editions of Charts 6021 and 6022, of the Muskoka Lakes. The Muskoka charts are significant in that they were printed back to back, on waterproof paper, and are the first C&AR charts to show the true colours of buoys and lights. Work is proceeding on several charts that will be available in the 2001 navigation season.

New charting projects started this year include New Chart 2207, to replace Chart 2286, Georgian Bay to Clapperton Island, and New Editions of the Lake of the Woods charts. The Lake of the Woods Charts will reflect true buoy and light colours, and will be printed back to back, on waterproof paper, similar to the Muskoka charts.

Training

Two training initiatives were offered this year, aimed at familiarizing staff with the new tools we have implemented. The first was provided through Universal Systems Limited and dealt with CARIS HIPS single beam data processing and using CARIS NT. The second pertained to data collection using Hypack Max, and was taught by Coastal Oceanographics staff.

C&AR had the pleasure of hosting the 2000 edition of the University of New Brunswick Ocean Mapping Group's annual Coastal Multibeam Training Course, in Burlington, Ontario. The course was a very comprehensive tutorial on the theory and operation of shallow water multibeam systems. Students were instructed on how to effectively conduct multibeam surveys, and how to deal with the massive data sets which result from these surveys.

One further training session was the one day Sea Survival and Underwater Escape Training Course. This consisted of a half-day of theory and familiarization with marine survival equipment and rescue techniques, and a half-day of training in the water. This was a very useful session for anyone who works in the marine environment.

Special Assignments

Ed Lewis, Manager Technical Services, continued to be involved in the federal government's Universal Classification System (UCS) initiative. In addition to his activities in UCS training, coordination and leading of classification activities at the regional office, he also serves on the Central and Arctic Region UCS Regional Application Committee and the CHS national UCS coordinating committee.

Geof Thompson returned to his normal duties after heading the Y2K initiative for the CHS offices in Burlington. The contingency plans made for all CHS functions and the many upgrades to software and hardware resulted in no disruption to CHS activities due to Y2K related problems.

Sean Hinds, who is leading a Quality Management System initiative for the region, has been directing a team of people with the goal of achieving ISO 9000 certification for all CHS C&AR activities.

Julian Goodyear spent the last part of 1999 and the first month of 2000 in an acting assignment with the CCG, in Ottawa. He was part of a team planning the reorganization of CG headquarters, and has subsequently returned to his post as Regional Director of Hydrography, C&AR.

In Julian's absence, Brent Beale and Bruce Richards alternated as Acting Regional Director.

Staff Changes

In the last year, we have lost several employees to other opportunities in the private and public sector: Nick January, Bill Gray, and Janet Matsumoto, as well as Dan Dexel and Mike Marsden. Dave Tobio and Matt Down participated in assignments with CCG.

award bourse

CANADIAN HYDROGRAPHIC ASSOCIATION STUDENT AWARD REPORT

The Canadian Hydrographic Association Student Award was created in 1993 with funds earned by this association in the management of Tom McCulloch's Canadian International Development Agency supported 3rd world hydrographic training assistance programme. Tom's projects had previously been supported by the then Canadian Institute of Surveying who wished to withdraw from the plan. The Canadian Hydrographic Association under the leadership of the then National President, Barry Lusk, accepted the roll of professional partner. During the first few years of this partnership the CHA earned approximately $30,000 which has been used since that time to support the student award which offers $2,000 per year to a deserving student. Seven awards have been made since its inception to students of various universities and colleges across Canada. Twenty four universities and college from across Canada and from each province presently participate in the award.

Each year in January the manager of the award sends information packages to each of the member schools encouraging their awards offices to post our brochure and distribute the application forms to interested student. Each year we receive about 30 applications. As the award is both subject and academic year specific applications are few. In June and July of each year a committee of two chooses the winner from the applicants that qualify.

Since inception seven awards have been made to the following people.

1993...Darren Colford, College of Geographic Sciences, Nova Scotia

1994...Heather Langill, College of Geographic Sciences, Nova Scotia

1995...David Scovill, University of Calgary, Alberta

1996...Jean-Francois Olivier, University of Laval Quebec

1997...Joseph Vogler, University of Calgary, Alberta

1998...Adam King, College of Geographic Sciences, Nova Scotia

1999...Dave Swaile, British Columbia Institute of Technology, British Columbia

Each year the winner of the award is encouraged to send his or her thank you message to Lighthouse so that all CHA members will be aware of that years recipient.

The $2,000 award is considered a major award, as awards go at universities, and is a coveted trophy. Along with the cheque there is also a plaque which in perpetuity will record the names of the winners. A medallion with the CHA crest is also given along with a certificate.

It is hoped that the principal investment will continue to generate funds sufficient to support this award well into the future.

THE CHA AWARD FOR DESERVING STUDENTS
LA BOURSE L'ACH POUR LES ÉTUDIANT MÉRITANTS

Rules for eligibility:

1. The applicant must be a full time student registered in an accredited survey science program (the program must have a Geographic Information System, Cartographic, Land or Hydrographic Survey components) in a university or technological college anywhere in Canada. The Administrator of the Award program will determine the eligibility of the program.
2. The award will be available only to students who are in their second year of study in the degree or diploma program that conforms to the basic subject topic. The applicant will be required to submit a transcript of his/her first year marks at the time of application. The marks must indicate an upper level standing in the class and an average 70% in the subjects taken.
3. The award will be presented to an applicant who can demonstrate a bona fide financial need, coupled with an above average academic performance as stated above.
4. The value of the award is $2,000.
5. The Applicant will be required to write a short paragraph explaining his/her financial need in a clear, concise, manner on the application form.
6. The applicant must submit one letter of reference from an official of the university or college at which the applicant spent the previous year. This letter of reference must include the address and phone number of the official.
7. The award applications will be submitted to the Adminstrator of Canadian Hydrographic Association Award Program by the end of June to the following address:

   Barry M. Lusk, Manager
   Canadian Hydrographic Association Award Program
   4719 Amblewood Dr.
   Victoria, BC V8Y 2S2
   Phone: (250) 658-1836
8. Each year, in July, an individual, who meets the qualifications and deadline will be chosen from the list of applications received. The award will be given to the successful applicant during the first week of August so that he/she may reasonably plan their next financial school year.
9. The successful applicant will be issued with a special Canadian Hydrographic Association certificate, duly framed, at the time the award is made. A duplicate certificate will be hung in the CHA offices.
10. The successful applicant's letter of appreciation will be published in our next issue of our professional journal "Lighthouse".
11. An individual student may receive the award once only.

Critères d'admissibilité:

1. Le candidat doit être un étudiant inscrit à temps complet dans une université ou un collège canadien à un programme de sciences qui inclut les systèmes d'information géoréférencée, les levés hydrographiques ou terrestres. L'administrateur de la bourse déterminera l'éligibilité du programme d'études.
2. La bourse s'adresse aux étudiants qui seront à leur deuxième année d'étude respectant les sujets de base. Le candidat doit soumettre une copie de son relevé de notes de sa première année avec sa demande. Les notes doivent être supérieures à la moyenne et avoir une moyenne de 70 % dans les sujets suivis.
3. La bourse est remise au candidat qui, de bonne foi, démontre des besoins financiers et qui respecte les performances académiques exigées ci-haut.
4. La valeur de la bourse est de 2000 $.
5. Le candidat doit écrire un court texte, clair et concis, décrivant ses besoins financiers sur le formulaire de la demande.
6. Le candidat doit soumettre une lettre de référence d'un officiel de l'université ou du collège où il a suivi son cours. Cette lettre de référence doit inclure l'adresse et le numéro de téléphone de l'officiel.
7. Les demandes doivent être soumise à l'administrateur de la bourse Association canadienne d'hydrographie pour la fin du mois de juin à l'adresse suivante:

   Barry M. Lusk, Administrateur
   Bourse Association canadienne d'hydrographie
   4719 Amblewood Dr.
   Victoria (Colombie-Britannique) V8Y 2S2
   Téléphone: (250) 658-1836
8. Le récipiendaire est déterminé en juillet parmi les demandes reçues qui rencontrent les exigences et les délais. La bourse est remise durant le première semaine d'août afin de permettre au récipiendaire de planifier financièrement son année scolaire.
9. Le récipiendaire reçoit un certificat encadré de l'Association canadienne d'hydrographie dont un duplicata est suspendu à leur bureau.
10. Une lettre d'appréciation du récipiendaire est publiée dans l'édition suivante de notre revue professionnel "Lighthouse".
11. L'étudiant récipiendaire peut recevoir la bourse qu'une seule fois.

Canadian Hydrographic Association News
Nouvelles du service hydrographique du Canada

Le Gardien Des Altitudes

Ce n'est pas d'hier que Pointe-au-Père est reconnu comme un site d'importance au Canada. Au milieu du 19e siècle, un premier phare a été érigé et le phare actuel est classé monument historique depuis 1976 par la Commission des lieux et monuments historiques du Canada. La station de pilotage de Pointe-au-Père, établie au début du 20e siècle, était sur la route des transatlantiques.

Peu de personnes connaissent l'existence du marégraphe de Pointe-au-Père et du rôle important qu'il a joué au Canada et en Amérique du Nord du point de vue géodésique. Peut être parce qu'il n'était pas très spectaculaire, qu'il était discret et faisait un travail continu, tout seul dans un petit hangar sur le quai.

Le marégraphe de Pointe-au-Père

La station marégraphique de Pointe-au-Père a été installée à la fin du 19e siècle, tout près du premier phare, par le Service hydrographique du Canada. Là, comme à bien des endroits au pays, il y avait un besoin de mesurer les marées pour pouvoir les prédire.

L'hydrographe utilise le zéro des cartes pour représenter les fonds marins sur les cartes marines. Il s'agit là du niveau au-dessous duquel l'eau des mers ne descend pratiquement jamais. Le zéro des cartes est obtenu à la suite de calculs basés sur des observations systématiques durant une assez longue période.

Il est essentiel de connaître et de contrôler précisément l'altitude du marégraphe pendant toute la période qu'il est en fonction. Aucun de ces appareils ne pourrait fournir des mesures valables et précises sans les référer à un réseau local de repères de nivellement pour s'assurer de la stabilité du site.

Pointe-au-Père, une référence géodésique canadienne

Au début du 20e siècle, il existe plusieurs réseaux verticaux gérés par différentes autorités locales et dont les données varient en exactitude et en précision. Afin de remédier à ce manque d'uniformité, les Levés géodésiques du Canada décident d'établir un seul réseau à partir de ces réseaux locaux. Les assises de ce réseau national sont basées sur les marées enregistrées aux marégraphes d'Halifax et de Yartmouth, sur l'océan Atlantique, de Vancouver et de Prince-Rupert, sur l'océan Pacifique, de Pointe-au-Père pour le Saint-Laurent ainsi qu'à une altitude standard à Rouses Point (É-U) sur les rives du lac Champlain à la frontière canado-américaine pour ainsi établir la Référence Géodésique Altimétrique Canadienne ou le « Canadian Geodetic Vertical Datum de 1928 (CGVD28) » aussi connu sous le nom populaire de niveau moyen des mers. Le CGVD28 est le premier réseau altimétrique précis utilisé sur l'ensemble du Canada.

The Guardian of Elevations

The recognition of Pointe-au-Père as an important site in Canada dates well back in time. The first lighthouse on the site was built in the middle of the 19th century, and the actual lighthouse has been declared, since 1976, a national historical site by the Historical Sites and Monuments Commission. The Pointe-au-Père Pilot Station, established in the early 20th century, was one of the major crossroads on the transatlantic route.

Few people know of the existence of the Pointe-au-Père tide gauge and the role it played in Canada and North America from a geodetic point of view. Perhaps this is due to the fact that this device did not look very spectacular. Or perhaps it is because it carried out its function continuously in silence, all by itself in a small shelter on the jetty.

The Pointe-au-Père tide gauge

The Pointe-au-Père tide gauge was first installed at the end of the 19th century, next to the first lighthouse, by the Canadian Hydrographic Service. At this location, as with numerous others across the country, there was a need to establish the amplitude of tides in order to accurately forecast tides in the future.

The hydrographer uses a reference level called chart datum to represent the reference elevation on marine charts. This level is chosen because the waters of the sea seldom fall below it. Chart datum is obtained from calculations based on systematic water level observations over a fairly long period of time.

It is essential to know and control the exact elevation of the tide gauge for the whole period it is operational. Not one of these instruments could give useful and precise measurements if these measurements were not referred to a local network of benchmarks used to control the stability of the site.

Pointe-au-Père as a Canadian geodetic reference

At the turn of the 20th century, there were a fair number of tidal measuring stations established all over Canada, linked to local vertical reference systems and supervised by various local authorities. The results obtained by these stations varied in accuracy. To overcome this lack of uniformity, the Geodetic Survey of Canada decided to establish one single network from all these privately owned stations. The framework for this national network is based on tidal water level records, from Halifax and Yarmouth on the shores of the Atlantic Ocean, Vancouver and Prince-Rupert on the shores of the Pacific Ocean, and the one installed at Pointe-au-Père, on the shores of the St. Lawrence River as well as a standard elevation at Rouses Point (USA) on the shores of Lake Champlain, on the Canada-United States International Boundary. The result was the establishment of the Canadian Geodetic

Pointe-au-Père, une référence internationale

Il faut adopter, avant l'ouverture de la voie maritime du Saint-Laurent en 1959, des références et des méthodes de calcul communes et uniformes pour qu'un navire, quel que soit son pays d'origine, puisse naviguer en toute sécurité le long du littoral canadien jusqu'au plus éloigné des Grands Lacs en plein coeur du territoire américain. La station marégraphique de Pointe-au-Père est choisie comme origine de la Référence internationale des Grands Lacs de 1955 (RIGL 1955) à cause de sa situation géographique, de la qualité et de la longueur disponible de ses enregistrements de la marée.

Le RIGL 1955 est entré en fonction le 1er janvier 1962. Pendant 30 ans, ce système de référence servira de base pour la régularisation des niveaux d'eau du système Grands Lacs/Saint-Laurent afin de protéger les intérêts des propriétaires riverains, de la navigation de plaisance et de la navigation marchande. Le nouveau Système de Référence International des Grands Lacs 1985 (SRIGL 1985) est adopté tant par le Canada que par les États-Unis et entre en fonction en janvier 1992 et dont les assises proviennent des données enregistrées aux marégraphes de Pointe-au-Père et de Rimouski-Est.

Pointe-au-Père, une référence nord-américaine

Les mouvements de la croûte terrestre, l'avènement du positionnement précis par satellites, tel le GPS, et l'amélioration des instruments de mesure verticale ont démontré que des écarts s'étaient introduits au fil des ans dans la référence verticale établie en 1928. Au cours des années 1980, le Canada et les États-Unis ont refait une compensation du réseau vertical pour tout l'Amérique du Nord. Les résultats obtenus forment le « North American Vertical Datum de 1988 (NAVD88) » et repose sur le niveau moyen de l'eau observé à un seul marégraphe, soit celui de Pointe-au-Père! Il va sans dire qu'une telle révision a des impacts dans plusieurs champs d'activités et qu'ils doivent être mesurés avant que le Canada adopte définitivement le NAVD88. Par contre, les États-Unis utilisent le NAVD88 depuis le début des années 1990 pour exécuter et référer leurs travaux géodésiques.

Un caractère unique

Lorsque le marégraphe de Pointe-au-Père est installé pour la première fois, il ne s'agit pas d'un événement historique en soi. À la même époque, d'autres appareils sont installés un peu partout le long des côtes canadiennes. C'est sa longévité et l'usage qui en est fait qui lui donne son caractère unique et historique.

Aujourd'hui, le quai est en ruine et

From left to right: Ed McKay (NGS), Jean-Marie Gervais (ACH / CHA), Marc Journault (SHC / CHS), André Mainville (DLG / DSD), Yves Thériault (SGQ), Rock Santerre (UL) et Bernard Labrecque (ACH / CHA).

Vertical Datum of 1928 (CGVD28) otherwise known as Mean Sea Level. The CGVD28 is the first precise altimetric network used across Canada.

Pointe-au-Père as an international reference station

Prior to the opening of the St. Lawrence Seaway in 1959, an agreement had to be reached on common reference points and methods of calculation in order to allow all vessels, regardless of their origin, to navigate safely along Canada's shoreline to the furthest point of the Great Lakes in the heart of North America. The Pointe-au-Père tide gauge station was chosen as the reference station for the 1955 International Great Lakes Datum (IGLD 1955) because of its geographical location and because of its accurate long term tidal observations.

On January 1st 1962 the IGLD 1955 became functional. This datum was in effect for the following 30 years serving as the reference to regulate the water levels in the Great Lakes system in order to protect the interests of the shore owners, the commercial mariners and pleasure craft boaters. The new International Great Lakes Datum 1985 (IGLD 1985) was adopted both by Canada and the United States of America and came into effect in January 1992. This new datum was established from data collected from the Pointe-au-Père and Rimouski-East tide gauges.

Pointe-au-Père a NorthAmerican Reference

Movement of the earth's crust, the advent of more precise positioning using satellite systems such as GPS and improvements in surveying instruments, proved that there were deviations in the vertical reference established in 1928. In the 1980s, Canada and the United States of America readjusted the benchmark network thus obtaining new elevations. The result was the establishment of the 1988 North American Vertical Datum (NAVD88) based on tidal information from a single tide gauge, the one in Pointe-au-Père! Needless to say that such a revision has had a certain impact in many fields of activity that must be measured before Canada definitely adopts the NAVD88. However the United States have been using the NAVD88 since the early 1990s as the reference for their geodetic work.

A unique character

When the first tide gauge was installed in Pointe-au-Père, no one thought of it as a historically significant event. During that period, a number of similar devices were installed at different locations along the Canadian coast. The historical significance of this station lies in its la station de pilotage est fermée. Le phare est éteint et les maisons et les dépendances sont devenues les composantes d'un musée et d'un site touristique. La station marégraphique de Pointe-au-Père est fermée depuis 1983 mais les repères de nivellement la contrôlant ne sont pas tous détruits mais pour combien de temps encore?

Le Gardien des Altitudes

En 1999, l'Association canadienne d'hydrographie, Section du Québec, a décidé de commémorer et de perpétuer l'importance des repères de nivellement servant à contrôler la stabilité du marégraphe de Pointe-au-Père et la qualité de ses enregistrements. Ces repères ont servi d'assise à plusieurs réseaux altimétriques canadiens et nord-américains. C'est pour cette raison qu'une borne interprétative et qu'un monument appelé « le Gardien des altitudes » ont été érigés à proximité du Musée de la mer de Pointe-au-Père et peuvent être visités par tous.

POSITION (NAD83) : 9929000

LATITUDE :	48° 31' 00.6" N
LONGITUDE :	68° 28' 10.0" W

ALTITUDE : 99L9000 Zéro des cartes marines : 7,15 m

Niveau moyen des mers (CGVD28) :	4,86 m
SRIGL 1985 :	4,87 m
Géodésique (NAD83) :	-20.99 m

Les partenaires du Gardien des Altitudes sont :

L'Association canadienne d'hydrographie (ACH/CHA)
Les Levés géodésiques du Canada
Le Service hydrographique du Canada (SCH/CHS)
Le Service de la géodésie du Québec
Le National Geodetic Survey des Etats-Unis
L'Université Laval, Département des sciences géomatiques (UL)
Services maritimes INFOMAR
La Garde côtière canadienne

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Young F. W., J. Murakami. 1989. *The North American Vertical Datum of 1988 (NAVD'88) internal status report prepared for CISM '88* Winnipeg, Manitoba May 24-27, 1988. **CISM Journal ACSGC**, Vol. 43, No 4: 387 - 393.

Comité de coordination des données hydrométriques et hydrologiques de base des Grands Lacs. 1992. **Brochure sur le système de référence international des Grands Lacs 1985**. 14p.

U.S. Army Corps of Engineers. 1994. Conversion to the North American Vertical Datum of 1988. Department of the Army, Lettre technique no ETL 1110-1-152.

longevity and the usefulness of the data obtained.

Today the wharf is in shambles and the pilot station is closed. The old lighthouse is extinguished and the annex is now a museum and tourist attraction. The Pointe-au-Père tidal station has been shut down since 1983 but the controlling benchmarks have not all been destroyed, but for how long?

The Guardian of Elevations

In 1999, the Canadian Hydrographic Association, Quebec Branch, decided to commemorate and perpetuate the importance of the benchmarks used to monitor the stability of the Pointe-au-Père tide gauge and the quality of its tidal measurements. It is for this reason that a commemorative monument and a benchmark named Guardian of Elevations have been established near the Musée de la mer museum and can be visited by all.

POSITION (NAD83) : 9929000

LATITUDE :	48° 31' 00.6" N
LONGITUDE :	68° 28' 10.0" W

ELEVATION : 99L9000 Chart Datum : 7,15 m

Mean Sea Level (CGVD28) :	4,86 m
IGLD 1985 :	4,87 m
Geodetic (NAD83) :	-20.99 m

The Guardian of Elevations partners are:

The Canadian Hydrographic Association (CHA/ACH)
The Geodetic Survey Division
The Canadian Hydrographic Service (CHS/SCH)
The Service de la géodésie du Québec
The National Geodetic Service of the United States
The Département de géomatique, Université Laval (UL)
The INFOMAR Marine Services Inc.
The Canadian Coast Guard

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The CHA Admiralty Launch Surveyor and the 250th Anniversary of the Founding of Halifax

by Dale Nicholson, Canadian Hydrographic Service, Atlantic Region

Central Branch's Heritage Launch Surveyor and several stalwarts of her hearty crew traveled to Halifax for a few days in June. They had been asked to take part in major re-enactment celebrations there.

Following the Aix-la-Chapelle Treaty of 1748, Louisbourg, then in the hands of New Englanders, was returned to the French. New England demanded that London reciprocate by establishing a major settlement to protect the colonies from their enemies. It was from these events that Edward Cornwallis and 3,000 settlers founded Halifax on 21 June 1749.

HMS Rose salutes Halifax

Today, the Halifax Regional Municipality with a population of over 330,000 has grown to be the economic and political centre of the Maritimes.

Two hundred and fifty years after the historic arrival of Cornwallis, Halifax again welcomed visitors ashore in longboats from a tall ship anchored in the harbour. On 26 June 1999, under threatening skies and before thousands of spectators, HMS Rose fired her guns to salute the shore and signal the longboats to approach and transport ashore the waiting dignitaries. Included among the settlers were politicians, soldiers, business-men and their families, as well as a few 'scurvy dogs,' all dressed in period costumes and ready to help the city celebrate the occasion.

Atlantic Crew: Left to Right. Elizabeth Crux (CHS), Don Nicholson (brother of Dale), Gerard Costello (CHS) and Dale Nicholson (CHS). Missing from photo: Mike Ruxton (CHS).

A major participant in the historic re-enactment was the Canadian Hydrographic Association's Admiralty Launch Surveyor, led by Coxswain Andrew Leyzack and crewed by members and friends of the CHA. The predominantly experienced souls of Central Branch were joined by a motley crew of Maritimers, pressed into service for the event.

From the base encampment on the Halifax Commons, the Surveyor crew joined hundreds of re-enactors making themselves available for the public and enjoying the many spectacles to be seen around the camp. Events at the site included a sham battle, an open-air concert and a seemingly endless supply of bagpipe music. Throughout the weekend, Surveyor's crew took advantage of the culinary delights provided by the Canadian Armed Forces (imagine Horatio Hornblower and company guest starring on M*A*S*H* and you will get the picture) while occasionally venturing out to enjoy the more modern aspects of downtown Halifax.

Saturday brought the greatest challenge to the Surveyor as she was called into service before the waiting public. In customary style, Surveyor and crew carried her assigned passengers safely to shore, stopping for a traditional 'oar salute' that was received with spontaneous applause from the crowd. The crew joined all the re-enactors in a march to Halifax's Grand Parade where a flag raising ceremony and musket volley enthralled the many spectators.

Besides the Maritime contingent, Surveyor's crew included Brian (CHS/CHA) and Jason Power, John Dixon (CHS/CHA), Heimo Duller (CHA), Andrew Leyzack (CHS/CHA), Jackie Miles (DFO/CHA), Fred Oliff (CHS/CHA), Bill (DOE/CHA) and Helen Warrender, Terese Herron (CHS/CHA), Shawn Cook (CCG), Louise Durham (CHA), and Jim Weedon (CHS/CHA).

Surveyor carries the new settlers ashore

With their major tasks completed, Surveyor's crew dismissed the offer of a tow by a more modern vessel, and made their way back across the harbour, powered by the oarsmen and fueled by a jug of grog (with a critical ingredient supplied by a certain unnamed CHS Atlantic Director).

On Sunday, all re-enactors were invited to a luncheon on the grounds of Governor's House, where medals were awarded to the leaders of each group, to be followed with individual medals for each person who participated. To top off the weekend, Surveyor's crew was invited aboard the HMS Rose for an afternoon sail. It was a beautiful sunny afternoon and some of the more adventurous souls took advantage of the opportunity to assist with the operation of the Rose, climbing the rigging to help stow the sails while transiting the Harbour. The expert guidance from Rose's crew made the event a thrilling, if slightly breathtaking experience.

For the Maritime participants, this was a rare opportunity to meet and share some time with colleagues and new friends from Central Branch of CHA and from Central and Arctic Region of CHS. Surveyor represents a proud heritage for hydrographers across Canada, and the chance to participate in such a unique and well-received event has created a lasting memory.

Ottawa Branch

We are happy to announce that The Ottawa Branch has been re-activated this year. We'd like to welcome our new crew heading things up. Dave Gray as Vice President, Ilona Monahan as Secretary and Jennifer Ross as Treasurer and Paul Holroyd as Director. Many thanks go to Marilyn Van Dusen, Sheila Acheson and Ralph Renaud for helping our new executive get things up and running. We now have 25 paid up members and are looking to recruit many more soon.

Thanks to our VP Dave Gray for the presentation of the A&E production "Longitude". The first of four lunch hour presentations was enjoyed during a pizza luncheon. This four part series tells the story of how John Harrison, in a life-long quest, solves the problem of determining longitude at sea and the story of Rupert Gould who discovers and restores Harrison's timepieces. This is a must see for anyone who missed it when it aired on television.

The Canadian Hydrographic Service held a successful golf tournament this year for which the Ottawa Branch of CHA was proud to donate prizes.

We enjoyed a large turn out for last years' Christmas party where we had the opportunity to get together with many members of the CHA. Planning is well under way for this year's party to which all are looking forward.

With the re-activation of the Ottawa Branch we're looking forward to many new endeavors.

We'd like to congratulate one of our members, LouAnne Szabo and her husband John on the arrival of their second child. Jake John Szabo was born Tuesday November 14, 2000 around 4:30 p.m. weighing in at 9lbs 9oz. Both are doing well. Congratulations LouAnne!!

Central Branch 1999

Evening Seminars

At the first meeting of 1999, Burlington canoeist Herb Pohl of the Wilderness Canoe Association, gave an enjoyable presentation of a solo canoe trip he took across the wilds of Labrador. The rugged beauty of the scenery as seen through the lens of his camera was breath-taking.

Dr. Walter Peace of the Geography Department at McMaster University in Hamilton was guest speaker at our second meeting. Dr. Peace presented an interesting talk regarding the controversial Hamilton Red Hill Creek Expressway. He covered a wide range of topics regarding this project ranging from the Paleo history of the valley to the recent urban/industrial expansion of the area only a generation ago occupied by farms.

At our third meeting Dr. Bob Bukata of the Aquatic Ecosystem Conservation Branch of the National Water Research Institute at Burlington engaged us in a frank, insightful and informative discussion regarding the many varied applications, advantages and shortcomings of different remote sensing technologies.

At the fourth meeting Captain Fernando de Santos presented some rather interesting and little known facts and stories behind one of this millennium's misunderstood characters, Cristofer Columbo or Christopher Columbus, if you prefer. North American history books paint a completely different picture of this person than do the texts of Europe.

George Drought was our guest speaker for the fifth and last meeting of 1999. Mr. Drought, local canoe guide and professional videographer, showed "soon-to-be-released to the public" footage of trips he has led down the historic Hood River in Canada's newest territory, Nunavut. A discussion followed regarding the controversial topics of land stewardship and environmental responsibility.

Annual General Meeting

The 10th Annual General Meeting and Dinner of the Branch was once again held at the Mimico Cruising Club in Etobicoke. Our guest speaker Corporal Kenneth Burton , Royal Canadian Mounted Police, spoke to us about the millennium celebration "A Voyage of Rediscovery". At 5 p.m. July 1, 2000 the RCMP coastal patrol vessel NADON will leave Vancouver, B.C., to begin a six months and 22,000 nautical mile voyage through the Northwest passage and circumnavigation of North America. The NADON voyage is a recreation of the ST. ROCH's historic voyages through the Northwest passage in 1940-42 under the command of Henry Larsen.

At the meeting 2000 Central Branch Executive were announced as follows:

Vice President - Andrew Leyzack
Secretary - Tim Janzen
Treasurer - Sam Weller

Executive Members - Dan Brousseau, Earl Brown, John Dixon, Sean Hinds and Mike Marsden.

BBQ

The 1999 BBQ took place on July 24th at the Herron/Cook residence in Dundas. The event was deemed a success and was heralded by a sunny, albeit very hot day. Some attendees beat the heat by staying under the cover of shade trees, while others (mainly the children) chose to dunk their heads in an apple

Some of the 30 participants Chase the Shade...

bobbing barrel. Throughout the day, the occasional game of boccie broke out , eating and socializing ran rampant, and fun was had by all.

H2O

The 28th Annual H2O bonspiel took place at the Grimsby Curling Club, Grimsby, Ontario, on February 27, 1999. Forty-eight curlers participated. The winning rink for the first place trophy was Brian Power and his team of Jane Bedford, Mel Webber, and Jason Power. Our congratulations are extended to the winners and our thanks to all participants.

The Bonspiel committee, on behalf of all participating curlers, extends sincere thanks the following sponsors:

- Devel-Tech Inc., Saskatoon, Sask.
- GeoNet Technologies Inc., Central Bedeque, P.E.I.
- Kev-Tech Associates, Bolton, Ont.
- KNUDSEN Engineering Ltd., Perth, Ont.
- Kongsberg Simrad Mesotech Ltd., Dartmouth, N.S.
- McQUEST Marine Sciences Ltd., Burlington, Ont.
- Offshore Systems International Ltd., North Vancouver, B.C.
- Universal Systems Ltd., Fredericton, N.B.

Membership

Central Branch welcomes several new members this year: Peter C. Bloté, Roger Cameron, Mina Foroutan, Bill Gray, Robert Hinchley, Alberto Almeida Lee and Boyd Thorson. Membership to date stands at 76 Central Branch Members including Kongsberg Simrad Mesotech Ltd. and NovAtel Inc. our two Sustaining Members.

International Members

The Central Branch administers International Members on behalf of the National Office. The International Membership Committee helps maintain contact with the Non-Canadian Members and ensures that they have an opportunity to voice opinions and take part in CHA activities. All International Members receive the Central Branch Newsletter to keep in touch between issues of Lighthouse. We welcome one new International Member: James P. Detar with C-MAP, Italy.

Newsletter

The Branch publishes a regular newsletter. It goes out as soon as possible after each business meeting to distribute minutes and news of coming events. Including the December issue, we will have had seven newsletters in 1999. Our special thanks go to Commander Larry Robbins, RNZN, who is our regular International Columnist, and to the others who have contributed special articles this year. The newsletter offers a forum for the news and views of our members, and Larry's column helps our International Members keep in touch and, incidentally, helps to remind us of the special strengths they bring to the CHA.

Web Site

Central Branch maintains a web site with the newsletters and lists of Central Branch Executive members, Committee members and the membership. It also provides links to members, information on Lighthouse abstracts and awards offered by CHA. All comments, suggestions and submissions are welcome to help build a more exciting site.

Heritage Launch

During 1999 the Admiralty Launch Surveyor and her crew enjoyed an eventful season which began on June 15 with a fundraiser launch-time BBQ on the front lawn of the Canada Centre for Inland Waters in Burlington. Later that month, the Launch and crew made their way east to help celebrate the 250th Anniversary of the founding of Halifax, Nova Scotia on the weekend of June 25th-27th. Over the August 1st long weekend, Surveyor took part in the Georgian Bay sailing Regatta at the towns of Thornbury and Meaford, Ontario. Despite heavy weather at Meaford, perseverance (and extra rum rations) helped get the Launch and her crew back to Thornbury on schedule to assist with the public unveiling of the much awaited chart 2283, Nottawasaga Bay. The opening of the International Cartographic Conference in Ottawa set the stage for Surveyor's next engagement, August 16-18th. In keeping with the conference's theme, Touch the past, visualize the future, a static display and hydrographic demonstration was given on the Rideau Canal where apparently, the rowing exercises were a real hit with the Asian delegates! On August 22nd a static display was given at the town of Grimsby's Festival of the Forty. Here the Surveyor helped identify Grimsby's role in repelling the last of the American troops in the wake of the Battle of Stoney Creek, 1813. The sailing season came to a close in October at the Faire at the Forks in Chatham, Ontario. Education day at this recreation of an 19th C Faire provided an opportunity for us to show elementary school children what hydrography was all about.

Through reenactments, the concept of living history is becoming alive and forward-thinking museums and historical organizations are beginning to embrace the merits of living history. Although many of these events tend to be driven by military or naval history, we are proud to say that through our participation we've been able to demonstrate to the public the role hydrography has played in our maritime heritage and in the development of our country. This was a particularly good year with respect to the number of people we were able to bring aboard even for a short visit. To our members, we encourage you to come out and visit us, you're always welcome aboard.

CHA Admiralty Launch Surveyor Simcoe Weekend at Toronto

The following letter was written to our carpenter, Mr. Harry Needham, recently retired from the Canadian War Museum in Ottawa. Our Surveyor encampment on Toronto Islands, August 1998 inspired this letter:

Dear Mr. Needham:

This past weekend I had taken the ferry over to the Toronto Island for a bit of relaxation as has been my habit for a number of years now. Imagine my surprise as I neared Snake Island (my favourite spot) to see an encampment of tents. My first thought was that they belonged to some outdoor group. My initial surprise turned to instantaneous delight when I realized that this was a re-enactment of some sort. By the time I had made my way over the bridge, lo and behold didn't a small craft appear fully loaded with rowers etc. and flying the Union Jack. What a stroke of luck and me without my bloody camera. Damn.

After watching the crew put the vessel through her maneuvers, I made my way over the bridge and into the camp where I was informed that, no - I had not travelled back in time but had stumbled onto the re-enactment of Lt. Joseph Bouchette's Hydrographic Survey of 1792. Bouchette and his party had indeed encamped on the island but as to the exact spot, it was never recorded. How bloody marvelous.

I had a wonderful time with the participants and promised I would be back amongst them the following day with my camera. The enclosed photos are the result of my return trip and are for your pleasure. The "Carpenter" told me to address the package to you c/o the War Museum and that you would be most appreciative in hearing about how much I had enjoyed this wonderful re-enactment of the founding of Toronto just a scant two hundred years ago.

Since I missed the "Surveyor" under sail with her crew in my photo session, would you be able to tell me where I could get copies of any to complete my set?

Let me end by saying thank you to all those involved in making this a most memorable Simcoe Holiday Weekend.

Yours, Gary Beecroft, Toronto.

Prairie Schooner Branch

KIS2001, The International Symposium on Kinematic Systems in Geodesy, Geomatics and Navigation will be held in Banff, Canada, during the period June 5 to 8, 2001. The symposium is organised by the Department of Geomatics Engineering of the University of Calgary. The Convenors are Dr. Gérard Lachapelle (lachapel@geomatics.ucalgary.ca) and Dr. M. Elizabeth Cannon (cannon@geomatics.ucalgary.ca) and The Call for Papers is available on www.geomatics.ucalgary.ca/KIS2001.

The individual members continued to pursue their careers and personal lives in 2000.

John Brigden carried out a rig move in the spring, and in the summer worked offshore Newfoundland as a Nav QC on a seismic vessel.

Bruce Calderbank spent the spring and summer offshore Nova Scotia as a Nav QC on a couple of seismic vessels. Bruce continued his voluntary work as Chairman of the ACLS CPD Committee and as a member of the ACLS Offshore Issues Committee.

Elizabeth Cannon was inducted as a Fellow of the Canadian Academy of Engineering.

Fred Cheng stepped down as the Chair of the Professional Development Committee of the ALSA, but stay on as a member of the Committee. The ALS approved a voluntary CPD program at their AGM in April.

Mike Chorney continued on secondment to SOEP as the Offshore Logistics Co-ordinator on the Thebaud platform offshore Nova Scotia.

Gerard Lachapelle received the APEGGA Frank Spragins Technical Award in April.

Paul Sawyer will continue to work in Colombia until late September.

David Thomson continued expanding Challenger Surveys and Services, with work in Northern Alberta and elsewhere.

Wendy Watson became a proud mum in the spring and enjoyed some time at home.

Frank Wisker continued as the marketing representative for Ashtech.

Pacific Branch 1999

Pacific Branch Executive

Vice-President:	Doug Cartwright
Treasurer:	James Wilcox
Executive:	Carol Nowak, Alan Smickersgill, Allan Thorn, Brian Watt, & Brian Schofield
Past V-P:	Rob Hare

Lighthouse Committee

Everyone is concerned over the future of Lighthouse. A lively discussion regarding Lighthouse was raised at the 1999 branch AGM. A Pacific Branch Lighthouse committee has been initiated. The following outlines some concerns presented to the committee:

* What has the affect been on the advertisers? Sandilands

* What has been the affect on the overseas paid-up members? McCulloch

* Suggest hiring someone to look after it, rather than relying on volunteers. This will cost money.

* Suggest having a CHA web page instead of a high gloss magazine? Raymond

* Suggest having an Annual Technical Journal Review for hydrography and leave the social news and events to other timely mediums i.e. web page/Newsletter. Mortimer

* Look into subcontracting with Geomatica. Sandilands

Seminars

On Thursday May 6th, at Glen Meadows Golf and Country Club, the CHA Pacific Branch officially said goodbye to Bruce Johnson - as a part of CHS Pacific (still a CHA member though). Bruce has moved on to DFO Informatics. Bruce was lightly roasted before receiving a CHS plaque with crest and a CHA beer glass.

For the 2nd half of the May 6th function, Jim Galloway gave a multi-media presentation on the survey of proposed Pilot Marine Protected Areas at Race Rocks and Gabriola Passage. Data acquired included EM3000 MBES surveys, QTCView seabed classification, physical sampling, side-scan sonar imagery and underwater video from Coastal and Ocean Resources Inc.

On June 16th, 1999, Richard McKenzie gave an overview of the replica Bark Endeavour and its scheduled visit to Victoria during the summer of 1999. This presentation led to involvement by CHA members performing security watches during the Endeavour's visit to Victoria. (see attached report by Allan Schofield)

Doug Cartwright gave a noon hour slide show of his 1999 CHS/NOAA Exchange aboard the NOAA ship Rainier

Social Events

Thanks are again due to Quester Tangent Corporation for sponsoring the ice for the 12th annual C.H.A. H2O Bonspiel. The 1999 event took place at the Glen Meadows Golf and Country Club and saw a small but enthusiastic group of curlers testing their skills and muscles. First place team and winners of a fine bottle of red wine were Al and Sue Thorn, along with Alex and Ross Raymond. Winners of the turkey and pizza shootouts were Al Thorn and Clayton of the "Hare Curlers" respectively. Style points were also awarded to Knut Lyngberg and Al Smickersgill, the latter demonstrating in fine fashion that the ice is mightier than the head. Thanks again to all participants and we look forward to next year.

Summer BBQue was held Sept. 19, 1999 at IOS

Membership

66 total members (including 2 life members) and 2 Sustaining Members. An "Early Bird" due structure will start for 2001 as follows: Members have up to 3 months after the AGM to pay their annual dues. After that they are considered late and a fee of an additional $10.00 will be charged.

Pacific Branch Spring 2000

Pacific Branch Executive

Vice-President	James Wilcox
Secretary/Treasurer	Sherman Oraas
Executive:	Rob Hare, Alex Raymond, Brian Schofield, Al Thorn,
Past Vice-President	Doug Cartwright

C.S.S. Wm. J. Stewart Memorial Plaque

Pacific Branch has commissioned a plaque in memory of the CSS Wm. J. Stewart. This plaque will be mounted to the seawall with the "Parade of Ships" next to Captain Cook's statue, situated in front of the Empress Hotel in Victoria. The ship was based in the Harbour from 1932 until 1975. She contributed significantly to the exploration of the British Columbia coast, with the Hydrographic Surveys that she performed. The inscription reads " This plaque is dedicated to those who have served on the "Willie J" and to all who continue to chart the British Columbia coast". The Branch executive anticipates a dedication ceremony in the summer, at which we hope to see both the old timers and the "newbies" pay their respects and share a few memories.

Coincidentally, the Spring 2000 Edition of the Maritime Museum of British Columbia journal (Resolution) is dedicated to "Hydrography on Canada's West Coast" and contains an article titled "From a Different Age: the Wm. J. Stewart". Long-time Pacific Branch member, Sandy Sandilands, wrote this article that outlines the ship's history. The other articles contain stories from Cook & Vancouver up to a modern day summary about the CHS.

Recent Events

On the 26th of February, the 13th annual H20 bonspiel was held. There was a disappointing turnout this year with only 4 teams and we also saw the unfortunate end of Quester Tangent's active participation and sponsorship of the event. However, the team of Willie Rapatz, Marg Rapatz, Mike Bolton, and Barb Danbrook were victorious.

Doug Cartwright presented a slide show of his voyage on the Bark Endeavour on the 30th of March at the Maritime Museum of BC. About 30 people were in attendance in a very suitable maritime setting for such a presentation. Several attendees continued afterward to a social gathering at Swan's brewpub.

Visit of H.M. Bark Endeavour Replica to Victoria B.C., August 16-29, 1999

In 1786 James Cook of the Royal Navy set sail in H.M. Bark Endeavour on a voyage of exploration and scientific investigation. This voyage was of major importance in the fields of discovery, navigation and science. On this voyage Cook became the first captain to calculate his longitudinal position with accuracy, using a complex mathematical formula developed in the 1760's. He was also the first to reduce scurvy among his crew.

In 1987 the Australian National Maritime Museum put forward the idea of building a full-scale museum replica of Endeavour as the centrepiece of their floating collection. The Endeavour replica sailed from Fremantle, where she was built by the charitable trust H.M. Endeavour Foundation, in 1994.

After visiting Australian ports she toured New Zealand. Next was a tour of 16 British ports before sailing across the Atlantic, arriving in Palm Beach, Florida, in March 1998. A tour of eastern seaboard ports commenced and she visited Halifax in October of 1998. Throughout 1999 she visited the West Coast of North America before returning across the Pacific to Australia. Endeavour visited Victoria B.C in August of 1999.

The Endeavour's purpose is for education and it is planned that the ship will become a centre of excellence for marine studies. For more information visit the website. http://www.barkEndeavour.com.au/

After two days in Sooke B.C., Endeavour arrived in Victoria. The Exhibition received great public support since it began in Victoria. Over 130 volunteer guides took 700-900 people aboard for tours each day.

The Pacific Region of the Canadian Hydrographic Service and the Pacific Branch of the Canadian Hydrographic Association were actively involved in the Victoria visit of Endeavour. The CHS provided all the Canadian nautical charts, tide tables and Sailing Directions that Endeavour required for her visit to the surrounding waters. A presentation of a plaque representing the past and the present of charting in Canada was made on behalf of the CHS and CHA to the skipper. A CHS representative had the opportunity to sail on the Endeavour from Sooke to Victoria. The CHA arranged for three crews of volunteers to participate in the evening watchkeeping of Endeavour as well as daily tour guides.

During the watchkeeping, we were split into five groups of two. Each watch consisted of two hours. Our duties began by sweeping and swabbing the decks. The shipwright on board made sure we did this job to ensure the decks were kept moist. We had to ensure that a close eye was kept on all shore displays. This is because at previous, less distinguished locations, some of the props ended up in the drink by those who had imbibed in too much drink. It was this same group of people who forced us to check that all lines from the ship to the dock remained secure throughout the night. A close eye was kept on the zodiac along side the Endeavour as well. Each watch monitored the wind gauge and the tides. If either went outside of established safe parameters, the ship's crew was to be awakened to adjust the lines and the gangway. Each watch was also responsible for checking the level of water in the bilge and the temperature on the fridge and freezer. All this was done while quietly creeping around in dark cramped quarters, trying to avoid awakening the rest of the volunteers who were enjoying the chorus of a dozen snoring landlubbers. The headroom was as little as 4'7" in some areas so there were a few cracked skulls. After our watch we attempted to sleep in the hammocks slung fourteen inches away from each other as in Cook's day. It was cramped for twelve people. Imagine how pleasant it must have been for the 65 who slept in the same space for close to three years on the original Endeavour.

The tour guide portion of the volunteer work involved splitting into several groups. Each group went to key locations throughout the ship and shore. Stations were set up so the visitors could go through the ship in small groups of 10 to 15. At each station a volunteer would recite the information about the ship, memorized from que cards handed out earlier. The information we gave out ranged from the history of the original voyage to the dimensions of the ship, sails and rigging, to the exciting tales of the one handed cook and the seats of ease.

Everyone involved has had a great time participating. So much so, one CHA member (Doug Cartwright) joined the ship as a crewmember on the final leg of her voyage from Hawaii to New Zealand!

CHA members left to right: Doug Cartwright, Brian Port, Carol Nowak, Mike Alfawicki, Allan Smickersgill, David Elliot, Alan Schofield, and an Endeavour Marine.

INTERNATIONAL MEMBERS OF THE CANADIAN HYDROGRAPHIC ASSOCIATION

Membership in the Canadian Hydrographic Association is open to anyone interested in maintaining a link with hydrography in Canada. People who live or work in other countries or who are not conveniently located to existing

CHA branches can become international members with the same rights and privileges as other members.

As authorized under the CHA by-laws, the National President has arranged for Central Branch to continue administering the International section of the CHA membership. Under this arrangement we endeavour to ensure that all international members receive the same level of service. International members may also join the branch of their choice.

International Membership is $30.00 (Canadian) per year, or the equivalent in Sterling or US currency. This includes a personal membership certificate suitable for framing along with annual update seals as well as copies of our journal Lighthouse each spring and fall.

Each internatioanl member also receives the Central Branch Newsletter. This helps our far-flung members keep in touch between issues of our journal and also offers a forum for members to share views and concerns.

Commander Larry Robbins of the Royal New Zealand Navy is our international correspondent for the Newsletter and writes a regular column with items of interest to international members. Drop snippets of news to him at: 42 Knights Rd., Rothesay Bay, Auckland 1310, New Zealand, Tel/Fax (+64) 9 410 2626. All scraps are very welcome! And if you have special news or views you are most welcome to write something longer for the newsletter or Lighthouse. Letters to the Editor are also welcome.

1999 International Members of the Canadian Hydrographic Association

Reha Metin Alkan	*Turkey*
Capt. F. Angelini (ItN)	*Italy*
Peter Barr	*Australia*
Geunter Bellach	*Thailand*
Fosco Bianchetti	*Italy*
Giuseppe Biscontin geom	*Italy*
Gary Chisholm	*New Zealand*
Luis Leal de Faria	*Portugal*
James P. Detar	*Italy*
Ron Dreyer	*West Indies*
Nick Emerson	*Hong Kong*
Randall J. Franchuk	*U.S.A.*
Ronald Furness	*Australia*
George Goldsteen	*Australia*
Adam J. Kerr	*United Kingdom*
Karl Kieninger	*U.S.A.*
Peter Knight	*New Zealand*
Universiti Teknologi Malaysia	*Malaysia*
Charles David Meador	*U.S.A.*
Rear Admiral Steve Ritchie (Retíd)	*Scotland*
Cdr. Larry Robbins	*New Zealand*
Reid Sandford III	*U.S.A.*
Paul Sanson	*France*
Kevin Smith	*New Zealand*

HINTS TO AUTHORS

Lighthouse publishes material covering all aspects of hydrography.
Authors submitting manuscripts should bear the following points in mind:

1. A hardcopy complete with graphics including tables, figures, graphs and photos.
2. Digital files, one with text only and a separate file for each graphic (tables, figures, photos, graphs) in its original form or in .tif or .pdf format. Black and white only. Photos may be submitted separately to be scanned. These may be submitted via E-mail or on CD ROM to the Editor.
3. Papers should be in either English or French and will be published without translation.
4. An abstract, information about the author(s) and contact information should be included.

The 1999 Annual General Meeting of the Canadian Hydrographic Association

19 January 2000 Teleconference call 12:00 PM EST

ATTENDANCE:

Pacific Branch: *C. Novak, D. Gartley, D. Cartwright, A. Raymond, & B. Schofield*

Prairie Schooner Branch: *B. Calderbank*

Central Branch: *S. Hinds, A. Leyzack, T. Janzen, B. Power & K. McMillan*

Ottawa Branch: *D. Gray, J. Ross, S. Acheson, M. VanDusen, & I. Monahan*

Quebec Branch: *B. Lebrecque e-mailed his regrets at not being able to attend the meeting.*

OPENING REMARKS

The National President, Ken McMillan welcomed everyone to the meeting and congratulated the Ottawa Branches new VP Dave Gray. Ken indicated that this was the 1999 AGM, which would receive the financial reports for 1998.

AGENDA

Item 1.

To receive the 1998, reports of the Directors

The national secretary/treasurer Brian Power indicated that all branches, active in 1999 had submitted written reports and audited financial statements for the year ending December 31st, 1998.

Prairie Schooner Branch: Bruce Calderbank presented the branch report and indicated that the dues for 2000 are in the mail.

Pacific Branch: Dave Gartley indicated that he did not have a copy of the 1998 branch report with him.

Brian offered to read the copy sent to him. One item in the branch's financial report drew some discussion that being the two bursaries that were set up with BCIT and UVIC from money given to the branch from the 1998 CHC. Ken McMillan commented that the awards presented a conflict with respect to the national student awards program managed by Barry Lusk . Ken indicated that the directors of the CHA should have jointly made a decision on the funds.

Doug Cartwright indicated that Pacific Branch had $115 in 1999 dues to forward to national.

Central Branch: Andrew Leyzack presented the 1998 branch report on behalf of Fred Oliff, past VP.

Quebec Branch: Bernard was not available to present the report. The report is in French and no one was on hand to translate it. Brian described the branch's initiative towards preserving the historical importance of Pointe au Père as the location of zero elevation used to establish the vertical datum in the St. Lawrence and Great Lakes. The branches project named "Gardien Des Altitudes", has built a monument commemorating this significant event in chart making history. The project will also include a display at the "Musée de la Mer".

Brian indicated that Quebec branch had not submitted their 1999 dues.

Ken thanked the branches for submitting their reports and financial statements.

Ken indicated that the student awards audited financial report had not been received and indicated the student awards account is at about $30,000 which is invested in a GIC, and accruing about $2,100 in interest.

Bruce (Prairie Schooner Branch) asked, how important this report was, what expenses were accrued and could the outstanding items be cleared up over the phone?

Brian explained that at the 1997AGM, the membership approved a motion to appoint auditors to review the financial records of the student awards program. At the same meeting a motion was carried appointing S. Weller and E. Lewis as the 1997 auditors of the student awards program.

Brian stated that Sam Weller had received a financial statement from Barry for the period January 1st, 1997 to July 20th, 1997. Sam replied to Barry requesting further information in order to complete an audit. Sam is away on holidays but a letter has been drafted to be placed on file with the national secretary/ treasurer and forwarded to all responsible parties, outlining the steps that were taken to fulfill his and Ed's obligation as auditor.

Discussion followed with respect to the need to follow up with Barry and have him submit a financial statement. Alex Raymond suggested that we thank Barry for the work he has done over the years, managing the awards and possibly consider alternate methods of managing the funds.

Currently the funds are invested in a Municipal Trust GIC in the name of the CHA.

Brian said that Barry has been doing a good job administering the award and should continue to do so, but stated there is a need for better records to be supplied to the auditors.

Sheila Acheson suggested that CIG might be another option to be investigated, as a means of managing the Student Awards program.

Action: Ken McMillan to contact Barry Lusk and request a financial statement

Item 2.

To accept the auditor's financial report for the year ending 31 December 1998.

Brian presented the audited statement of income and expense for the period ending December 31st, 1998, see attachment.

The balance forwarded from December 31st, 1997 was $27,065.99 and the account balance on December 31st, 1998 was $24,753.40.

Motion to accept the audited 1998 financial statement as presented.

Tim Janzen / Sean Hinds ***CARRIED***

Item 3.

Appointing auditors for the 1999 National Branch Account.

To vote on the motion to appoint Andrew Leyzack and Tim Janzen as the auditors for the 1999 National Branch account.

Motion: Bruce Calderbank / Doug Cartwright ***CARRIED***

Item 4.

Action item dealing with branch funds carried forward from the 1998 AGM.

Motion put forward by Dave Pugh and Dave Gartley: "Monies from a Branch which is No Longer Operational (defined as having failed to submit a completed financial report for the previous year due one month prior to the Annual General Meeting) shall be transferred to the National office.

These monies shall be held in trust in the original amount for the purpose of re-establishing the Branch when requested by a Branch Executive group in good standing. The amount of monies transferred must reflect the last audited financial statement.

Monies not returned after a period of ten (10) years shall default to the general operating fund of the national office."

Discussion- Sheila asked if this would immediately affect Ottawa Branch? Ken replied that the ruling would only come into effect after the proposal is accepted.

Bruce commented on the time of "one year period for the failure to submit" as a little harsh but recognized the need to deal with funds left in unused accounts. As well Bruce asked how do we enact this process. Ken replied that this should be the responsibility of the directors.

Sean asked how we would go about closing a Branch account? Both Ken and Sean suggested standardizing accounts and have the branch's banks forward a year-end statement to the National office.

Motion: Bruce Calderbank/ Doug Cartwright ***CARRIED***

Item 5.

Other Business

Andrew Leyzack stated that Central Branch had received a request from the Accounting and Administering Services for prove that we are a non-profit organization. Andrew had spoken with Dave Pugh, who suggested getting a business number. Andrew also indicated that the proof might exist in the "Branch's Letters of Incorporation" which he requested a copy. Sheila thought they may be filed away some where in Ottawa and would have a look. Sean recalled the process that was involved in becoming incorporated and listed some of the documents that should be in existence. Ken said he would ask Barry Lusk for more information.

Lighthouse: Andrew stated that he would like to see National Branch coordinate the branch's efforts on Lighthouse in order to get outstanding issues out for the CHS 2000 in Montreal. The question was asked if it would speed up the process if we changed the format to be a non-glossy newsletter style, to which Brian Schofield said that it probably would not and that the hold up right now was waiting for material from Terese. Brian said there has been considerable work done on editions 57 and 58.

Brian Power and Andrew said that Terese had the package of material ready and that it may have already been sent. Brian Schofield will get in contact with Terese by e-mail.

Andrew stressed the need for the National Branch to act as the overseer for Lighthouse, especially since Terese will be stepping down as editor when the outstanding issues are published.

Brian Schofield asked to have a Lighthouse meeting by all parties involved. Ken McMillan suggested that this be a special director's meeting to deal only with Lighthouse and be conducted by teleconference. Ken will contract Terese and the meeting will be scheduled for when she is available.

The 2000 AGM is scheduled to take place in Montreal, at CHS 2000, during the week of May 15-19th, 2000 The Quebec Branch will arrange the date, time and location for the meeting.

Brian reminded the Branch to submit their 1999 year end reports and financial statements as soon as possible.

Brian Power received a new paper article from Sean Hinds entitled Web sites help match students with scholarships and studies. This article mentions, that many students are often unaware of the sources of free money in bursaries, scholarships and awards that are available and points out that companies and organizations often do a poor job in marketing their programs. Sean Hinds felt that such a vehicle as this which aims at matching students to available money- would benefit the CHA's Student Awards program. The web site is www.studentshomepage.com.

Motion to adjourn meeting: Bruce Calderbank /Doug Cartwright

Meeting adjourned 13:30 PM

POSITIONING / EMPLACEMENTS

The acceptance and positioning of advertising material is under the sole jurisdiction of the publisher. However, requests for a specified position will be considered if the position premium of $25 has been included in the insertion order.

L'approbation et l'emplacement de l'annonce sont à la discrétion de l'éditeur. Cependant, toute demande d'emplacement spécifique sera considérée si une prime de 25 $ est ajoutée à la demande de parution.

MECHANICAL REQUIREMENTS EXIGENCES MÉCANIQUES

Advertising material must be supplied by the closing dates as camera-ready copy or film negatives (Colour ads must be film negatives). Copy preparation, including colour, bleed and photos will be charged at the printer's cost plus 10%. Proofs should be furnished with all ads.

Single-page inserts will be charged at a full page body rate. Material must be supplied by the client. Page size must co form to the single page insert trim size (below).

L'annonce publicitaire doit être un prêt à photographier ou sur film négatif (les couleurs supplémentaires doivent être sur film négatif) et être fournie aux dates de tombée. La préparation de copie couleur, à fond perdu et de photos sera chargée au tarif de l'imprimeur plus 10%. Les épreuves devraient être fournies avec tous les suppléments.

Les insertions d'une page seront chargées au tarif d'une pleine page. Le matériel devra être fourni par le client.

DIGITAL REQUIREMENTS EXIGENCES NUMÉRIQUES

Ad material may be submitted in digital form, if colour .tif format and if black and white .pdf format.

L'annonce publicitaire peut être soumis sous forme numérique en format .tif pour la couleur et en format .pdf pour le noir et blanc.

PUBLICATION SIZE DIMENSIONS DE LA PUBLICITÉ

Publication Trim Size/*Dimension de la revue:*	8.5"	x	11.0"
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or/*ou:*	3.375"	x	9.75"

PRINTING / IMPRESSION

Offset screened at 133 lines per inch.

Internégatif tramé à 133 lignes au pouce.

CLOSING DATES / DATE DE TOMBÉE

LIGHTHOUSE is published twice yearly in Spring and Fall. The closing dates are March 15th and October 15th respectively.

LIGHTHOUSE est publiée deux fois par année, au printemps et à l'automne. Les dates de tombée sont le 15 mars et le 15 octobre respectivement.

RATES / TARIFS

All rates are quoted in Canadian Funds. Sustaining Members receive a 10% discount.

Tous les tarifs sont en devises canadiennes. Les membres de soutien ont droit à un rabais de 10%.

	B &W/N & B	Colour/Couleur	
		Une/Spot*	Four/Quatre
Outside Back Cover *Couverture arrière*	NA/SO	NA/SO	$1025
Inside Cover *Couverture intérieure*	$300	$400	$825
Body, Full Page *Pleine page*	$275	$375	$675
Half Page *Demie-page*	$200	$300	$675
Single-page Insert *Insertion d'une page*	$275	$375	$675
Professional Card *Carte d'affaire*	$125	$225	NA/SO

*Spot Colour (Orange, Red, Blue)/Une couleur (orange, rouge, bleu)

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Advertisers will be protected at their contract rates for the term of their contracts up to one year. Cancellations are not accepted after closing date.

Les tarifs sont assurés aux termes des contrats publicitaires jusqu'à concurrence d'un an. Les annulations ne sont pas acceptées après la date de tombée.

All advertising material should be directed to:
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