

INVITATION TO TENDER

Acquisition and processing of multibeam and gravity data off South Greenland

(Open procedure)

1. Introduction

The Geological Survey of Denmark and Greenland (GEUS) intends to acquire and process multibeam and gravity data off South Greenland. Service providers are invited to submit tenders.

Bids shall be submitted in a sealed envelope, (1 original and 1 copies), prior to 12.00 hrs GMT-1, 22 April 2008.

Please note that funding for the above survey is provided by the Danish Finance Bill for 2008, which is expected to pass the Danish Parliament on 17 April 2008.

2. Services to be provided

2.1 Acquisition and processing of multibeam and gravity data

As part of activities in relation to the United Nations Convention on the Law of the Sea (UNCLOS) Article 76, GEUS intends to acquire multibeam and gravity data off South Greenland. The minimum survey will consist of 25 to 35 survey days. Map of the general survey area and a draft acquisition program is shown in figure 1, enclosure 1.

A detailed description of technical requirements for multibeam and gravity acquisition and processing is found in enclosure 2.

2.2 Time schedule

The work off South Greenland has to be carried out during the summer period and the best season is late June to early October. The data acquisition has to be completed during this period. Processing of Multibeam data shall be performed in succession with acquisition and start as soon as data are available.

Final processed multibeam data must be delivered to GEUS not later than November 30, 2008.

3. Minimum information requirements

3.1 Qualifications for multibeam and gravity

The following outlines and lists the subjects which are specified further in the tender documents:

- The service provider shall have extensive experience and proven competence in executing multibeam and gravity data acquisition and processing work in similar areas.
- The documentation to be submitted with the tender for the contract shall include:
 - organisation and resources including specialists;
 - qualifications of allocated personnel;
 - References from similar work undertaken as main contractor during the past 3 years, stating clients, locations, types of work, equipment and techniques employed and contract values. Provide for 3 of the listed contracts the names and addresses of the client and contact names, who may be approached for references;
 - personnel safety statistics for the past 3 years;
 - provide evidence/documentation of an implemented quality system according to ISO 9001, or equivalent;
 - provide evidence/documentation for an implemented environmental system according to ISO14001, or equivalent;
 - provide evidence/documentation for an implemented health and safety system;
 - Audited annual accounts for the past 3 years and information about turnover of services performed relating to seismic acquisition and/or processing.
 - declaration that the company does not have unpaid, due debts towards the Danish government or national governments in the country in which the company is situated
 - GEUS will exclude from the short-listing procedures any person or company who has unfulfilled obligations relating to the payment of taxes in excess of DKK 100,000. Reference is made to the Danish act on restrictions on debtors' eligibility to participate in public tender procedures (Act No. 1093 of 21 December 1984). The prospective tendered shall provide documentary evidence of his fulfilment of this eligibility criterion.

The contractor shall provide a complete survey system, including vessel, multibeam sonar system, gravity system, operators and engineers, on-board data processing and QC capability and ancillary office capacity to support the survey program.

The officer in charge shall hold an "IHO category A surveyors license" or equivalent. CV's from relevant personnel shall be included in the tender.

The contractor, in consultation with GEUS, will take responsibility for survey planning.

3.2 Proposal for scope of services and technical specifications

The scope of services is outlined in Enclosure 1 and the proposal shall include a description of project organisation including project management, co-ordination and communication, QC and safety management.

3.3 Compensations (Economical offers in DKK)

The economical compensation includes:

- Financial proposal for multibeam and gravity acquisition and processing.

The tender shall use the format in Enclosure 1 (Price quotation), to give a price quotation for the multibeam and gravity acquisition, based on the scope of services given in Enclosure 1.

Bids not complying with this format may be rejected.

3.4 Language, format, number of copies

The bid shall be submitted in English or in Danish in a sealed envelope as outlined in section 5.2 and 6.

4. Contract

A draft contract is enclosed as enclosure 3.

5. Deadline of tender

5.1 Deadline for supplementary information/questions

Any additional questions, request for supplementary information regarding the Tender Documents, and any reservations against the terms of agreement shall be addressed to the

Geological Survey of Denmark and Greenland (GEUS)
Øster Voldgade 10
DK-1350 Copenhagen K,
Denmark
Attn.: Christian Marcussen

By mail or by fax no. + 45 38 14 20 50 - being marked "URGENT - GEUS J. no. 0413-00117" or e-mail cma@geus.dk and received by GEUS prior to 12.00 hrs GMT-1 on 19 March 2008.

Not later than 26 March 2008 GEUS will answer the requests/questions in writing.

Requests/questions and answers will be forwarded to all tenders in an anonymous form together with any necessary clarifications or amendments to the Tender Documents caused by the requests/questions. Within the same time limit GEUS will decide to what extent any submitted reservations against the terms of agreement etc. can be accepted as general amendments to the Tender Documents.

It is assumed that adjustments to the Tender Documents based on the questions and opinions of the tenders will not be to such an extent that it implies a new tender announcement in the EU.

5.2 Deadline for receipt of tenders

The tender shall be sent by registered mail or courier in a sealed envelope (1 original and 2 copy) and shall be received by the Geological Survey of Denmark and Greenland prior to 12.00 hrs GMT-1 on 22 April 2008.

Tenders received later than the above-mentioned deadline will be rejected and returned unopened.

5.3 Duration of tender

Tenders may lapse after 3 months

6. Tender submission

The tender shall be marked: “Confidential, A76 – Multibeam tender, GEUS J. no. 0413-00156” and addressed to:

Geological Survey of Denmark and Greenland (GEUS)
Øster Voldgade 10
DK-1350 Copenhagen K,
Denmark
Attn.: Christian Marcussen

Tenders shall be submitted in (1 original and 1 copy). The language shall be English or Danish.

Attention is drawn to the fact that mail might be opened in the administration of GEUS, if the envelope is not marked as stated above. Tenders submitted by telex, fax or e-mail are not accepted.

7. Opening of tenders

Tenders will be opened in private and will take place immediately after time limit.

8. Tender evaluation

8.1 Criteria

The criteria for award of contract will be the economically most advantageous tender taking into account criteria listed in the tender documents.

Evaluation of tenders will be based on:

- Multibeam acquisition and processing and gravity acquisition based on a day rate.

8.2 Multibeam acquisition and processing and gravity acquisition.

A two-step approach to the evaluation will be used:

The first step concerns the general qualifications of the tendered. At least 4.0 points should be obtained in order to qualify for the second part of the evaluation.

Criteria I Multibeam and gravity	Weight %
Extensive experience and proven competence in Multibeam acquisition in similar areas	40
Organisation, management and resources including specialists	20
Qualifications of allocated personnel incl. Key personnel CV	20
QC, health and safety	20

The second step concerns an evaluation of the offer and the overall criteria: the economical most advantage tender.

Criteria II Multibeam and gravity	Weight %
Multibeam equipment	30
Gravity equipment	10
Cost	40
Capacity	10
Mobilisation/Demobilisation	10

8.3 Points

Points are given according to the scale below

Best possible	8 points
Very satisfactory	6 points
Satisfactory	4 points
Unsatisfactory	2 points
Evaluation not possible	0 point

Odd number points can be given. In the evaluation of the costs, the lowest bid is given 8 points. Higher bids are awarded points inversely proportional to the lowest bid (using two decimal points).

Points = $8 \times ((\text{lowest bid}) \text{ divided (by actual bid)})$

Example:

Lowest bid: 20 DKK

Actual bid: 22 DKK

Points = $8 \times (20:22) = 7,27$ points

GEUS will be free to accept offers on only one part of the service i.e. seismic acquisition or to reject all offers.

9.0 Award criteria

The final contract will, subject to GEUS' evaluation and decision, be awarded to the economically most advantageous tender representing value for money (highest number of points). GEUS reserves the right to choose freely between tenders differing less than 10 %.

10. Cancellation

GEUS reserves the right to cancel the tender.

10.1 Changes before deadline

GEUS will be free to change the offer in the period for tender and possibility to extend the tender period.

11. Expenditure

Participation in the tender is at the company's own risk and expense. GEUS accepts no liability whatsoever arising from participation in this tender.

12. Supplementary material:

Enclosure 1: Acquisition and processing of multibeam data off South Greenland: Technical requirements.

Enclosure 2: Draft Agreement: Acquisition and processing of Multibeam data off South Greenland

Enclosure 3: Specification of a multibeam survey off South Greenland

Enclosure 1:

Acquisition and Processing of multibeam and gravity data off South Greenland:

Technical requirements

Objectives

The Geological Survey of Denmark and Greenland (GEUS), on behalf of the Danish Government, intends to acquire and process multibeam and gravity data in specific regions on the continental margin and adjacent slope and rise off South Greenland, in order to obtain multibeam bathymetry and backscatter data. These data are required to support a potential claim for extended jurisdiction by Denmark under the United Nations Convention on the Law of the Sea (UNCLOS) Article 76. There is a requirement for collection and processing of high quality, multibeam data in water depths of approximately 1500 to 4000 meters off South Greenland, in order to precisely define the location of the foot of the slope as defined under Article 76.

Survey plan

Acquisition of both full-coverage and profile data are planned. A draft survey plan is shown in figure 1: Two adjacent lines have to be surveyed from a position following the continental slope as the first step in order to decide the exact location of the cross-lines. These two lines are in the following called the northern and southern line.

In addition to these lines cross-lines (cross-line 1 to 15) have to be surveyed. The exact location and direction will be decided based on the data collected on the northern and the southern line.

Data must be collected during transit between all survey lines as well as on transit after commencement of the cross-lines. Decision of the exact location of data collection on transit after the survey will be decided after the northern and the southern line and cross-lines 1-15 have been surveyed. Coordinates for the planned survey lines are listed in the attached txt-file.

Requirements

1. Provision of a survey vessel capable of acquiring deep-water multibeam swath bathymetry, multibeam sonar backscatter data and gravity data in the designated area off South Greenland. Accommodation should be provided for at least one representative from GEUS.
2. Provision of a hull mounted deep-water multibeam system(s) and topside electronics aboard the survey vessel. The multibeam system shall collect full-coverage bathymetry and backscatter and be optimized to work in depths between 1000 and 4000 meters. The multibeam package shall include:
 - differential GPS and navigation system.
 - vessel motion sensing system.
 - capability to collect and process data needed for water column speed of sound and refraction corrections. Capability to collect and process on-line sound speed corrections collected at transmit point.
 - the ability to process data underway and produce onboard plots suitable for real-time quality control.

3. The contractor will provide a complete survey system, including vessel, multibeam sonar system, operators and engineers, on-board data processing and QC capability and ancillary office capacity to support the survey program. The officer in charge will hold an IHO category A surveyors license or equivalent. CV's from relevant personnel will be included in the tender.

4. The contractor, in consultation with GEUS, will take responsibility for survey planning.

Deliverables

1. Raw data

All of the digital output from the multibeam sonar during data acquisition, and ancillary data not already integrated into the multibeam data stream including full orientation and position data, sound velocity profile information, tidal information and the integration parameters used including (but not limited to) installation offsets, misalignment angles and clock time differences. Positional information will include, at least: number and geometry of satellites used in position computations; age of pseudo-range corrections used in position computation, and; horizontal dilution of precision associated with each position computation. In addition to data provided with sonar data recordings, separate files containing the tide data and sound speed data applied to all multibeam soundings will also be provided. Tidal data will be supplied by GEUS prior to the survey. The data format and all data elements (e.g., date/time referenced to UTC, tide relative to MLWS to nearest cm, etc.) will be described.

2. Processed full density data.

Aboard ship, during the data acquisition phase, all the raw data, including multibeam and ancillary integrated sensors must be examined and errors removed. Data will be corrected for position, elevation, orientation, water column sound speed and refraction effects and provided in a cleaned fully integrated form. All soundings and ancillary raw and reduced data must be provided with quality flags, indicating whether the data has been rejected or deemed to be outside deliverable survey specifications. Cleaned, reduced data will be provided on appropriate media in FAU format (Appendix 1), WGS84/UTM zone 21.

3. Reduced data set.

A set of gridded data will be produced from the processed sounding data, from which two color-coded shaded relief maps will be delivered. The shaded relief models will be illuminated from orthogonal directions with a sun elevation no greater than 45 degrees. Data will be gridded at a grid size that is approximately twice the mean horizontal footprint of the beam at nadir (e.g., a 1.5 degree system at 1000 m would be gridded at ~50 m). This implies that the data set will be divided into regions of common depth and gridded at different scales depending on depth. The number of gridding regions will be determined in consultation with GEUS. Other representations that achieve the same resolution limits may also be acceptable. Gridded data will be delivered in digital files on appropriate media as both FAU grids and ASCII XYZ format.

4. Backscatter data

For all multibeam data, raw backscatter data and reduced estimates of the seabed backscatter strength will be provided. The methods used to reduce the backscatter data will be fully documented. Geo-referenced maps of backscatter shall be provided at same scale as shaded relief maps described above.

5. Gravity data

Gravity data shall be collected on all straight-line bathymetric tracks of at least 5 km length and constant speed. The raw marine gravity data shall be collected and stored at 10 sec intervals or less. The contractor shall provide GPS coordinates from the ship navigation system and bathymetric data depth vertically below ship extracted from multi-beam data at a similar interval for the processing of gravity data into marine free-air and Bouguer anomalies.

Processing of data will be done with zero-phase filtering, providing track no, UTC, latitude, longitude, filtered gravity, free-air anomalies (GRS80 ellipsoid) and marine Bouguer anomalies (standard density 2.67 g/cm³). A detailed processing report should include details on filtering and harbour gravity ties.

Gravity harbour ties are required at every port call. If interval between port call exceed approximately 14 days, GEUS may be willing to accept the substitution on one or more harbour ties with ties (cross-overs) with existing marine surveys, providing such surveys are recent (i.e., GPS navigation has been used), demonstrated to have an accuracy of 1.5 mgal r.m.s. or better, and a well-defined and well-described gravity reference system. It is up to the GEUS to verify the quality of such data, and GEUS will give its consent for the substitution of harbour ties in advance. GEUS will be willing to help in providing information on suitable tie-in data sources from the national Danish gravity data base.

6. Metadata shall be provided for all bathymetric, backscatter and gravity data files.

7. All data and digital plot files shall be provided on appropriate digital media in a completely documented format. The contractor shall also provide a detailed listing of all files submitted, their size, and format.

8. An interim report, including raw and processed data and draft colour shaded relief maps and backscatter maps, shall be delivered to GEUS within one week of completion of operations.

9. A final report documenting equipment, procedures and survey operations shall be delivered to GEUS within 60 days of the completion of the survey. This report will include a full description of the bathymetric data collection procedures as required under UNCLOS Article 76 and outlined in the Scientific and Technical Guidelines of the UN Commission on the Law of the Sea (http://www.un.org/Depts/los/clcs_new/commission_guidelines.htm) unless otherwise specified.

Survey specifications

1. The multibeam sonar will have an effective beam width of no greater than 2 degrees in both the along-track and cross-track directions and lateral coverage of at least 3 km for depths greater than 1000 m. Maximum cross-track swath opening angle ± 60 deg for bathymetric data. For backscatter data cross-track swath opening angle may be opened to ± 75 deg.

2. Depth errors (at the 95% confidence level) will be less than 1% of the observed water depth. The contractor will document the procedures used to assure that data meets these specifications as well as providing an error budget for the complete survey setup.

3. Prior to commencing operations, the contractor shall conduct system accuracy tests to quantify the accuracy, precision and alignment of the multibeam sonar system in water depths and conditions

equivalent to those found in the survey area. Testing shall include determination of residual biases in roll, pitch, heading and navigation timing error and transducer draft. A description of these values as well as the methodology used to determine these values will be delivered to GEUS.

4. Data from turns shall be excluded from the delivered products. Line numbers will be changed with each turn.

5. All depths shall be referenced to Mean Low Water Spring (MLWS).

6. Coordinated Universal Time (UTC) shall be used for all times recorded.

7. The sound speed profile in the survey areas must be measured and monitored at sufficient frequency and to an appropriate depth to assure that the bathymetric data provided meets the required depth accuracy specification. The sound speed profile should be determined with a calibrated system capable of measuring the speed of sound with errors no greater than 2 m/sec (at the 95% confidence level). A calibrated sound speed measuring system capable of measuring the sound-speed profile to at least 95% of the deepest anticipated depth in the survey area must be available, though collection of sound speed data to 95% of the full depth of the survey area shall only be required at beginning and end of the surveys. The on-line sound speed collected at transmit point shall be merged on time basis with the sound speed profile.

6. The draft, settlement and squat of the vessel will be measured, monitored, applied, and recorded with sufficient frequency to ensure that the bathymetric data provided meets the required depth accuracy specification

7. The system must be capable of achieving bottom coverage at all survey depths such that no less than 3 beam footprints, center-to-center fall within a lateral distance of 10% of the water depth in the along-track dimension. It is understood that occasionally there may be brief periods of data degradation that are too short to justify resurveying. Occasional gaps of up to 5 consecutive ping cycles will be acceptable.

8. Cross-lines will be run at a frequency determined by the contractor as a continuing check on data quality as indicated in enclosure 2. Tie lines must agree at the acceptable depth error level (1% of depth at 95% confidence level) to at least +/- 45 degrees from nadir. The full swath width to which the tie lines demonstrate that data collected meet or exceed the acceptable depth error (1% of depth at 95% confidence level) will be the swath width used to determine line spacing and overlap. The contractor will decide numbers of cross-lines to be run prior to the general survey lines.

9. Horizontal positioning of the vessel, as determined via differential GPS, should be accurate to within 5 meters (at 95% confidence) during all surveying. An integrated DGPS/motion sensor solution should be offered to help mitigate navigational problems arising from intermittent transmission of DGPS corrections. All positioning shall be referenced to the WGS84 Datum. The contractor must demonstrate the accuracy prior to the survey.

10. The gravity data should be collected with a marine gravimeter, e.g. Lacoste and Romberg or similar type, capable of providing gravity measurements at an accuracy better than 2 mgal r.m.s. ($1 \text{ mgal} = 10^{-5} \text{ m/s}^2$) after filtering. The filtering length (full width) will be no longer than 5 min. The drift of the gravimeter during marine observations will be less than 5 mgal/month. The contractor will indicate the performance and reliability of the proposed gravity survey system. In case of

shorter errors or gaps in the gravimetric data collection, while operating with multibeam bathymetry, GEUS will not request a resurvey. However, as overall objectives 95% of all planned bathymetric survey lines longer than 5 km must have useable gravity data.

The marine gravity measurements will be tied to harbour reference gravity points before and after the bathymetric/gravimetric survey, preferably in South Greenland (GEUS will provide the necessary information). If the tie-ins are more than 1 week prior or after the actual survey, the contractor will demonstrate the performance of the gravimeter to be sufficiently stable to give a bias accuracy of better than 2 mgal during the survey period. The gravity reference point values must be given in absolute gravity system or IGSN71. A land gravimeter will, if necessary, be used to tie into reference gravity points not immediately located at pier.

Scope of Work:

Acquisition of multibeam sonar data is required in the areas shown in Figure 1. Adjustments of the acquisition program can be expected.

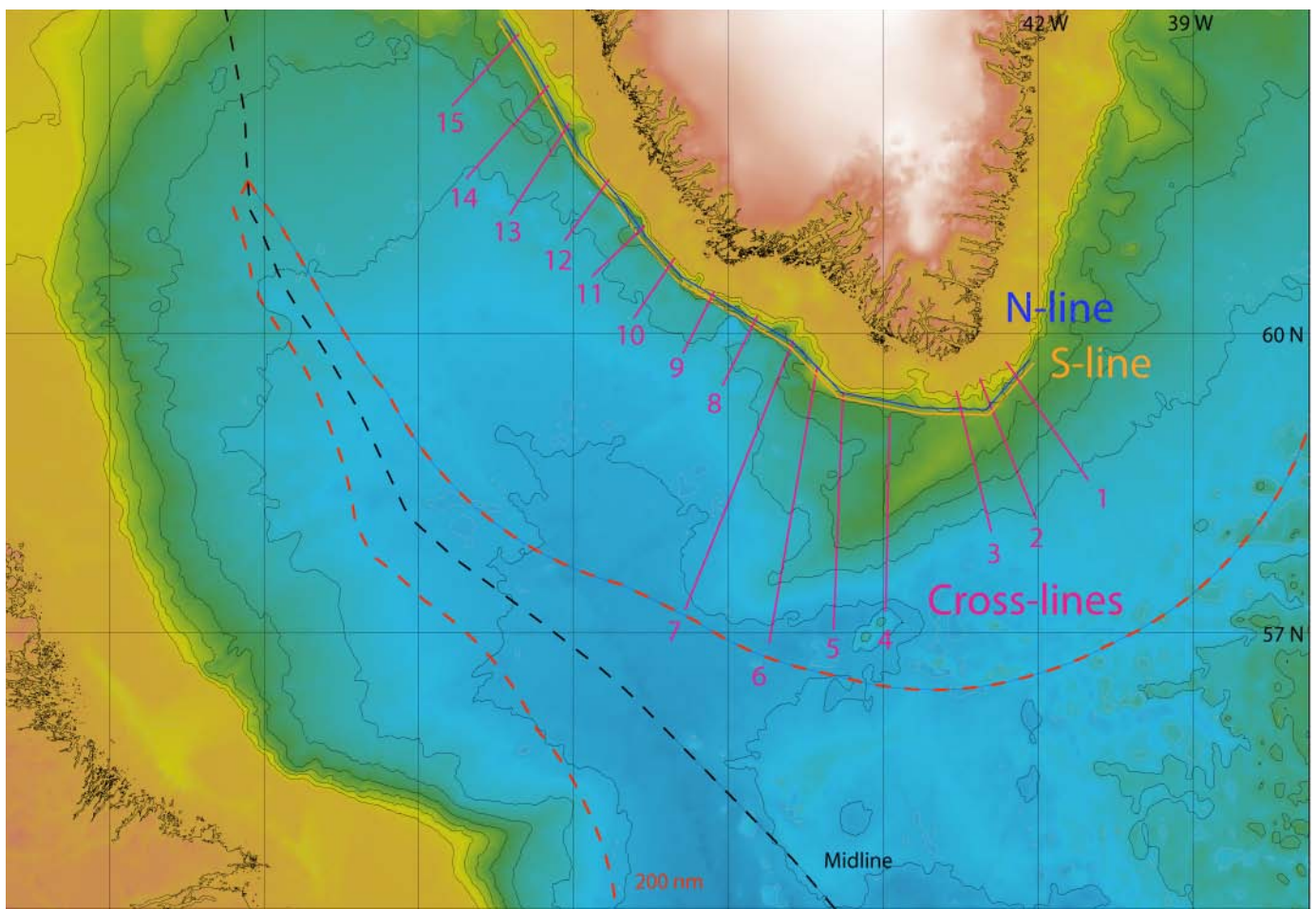


Figure 1. Survey area

Price quotations

The tenderer shall use the format below to give a price quotation for the multibeam acquisition, based on the scope of services given above. Bids not complying with this format may be rejected.

Multibeam data acquisition and processing pricing schedule:

Mob-/Demobilisation to the area of operations off South Greenland

Lump Sum DKK

Day rate:

Acquisition and processing of xx.xxx km² data off South Greenland

DKK/day

Standby

DKK/day

Gravity data acquisition pricing schedule:

Mob-/Demobilisation to the area of operations off South Greenland

Lump Sum DKK

Acquisition rate

DKK/day

Processing

DKK/km

Appendix 1

FAU Format

General comments to the format.

When data from the hydrographic survey is converted to FAU, it is vital for the further process that the structure in the observations is conserved, i.e. that there is a Survey data structure for each beam in each ping. If, during the conversion, some beam possibly cannot be assigned an observation, a substitute Survey data structure must be inserted at its place and its quality number must be set to 128.

The *int* and the *time_t* are 4 bytes long each; the *short* is 2 bytes and *char* 1 byte, each byte consisting of 8 bits.

Only quality values between 1 and 15 are valid quality indicators, the other bits in this byte are reserved for additional flagging. A precise description of the quality indicator values will be provided by GEUS.

The FAU data format is:

```
typedef struct {
int           N;           /* Northing of depth, in units of centimeter . */
int           E;           /* Easting of depth, in units of centimeter. */
int           depth;      /* observed depth in units of centimeter. */
time_t        sec;        /* UNIX time for the ping */
short         angle;      /* observed beam angle with respect to the Nadir, in units of 1/100 degree; */
char          heave;     /* observed heave for the beam, in units of 2cm */
char          roll;       /* observed roll for the beam: in units of 1/10 degree; */
unsigned char quality;    /* quality of the depth observation */
unsigned char amplitude; /* amplitude of the observation, not used for the moment */
char          pitch;      /* observed pitch for the beam in units of 1/10 degree */
unsigned char centisec;   /* fractional ping time in units of 1/100sec. to be appended to sec */
}Survey_data;
```

The only relevant quality allowed for flagging data is: "Deleted by the multibeam system".

```
#define ERRORBIT          128 /* 1000 xxxx set in quality field when obs. is deleted by the multibeam system */
```

Other quality values used by customer is:

```
#define MULTIPATH          144 /* 1001 xxxx set in quality field when a multiple path depth is identified */
#define UNVERMSP           160 /* 1010 xxxx bits for flagging observations by parameter settings for MapSpike */
#define ERRORSSP           192 /* 1100 xxxx bits for flagging observations by VISE */
```

Enclosure 2:

DRAFT

Agreement

Acquisition and processing of Multibeam data off South Greenland

With reference to your tender dated _____, we the Geological Survey of Denmark and Greenland (GEUS), hereby award you, _____, the subject contract (hereinafter referred to as “the contract”) on the following terms and conditions.

The contract is made by and between the following parties designated as “GEUS” and “contractor”:

GEUS: Geological Survey of Denmark and Greenland

Øster Voldgade 10, DK-1350 Copenhagen K, Denmark

Contractor: _____

Whereas GEUS desires that all services and/or works in connection with acquisition and processing of multibeam data (which services and/or works are more particularly described elsewhere within the contract documents referred to in article 2 hereof and are hereinafter called “the service”) should be executed. And whereas contractor represents it possesses all requisites necessary to perform the service diligently in accordance with current standards and practices of the industry and subject to the provisions of the contract documents.

Now therefore, in consideration of the mutual covenants and agreements hereinafter provided, it is hereby agreed as follows:

Art. 1 Words and expressions

In this agreement words and expressions have the same meanings as are respectively assigned to them in the general conditions.

Art. 2 Contract documents

The following documents shall be deemed to form and be read and construed as part of the contract:

- This agreement.

- Commercial section
 - General conditions
 - Special conditions
 - Appendix A – compensation

- Technical section
 - Appendix B – technical specification
 - Appendix C– quality and management systems specification
 - Appendix D – safety training and working environment
 - Appendix E – quality control specifications (to be included)

No change, amendment or other modification to or in any document or provision forming part of the contract shall be valid or effective unless produced in writing and signed on behalf of each of the parties hereto by its authorised officer(s).

Art. 3 Covenants for execution of the service

3.1. Contractor

In consideration of the payment to be made by GEUS to contractor, the contractor hereby covenants with GEUS to perform and complete the service in conformity in all respects with the provisions of the contract.

3.2. GEUS

GEUS hereby covenants to pay contractor in consideration of the performance of the service the compensations at the time(s) and in the manner prescribed by the contract.

Art. 4 Contract value

All contract rates of compensation and any other price(s) agreed upon by the parties include any charges and provisions necessary for the total completion of the service covered by the contract in a workmanlike and expeditious manner and in accordance with the contract documents, shall be

remunerative to, and shall cover all expenses and dues borne, or to be borne, by contractor together with all responsibilities that contractor has undertaken and any consequence deriving therefrom.

Art. 5 Articles which survive termination

The provisions of the contract, which by their nature survive final termination of the service, shall remain in full force and effect after such termination.

Art. 6 Effective date of contract

The contract is effective on when signed by both parties.

Art. 7 Acceptance

The parties hereto accept the terms and conditions contained herein, and agree to be bound by them, and the duly authorised representatives of the parties execute the contract below.

For and on behalf of GEUS

For and on behalf of contractor

Name:

Name:

Title:

Title:

Sign.:

Sign.:

Encl.: As cited in article 2.

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Commercial section

General conditions – acquisition and processing of multibeam data acquisition

Art. 1 Definitions and interpretation

For the purposes of the contract, and unless otherwise stated in the text, certain words and expressions used in the contract shall have the following meanings, it being understood that reference to the singular includes reference to the plural and vice versa.

1.1 Definitions

- 1.1.1 “GEUS” and “contractor” shall have the respective meanings ascribed to them in the agreement.
- 1.1.2 “The contract” shall mean the documents scheduled in article 2 of the agreement and any contract amendment(s) issued subsequent thereto.
- 1.1.3 “The contract price” shall mean any or all the amounts (as the context so admits) payable to or for the account of contractor for the satisfactory and proper performance by contractor of its obligations in accordance with the provisions of the contract.
- 1.1.4 “Affiliate” shall mean, in respect of any party.
- i) any company or other legal entity which is controlled by a party, or
 - ii) any company or other legal entity which directly or indirectly controls a party, or
 - iii) any company or other legal entity which is directly or indirectly controlled by any company or other legal entity which directly or indirectly controls a party.
- For the purpose of this definition “control” means the right to exercise the votes attaching to more than fifty percent (50%) of the issued equity shares of such company or other legal entity, or the right to appoint more than half the directors of such company or other legal entity.
- 1.1.5 “Area of operations” shall mean any location or area utilised in connection with the contract.
- 1.1.6 “Assignee” shall mean the entity, person or third party to which the contract may be assigned in the manner and to the extent permitted under the terms thereof.
- 1.1.7 “Effective date of contract” shall mean the date specified as such in the agreement.
- 1.1.8 “Equipment and/or materials” shall mean the equipment, machinery, instruments, tools, materials provided by contractor for the performance of the service.

- 1.1.9 “Force majeure” shall have the meaning ascribed to it in article 31 “force majeure”.
- 1.1.10 “Party” shall mean either GEUS or contractor and the plural of it means both of them.
- 1.1.11 “Representatives”:
Contractor's representative shall mean the person or persons notified to GEUS and authorised to act on contractor's behalf in matters relating to the contract all as specified in accordance with clause 9.1.
- GEUS's representative shall mean the person or persons designated by GEUS in the area of operations as specified in clause 9.2.
- 1.1.12 “Scope of contract” shall mean the activities designated in article 1 “scope of contract” of the special conditions.
- 1.1.13 “Sub-contract” shall mean any contract entered into between contractor and any third party in the manner and to the extent permitted under the terms of the contract hereunder contractor sub-contracts the performance of any part of the service and “to sub- contract” shall be construed accordingly.
- 1.1.14 “Sub-contractor” shall mean any company, corporation, firm, partnership or any combination thereof engaged directly or indirectly by contractor for the performance of the service or any part thereof.
- 1.1.15 “The service” shall mean all services and works to be provided by contractor under the contract, as more fully described in article “scope of contract” of the special conditions.
- 1.1.16 “Third parties” shall mean all parties other than the parties to the contract.
- 1.1.17 “Vessel” shall mean the survey vessel used by contractor, where applicable, in the performance of the service.

1.2 Interpretation

- 1.2.1 The contract constitutes the entire agreement between the parties with respect to the subject matter hereof and shall supersede and cancel all prior agreements or understandings, whether oral or written.

- 1.2.2 The headings of all sections of the contract are inserted for convenience of reference only and shall not affect the construction or interpretation of the contract.
- 1.2.3 If any provision of the contract is or becomes illegal, void or invalid, that shall not affect the legality and validity of the other provisions of the contract.
- 1.2.4 The contract shall also be for the benefit of and binding upon GEUS's and contractor's successors and assignees.
- 1.2.5 Unless specifically stated otherwise, all references to days and/or months shall mean calendar days and/or months, respectively, according to the Gregorian calendar.
- 1.2.6 Unless specifically stated otherwise in the contract, references in the general conditions or in the special conditions to numbers and letters designating articles and/or clauses and/or paragraphs relate only to the articles and/or clauses and/or paragraphs of the general conditions or the special conditions, respectively.

Art. 2 Contract duration and termination

2.1 Duration

The duration and any extension(s) of the contract shall be specified in the special conditions.

2.2 Termination procedure

Any termination shall become effective as of the date and in the manner specified in the notice of termination and shall be without prejudice to any claim, which GEUS may have against contractor.

On receipt of such notice contractor shall, unless otherwise directed by the notice of termination, immediately discontinue the service and/or the placing of orders in connection with the performance of the service and shall, if so requested, use any reasonable effort to cancel all existing commitments upon terms satisfactory to GEUS and shall thereafter perform only such portion(s) of the service as may be necessary to preserve and protect the part of the service being performed and to protect all contractor's or GEUS's goods located at contractor's base, or in transit thereto.

2.3 Early termination

- 2.3.1 GEUS in its sole discretion may terminate for any reason and at any time the contract by giving written notice thereof to contractor.
- 2.3.2 If the contract is terminated by GEUS pursuant to paragraph 2.3.1 above, contractor shall be entitled to the reimbursement of the costs of that portion of the service performed to the satisfaction of GEUS up the date of termination, evaluated at the rates and prices, if any, provided for in the contract. Such reimbursement shall include the cost of any goods already purchased by contractor in respect of the service and mobilisation as well as demobilisation expenses evaluated at the prices provided for in the contract.
- 2.3.3 Upon such termination and payment of sums due to contractor pursuant to paragraph 2.3.2, if any, title to and possession of all work, equipment and/or materials and supplies, incorporated or to be incorporated in, or documents related to, the service, shall pass to and vest in GEUS on a “where is, as is” basis. Excepted are data and work not accepted by GEUS in the sense that GEUS is refusing to pay for it. Contractor shall, if so required by GEUS, assign any of its sub-contracts to GEUS.

2.4 Right of cancellation

Without prejudice to the other provisions of the contract, GEUS shall be entitled to terminate the contract in the following cases:

- a) contractor has not commenced the service by the date provided for in the contract or has not completed it, due to causes attributable to contractor, within the agreed term;
- b) contractor refuses to perform the service in accordance with the terms and conditions set forth in the contract; in particular, contractor supplies personnel and/or equipment and/or materials not meeting the requirements indicated, or does not promptly replace malfunctioning equipment and/or materials or parts;
- c) contractor fails to substantially comply with its material obligations as set forth herein;
- d) contractor becomes insolvent, bankrupt or makes an assignment for the benefit of creditors; or a receiver is appointed for a substantial part of contractor's assets;

- e) contractor dissolves, liquidates or terminates its corporate existence other than by merger or reorganisation into an affiliate; or an order is made by a court or an effective resolution is passed for the dissolution, liquidation or winding up of contractor;
- f) contractor assigns the contract to third parties or sub-contracts the service without GEUS's prior written consent;
- g) contractor fails to comply with current legislation relating to insurance, salaries, wages and social security contributions for its personnel and safety legislation;
- h) contractor makes variation(s) to the scope of contract, without GEUS's written approval and/or authorisation;
- i) contractor suspends the performance of the service in the event of legal disputes;
- j) contractor fails to meet the quality requirements during the execution of the service and such failure has significant effect on data quality;
- k) force majeure events persist for a period in excess of ten (10) days;
- l) in case of irregularity of contractor's administrative and/or legal position.

2.5 If GEUS considers that one of the aforesaid causes of termination exists, it may give written notice thereof to contractor requiring contractor to remedy such cause within a period of not less than fifteen (15) days of receipt of GEUS's notice. If, upon the expiry of the aforesaid period, such cause has not been remedied or removed or if an agreement has not been reached on a plan to remedy or remove the cause, the contract shall automatically terminate, and GEUS shall be entitled to be reimbursed, within sixty (60) days of receipt by contractor of the relevant debit note, for all damages incurred in connection with such termination, however, not including consequential losses and/or damages.

The termination of the contract pursuant to this clause 2.5 shall not relieve contractor from any of its obligations or liabilities incurred as a consequence of default(s) committed prior to such termination.

Art. 3 Quality assurance

3.1 The service shall be carried out in compliance with the requirements listed in appendix B and C.

3.2 Failure by contractor to meet GEUS's quality requirements shall constitute breach of contract and shall entitle GEUS to terminate the contract pursuant to clause 2.5, provision being such failure significantly reduces quality of acquired data.

Art. 4 Special conditions and appendices - priority of documents

4.1 The special conditions and appendices to commercial section and technical section A, B, C and D as mentioned in article 2 of the agreement relate to the services specified below:

Special conditions for acquisition and processing of multibeam data acquisition

- Appendix A: compensation for acquisition and processing of multibeam data
- Appendix B: technical specification for acquisition and processing of multibeam data
- Appendix C: quality and management systems for exploration services
- Appendix D: safety training and working environment

4.2 Priority of documents

In case of any inconsistency between the contract documents indicated in article 2 of the agreement, each document shall prevail on the others in accordance with the order set forth below:

- 1) the special conditions and appendix A;
- 2) the agreement;
- 3) the general conditions;
- 4) the quality and management systems - appendix C;
- 5) the technical specification as appropriate
- 6) Appendix D – safety training and working environment

The above documents shall be deemed to be complementary, so that all the terms of any such document shall be considered to be included in all the others and thus fully applicable.

Art. 5 Area of operations acquaintance

Contractor declares and represents that it is acquainted in all respects with the regulatory, fiscal and logistics situation, climatic and environmental conditions existing in the area of operations and that it has evaluated all costs and risks connected therewith.

Thus, contractor is solely responsible for any misunderstandings and/or incorrect information, however obtained.

Art. 6 Standard of performance

6.1 Contractor shall, at contractor's sole cost and expense, furnish supervision, manpower, equipment and/or materials and supplies necessary for the performance of the service in a diligent, good and workmanlike manner.

Contractor shall not employ in any work for GEUS any employee whose employment violates applicable labour laws.

6.2 All equipment and/or materials, supplies or manufactured articles furnished by contractor in the performance of the service shall be the best quality for their respective purposes and shall be free from all defects, latent or otherwise. Any portion of the service found defective or unsuitable shall be promptly removed, replaced or corrected by contractor without additional charge to GEUS.

6.3 Progress in the work

In the event that the work falls behind schedule or that it becomes evident that progress has been too slow to ensure completion of the service in the prescribed time, contractor shall take immediate steps that can be reasonably expected to expedite the rate of progress of the work.

Art. 7 Inspection and tests

7.1 Contractor shall permit GEUS's representative(s) or inspector(s) to conduct the requisite inspection and tests, including inspection of the vessel and to examine the equipment and/or materials to be used for the service, it being understood that vessel time elapsed due to such tests and inspections, that would not else have elapsed, shall be paid for at xx DKK per hour. The presence of GEUS's representative(s) shall not in any way relieve contractor from full and exclusive responsibility for the execution of the service.

7.2 In case the nature of the service requires that it be submitted to tests as the service proceeds, or submitted to specific test or inspection according to the contract, contractor shall notify GEUS adequately (never less than 48 hours in advance) that the test can be initiated in order that GEUS's representative(s) shall have the opportunity of being present at all such tests, and no work shall be covered up or put out of view until so inspected.

7.3 Unless an agreement to the contrary has been made, it is understood that tests necessary for the kind of service in question, according to good practice, shall form an integral part of the carrying out of the service and shall be for the account of, and carried out under the responsibility of, contractor. Contractor shall also supply the necessary testing equipment.

Art. 8 Changes or modifications in the service

8.1 GEUS shall have the right at any time during the term of the contract to ask contractor to make any reasonable changes or modifications that GEUS considers advisable in the service or in the plans and specifications, and contractor shall carry out such changes or modifications.

Changes or modifications may include additions to or reductions in the amount of work.

8.2 In the case of a lump-sum contract, if such modifications increase the cost of the service, the contract price shall be increased proportionately; likewise, if the modifications represent a diminution in the cost of the service, a corresponding reduction shall be made in the contract price. However, mobilisation and demobilisation charges will remain unaltered, regardless.

8.3 In all cases the parties shall agree in writing the amount of increase or decrease in the contract price before the modifications are carried out. GEUS will not pay for any modification unless the price thereof has been agreed in writing in advance.

8.4 The contract price shall not be increased on account of additional work or additional materials required to remedy defects attributable to contractor or to carry out tests in excess of those specified in the special conditions if such additional tests are necessary because of defects attributable to contractor.

8.5 Contractor shall not change, modify or alter any part(s) of the service except as directed by GEUS in writing.

In the event of any variation(s) made by contractor without GEUS's prior approval, contractor shall, at its expense, restore any varied part(s) of the service to the condition required by the contract.

8.6 If contractor fails to comply with the provisions of clause 8.5, GEUS reserves the right to terminate the contract pursuant to clause 2.5.

Art. 9 Representatives

9.1 Contractor shall designate in writing to GEUS the person or persons who will have supervisory authority of the service and with whom GEUS's representative(s) may co-ordinate the performance thereof.

Notices concerning the service which are transmitted to contractor through its designated representative(s) and which are consistent with the provisions of the contract shall be deemed those of Contractor and shall be deemed, for the purposes of the contract, to have been sufficiently given.

9.2 GEUS will designate in writing one or more representative(s) in the area of operations to whom contractor's representative(s) may deliver reports and other confidential information developed from the service.

GEUS's representative(s) will consult with contractor's representative(s) in the planning and co-ordination of the service and all instructions given by GEUS's representative(s) consistent with the provisions of the contract shall be deemed those of GEUS and shall be complied with.

Art. 10 Reports

The reports that contractor shall provide to GEUS during, and/or after the completion of, the service are set out in the special conditions.

Art. 11 Contractor's obligations

In addition to any and all charges provided for in other clauses as being for contractor's account, contractor shall provide and/or arrange for and/or meet the cost of:

11.1 Mobilisation to, and demobilisation from, the area of operations of all marine and land means and equipment.

11.2 All expenses associated with the personnel provided under the contract, including but without limitation, all wages, salaries, overtime, taxes benefits, allowances, social security contributions, and (save as may be otherwise expressly provided herein) the cost of passports,

accommodation, subsistence, travelling (including travels for crew rotation) insurance and medical treatment.

- 11.3 Maintenance and repairs of all equipment and/or materials to ensure its/their efficient operation; supply of all spare parts and consumables required, for the proper conduct of the service such as: fuel, lubricants, photographic material, paper and printing chemical products, gases and/or compressed air.
- 11.4 Customs duties and agency fees, which shall be reimbursed to contractor as stated in clause 12.3.
- 11.5 Any and all liabilities or claims for any taxes or governmental charges of whatever nature which any governmental authority (including any political sub-division thereof) claiming jurisdiction over the contract may impose, assess or levy against contractor under the contract.
- 11.6 Complying with, and ensuring that the sub-contractors and their respective personnel comply with, all applicable laws, by-laws, rules and regulations and any conditions or restrictions contained in any license or permit relating to the service.
More specifically, contractor shall take all precautions necessary to ensure the safety of contractor's personnel and property and the personnel and property of any third parties.
- 11.7 Repeating, subject to a contractor multibeam marine crew being available in or near the area of operations, such field operations as are necessary to re-record any tapes that, due to contractor's fault, are lost, destroyed or damaged beyond repair.
In the event that no multibeam marine crew is available in or near the area of operations, contractor may elect, instead of re-recording the tapes, to credit GEUS with the rate(s) of compensation, as appropriate, initially charged to contractor.
- 11.8 Registration of the contract, where required, in the country where the service is rendered.
The relevant cost, expenses and/or charges, if any, shall be reimbursed by GEUS as stated in clause 12.3.
- 11.9 Downtime resulting from the failure of the vessel and/or the malfunction of the equipment and/or materials including the radio-positioning chains.
- 11.10 Compliance with all requirements of the laws of the country having jurisdiction over the area of operations as regards establishing its company on a proper legal basis to operate or do business therein, including registration, if required.

Art. 12 GEUS's obligations

In addition to the payment to contractor of the fares of compensation/fees set forth in appendix A, GEUS shall provide and/or arrange and/or meet the cost of:

12.1 Self-insurance covering liabilities for injury to or death of its representative(s).

12.2 Expenses (against supporting documents) associated with, or judgement arising out of, any predictable damage or loss caused to third parties, including damage to or loss of fish traps, nets, posts; provided, however, that the service shall be performed with due care, skill and diligence and in accordance with accepted industry standards.

12.3 a) costs, expenses and/or charges, if any, of registering the contract in the country where the service is rendered

b) reimbursing contractor for the cost of:

- Customs duties and agency fees in 11.4 if the call of port is according to instruction from GEUS;
- Permits, licences, authorisations as stated in article 28 “permits and authorisation”.

12.4 Fees of any data, maps, reports, in addition to those mentioned in the contract.

Art. 13 Safety, accident prevention and health measures

13.1 Contractor assumes full responsibility to provide for the safety, security and health of contractor's personnel and to observe the respective laws and regulations of the area of operations, including but not limited to the obligation to develop a safety plan according to Multibeam Survey Standards.

Contractor further covenants warrants and represents that its personnel and the personnel of its sub-contractors are suitably trained to safely perform the service. Ref. Appendix D - safety training and working environment.

13.2 Contractor's obligation to observe safety measures according to this article 13 shall be considered an essential, basic obligation, failure to comply with which shall give GEUS the right to suspend the service or to terminate the contract under article 2 “contract duration and termination”.

13.3 The responsibility for taking adequate safety measures rests solely with contractor. Contractor shall appoint a safety officer.

13.4 Contractor shall inform GEUS and the proper authorities forthwith of any injury /damage to contractor's personnel/equipment and/ or materials or to the personnel/equipment of its sub-contractors.

Contractor shall submit to GEUS, within seven (7) days of the date of the injury/damage, the accident report.

Art. 14 Environmental compliance

14.1 Contractor shall give all notices and otherwise fully comply with all laws, statutes, regulations, ordinances, rules, standards, orders or determinations of any governmental authority (including related determinations, interpretations, orders or opinions by any judicial or administrative authority) which has jurisdiction over contractor, the service or the area of operations pertaining to protection or conservation of the air, land, water, human health, industrial hygiene or other aspects of the environment. Including but not limited to the obligations listed in multibeam survey standards in the conditions to issue a license to carry out scientific research in Greenland waters.

14.2 Hazardous materials

Contractor represents and warrants to GEUS that upon delivery or performance of the service, the service will not contain or otherwise have incorporated into it any chemical, material or other substance defined as or included in the definition of “hazardous substance”, “hazardous material”, “hazardous chemical”, “hazardous chemical substance”, “hazardous waste”, or “toxic substance” or words of similar meaning and regulatory effect, as such terms are defined under any environmental laws, any broader definition of such terms that is used by a state or locality that has jurisdiction over the service, or the area of operations or any interpretation by administrative or judicial authorities, or any other chemical, material or substance, exposure to which is prohibited, limited or regulated by any governmental authority or which may or could pose a hazard to human health and safety.

14.3 Pollution control/hazardous waste responsibility and indemnification

- a) Contractor shall assume all responsibilities, including control and removal of, and hold harmless and indemnify GEUS from and against any and all losses, costs (including payment of attorney's fees and other litigation costs) damages or liabilities, and in respect of all claims by any person or entity whatsoever for injury to person or property or any other loss or damage arising out of or in connection with pollution or contamination of the environment caused, in whole or in part, by any act or omission of

contractor and its sub-contractors, including but not limited to: spills, leaks, drainage or dumping of fuels, lubricants, motor oils.

- b) Contractor shall assume all responsibility for properly treating, storing, transporting, disposing of or otherwise managing all hazardous waste in its control or resulting from its work under the contract in strict compliance with all applicable laws, rules or regulations.

Contractor further agrees to hold harmless and indemnify GEUS from and against any and all losses, costs (including attorney's fees and other litigation costs), damages or liabilities, and in respect of all claims by any person or entity whatsoever for injury to person or property or any other loss or damage, arising out of or in connection with any failure of contractor and any sub-contractor to properly treat, store, transport, dispose of or otherwise manage its hazardous waste.

- c) Without relieving contractor of any of its obligations, it is agreed that GEUS may notify immediately relevant authorities having jurisdiction over the area of operation for the purpose of ensuring the necessary control and removal of any pollution or contamination which is the responsibility of contractor under the foregoing provisions. Contractor shall reimburse GEUS any cost thereof. It is understood that both parties shall keep each other informed during such situations and try to agree on the most appropriate action to take.

Art. 15 Independent contractor

Contractor, in the performance of the service, is and shall remain an independent contractor with exclusive control of its personnel. Contractor shall have no authority to act on behalf of GEUS nor shall contractor have the power neither to bind GEUS in any manner nor be considered as an agent of GEUS.

Art. 16 Liabilities and indemnities

16.1 The parties shall, save as is otherwise herein specifically provided, indemnify and hold each other harmless from and against any and all claims, liabilities, costs, damages and expenses of every kind and nature with respect to injury to or death of any person employed, directly or indirectly, by the parties, their sub-contractors/contractors or affiliates arising during or as a result of the performance of the service from any cause whatsoever, including, but not limited to; the negligence of the parties, their sub- contractors/contractors, or their respective employees.

- 16.2 a) Contractor shall be liable for damage to its equipment and/or materials and for loss of and/or damage to such materials that belong to GEUS and that Contractor has received in order to perform his services according to this contract.
- b) Contractor shall be liable for and shall indemnify and hold GEUS harmless from and against any claims for and proceedings resulting from shipwreck or any equipment and/or materials (floating or otherwise) which may sink or be lost overboard in the course of the performance of the service. In such case contractor shall act according to the laws of the country having jurisdiction over the area of operations and secure sufficient insurance coverage to meet the requirements.
- c) Without relieving contractor of any of its obligations, it is agreed that GEUS may notify immediately relevant authorities having jurisdiction over the area of operation for the purpose of ensuring the necessary control and marking or raising or removal of the vessel or any equipment and/or materials (floating or otherwise) which may sink or be lost overboard in the course of the performance of the service. Contractor shall reimburse GEUS any cost thereof. It is understood that both parties shall keep each other informed during such situations and try to agree on the most appropriate action to take.

16.3 Contractor shall be liable for and shall indemnify and hold GEUS harmless from and against all losses and claims for and proceedings resulting from death, injury, damage or destruction, howsoever caused to any third party, or their property whatsoever which shall arise out of or in consequence of the performance of the service, including any losses and claims arising out of the failure by contractor or contractor 's personnel to comply with the safety regulations mentioned in article 13 "safety, accident prevention and health measures".

16.4 Contractor shall defend, indemnify and hold GEUS and GEUS's representative(s) harmless from and against any liability or penalty which may be imposed on GEUS or on GEUS's representative(s) by reason of any alleged or actual violation of law by contractor or its sub-contractors and also from all claims, suits or proceedings that may be brought against GEUS or GEUS's representative(s) arising under, growing out of, or by reason of or pursuant to the performance of the service with respect to such alleged or actual violation of law whether brought by employees of contractor or its sub-contractors, by third parties or by any governmental authority.

16.5 In no event shall either party be liable to the other for indirect, special or consequential damages of any kind, including but not limited to loss of revenue or anticipated profits resulting from the carrying out of the service.

Art. 17 Insurance

17.1 Without prejudice to the liabilities and responsibilities of contractor under the provisions of article 16 “liabilities and indemnities”, Contractor shall at its own expense effect and maintain in force during the term of the contract the following insurance’s:

- (a) Insurance covering injury to, and/or death of, contractor's personnel and/or the personnel of its sub-contractors in compliance with the legislation applicable to the contract.
- (b) Insurance covering liability for damage to, and/or loss of, contractor's facilities, equipment and/or materials and/or those of its sub-contractors, including war risks,.
- (c) Insurance covering liability for damage to and/or loss of GEUS's materials mentioned in clause 16.2a).
- (d) Contractor shall ensure that the hull and machinery protection and indemnity insurance’s in respect of the vessel, if used in the performance of the service, are in effect during the term of the contract, at no cost to GEUS, in an amount of not less than owners full admitted value of the vessel. Also, contractor shall obtain removal of wreck insurance to cover contractor's obligations in clause 16.2b).
- (e) Public liability insurance covering personal injury and/or property damage, with a limit of DKK 10 million for anyone incident or series of incidents, arising from one event or incident and unlimited as to number of claims in any year.

The limits specified above are minimum requirements and shall not be construed in any way as limits of liability or as constituting acceptance by GEUS of responsibility for financial liabilities in excess of such limits.

17.2 General insurance requirements

- (a) Contractor shall maintain in force the above-mentioned policies through a reputable international insurance company.
Contractor shall likewise require each of its sub-contractors to maintain third party liability insurance for such risks through a reputable international insurance company, covering the activities of such sub-contractors and their employees.
Any deficiencies in the cover or policy limits of sub-contractor’s insurances shall be the sole responsibility of contractor.

- (b) Contractor warrants that the insurances referred to in clause 17.1 shall be in full force and effect prior to the commencement of the service.
- (c) Contractor shall, within (7) days of the execution of the contract, provide GEUS and relevant authorities with written evidence that the aforementioned insurance's have been effected and are in full force with respect to the contract and shall furnish to GEUS and relevant authorities, as soon as available, copies of the current certificates relating thereto.
- (d) Contractor shall provide to GEUS with written confirmation that its underwriters have agreed to waive all rights of subrogation against GEUS, its parent companies, affiliates and such of the joint ventures as are engaged in the area of operations.
- (e) Contractor shall ensure that GEUS is included in all the policies as co-assured.
- (f) All insurance's carried by contractor hereunder shall exclude the right of subrogation and deductibles against GEUS, its contractors or their sub-contractors.
- (g) The cost of the above insurance coverage shall be included in the rates of compensation/fees set forth in appendix A, as appropriate.
- (h) All insurance policies shall be endorsed to provide GEUS with at least thirty-(30) day's notice of cancellation.
If contractor fails (or refuses) to obtain or to continue any insurance required to be effected by it under the provisions of this article 17, or to provide GEUS with insurance certificates or renewal certificates, GEUS shall, without prejudice to any of its other rights, have the right to procure such insurance at contractor's expense, in which event any sums so paid by GEUS in this regard shall immediately become due and payable to GEUS by contractor, and GEUS shall be entitled to deduct such sums from any monies due or which may become due to contractor in addition to any other remedies GEUS may have under the contract .

Art. 18 Compensation and method(s) of application

18.1 GEUS will pay contractor, as full compensation for the service, the rates of compensation/fees (net or vat), as appropriate, set forth in appendix A and as provided therein or in the special conditions.

18.2 The rates of compensation/fees set forth in appendix A shall be inclusive of any and all taxes applicable in the country where the service is rendered and in contractor's country.

Art. 19 Invariability of prices

The rate of compensation and/or fees set forth in appendix A shall remain unchanged during the term of the contract.

Art. 20 Invoicing

20.1 Contractor shall forward monthly the invoice to GEUS, with the following provision:

- a) Mobilisation shall be invoiced as soon as possible pursuant to completion.
- b) All work that has not already been invoiced shall be invoiced as soon as possible pursuant to completion of demobilisation.

20.2 Contractor shall bill GEUS on the following basis:

20.2.1 Mob/demob fees: as stated in the special conditions and in appendix A.

20.2.2 Rates of compensation: as stated in the special conditions and in appendix A.

20.3 All invoices under the contract shall quote the contract reference number: GEUS j.nr 0739-033, and shall be mailed as follows:

One original to the address specified in the special conditions.

20.4 If GEUS disputes an invoice, in whole or in part, GEUS shall promptly notify contractor of the dispute and shall pay only 50 % of the disputed portion.

GEUS and contractor shall endeavour to settle and adjust any disputed amount forthwith.

Art. 21 Payment

21.1 GEUS shall pay by bank transfer all billings within the period specified in the special conditions.

21.2 All payments to contractor under the contract shall be in the currency set out in the special conditions and shall be made to the address (es) specified on the invoice(s).

21.3 GEUS shall pay contractor's last invoice upon receipt of the final report.

21.4 All payments due under or in connection with the contract shall be subject to the rules and regulations of National Bank of Denmark.

Art. 22 No assignment of credits allowed

Contractor agrees not to assign its credits, except those, which will be duly approved by GEUS in advance. Such approval will not be unreasonably withheld.

Art. 23 Audit

Contractor agrees to retain all pertinent books and records (i.e. payroll records, accounting records, payment records, invoices, time reports and travel/entertainment expense reports) relating to the service for a twenty-four (24) month period commencing at the end of the calendar year in which the service was completed or at the end of the calendar year in which the contract has been terminated pursuant to article 2 “contract duration and termination”, and for any additional period as may be necessary to permit GEUS to complete any audit commenced within such period. Representatives and auditors of GEUS shall have access at any time during normal working hours to the books and records maintained by contractor relating to the service, and shall have the right to copy and audit such books and records.

Art. 24 Taxes

24.1 Taxes

24.1.1 Any and all income taxes (or taxes based upon or determined by reference to income, profit or gain) of contractor group are the sole responsibility of contractor.

24.1.2 Contractor shall be responsible for and assume full liability for the collection and payment of all present and future employment taxes, levies or assessments including, without limitation, national insurance and other employee benefits imposed by any governmental or taxing authority and arising from the employment of any person by contractor group.

- 24.1.3 Contractor shall provide to the appropriate governmental or taxing authority all information necessary to satisfy any duty it or GEUS has to report information to the said authority with respect to any of the taxes referenced above. Compliance with these obligations shall be deemed a part of contract performance and subject to audit.
- 24.1.4 Contractor shall defend, indemnify and hold GEUS harmless from and against any and all taxes on income, profits or gain imposed by any governmental or taxing authority on contractor or GEUS in respect of any payment made to or earned by contractor hereunder.
- 24.1.5 If and to the extent required by the laws of any country having jurisdiction, GEUS shall have the right to withhold amounts from payments due to contractor hereunder, and any amount so withheld shall be credited against any payments due to contractor under the contract.
- 24.1.6 In case GEUS is held liable for unpaid taxes due to any non-compliance by contractor with this article, contractor agrees to indemnify and reimburse GEUS on demand for all such taxes so paid.
- 24.1.7 Contractor shall comply with any duty to report on employees and companies resident abroad and foreign companies connected with the service.
- 24.1.8 All excise, sales or use taxes, or taxes of a similar nature which might be imposed on the furnishing by contractor of the work and scheduled items hereunder, as well as all customs duties or fees and import or export charges paid by contractor, shall be fully included within prices payable by GEUS hereunder.
- 24.1.9 The services to be supplied by contractor in connection with the contract are zero rated for vat purposes. Accordingly contractor shall not charge GEUS with vat on such services unless vat is payable by contractor and not recoverable.
- 24.1.10 The contract price and the rates specified in appendix A are exclusive of vat unless otherwise specified therein.

Art. 25 Bankruptcy

If a petition in bankruptcy is filed by or against contractor or a receiver is appointed for any part of contractor's assets provided by contractor pursuant to the contract or for a substantial part of any of

contractor's other assets or an assignment is made of any part of contractor's assets for the benefit of its creditors, or process of court or authority is levied or enforced upon or issued out against any substantial part of contractor's assets and such process is not discharged within a reasonable time, or an action is taken under the laws of the country where contractor is domiciled or any other event occurs which would materially impair contractor's ability to fulfil its obligations hereunder, contractor shall promptly notify GEUS of such petition, receiver's appointment, assignment, process, action or defined event, and GEUS may at its option within not less than fifteen (15) days after such notification terminate the contract, as stated in article 2 "contract duration and termination". In any case GEUS may terminate the contract if contractor fails to notify GEUS as aforesaid.

If all or any part of the service is terminated, for reasons set forth in this article, GEUS shall pay contractor its total cost to date of termination in performing the service in conformity herewith but not to exceed the value, based upon the contract taxes or portion thereof, for work done; said payment to represent full and final payment for all works completed and for complete termination of the contract.

Art. 26 Assignment

26.1 Assignment by GEUS

GEUS may assign the contract to third parties, subject to contractor's consent, which consent shall not be unreasonably withheld.

26.2 The assignee(s) shall take the place of GEUS and succeed to its rights and duties as from the date of assignment.

Contractor agrees to obtain all necessary insurance policy endorsements relating to the contract so that the assignee has the same rights under such policies as GEUS.

26.3 Assignment by contractor

Contractor agrees not to assign the contract or sub-contract any work to be furnished hereunder without the prior written consent of GEUS, and the assignment of the contract or the sub-contracting of any work to be performed hereunder, if so permitted by GEUS, shall not relieve contractor of its duties or obligations hereunder; contractor shall be jointly liable with its sub-contractors or assignees for all duties and/or obligations arising from the contract until duly and completely performed.

If contractor assigns the contract or sub-contracts any work to be furnished hereunder without such consent, the contract may be immediately terminated at GEUS's option, as stated in article 2 “contract duration and termination”.

Art. 27 Approved sub-contractors

Contractor shall identify each sub-contractor it proposes to utilise. GEUS reserves the right to approve any such sub-contractor or qualify such approval prior to commencement of the work(s) to be performed under each work order.

All sub-contractors are required to have the minimum insurance prescribed herein.

Art. 28 Permits and authorisation

Subject to the provisions in 12.3.b), contractor shall obtain all permits and licences to be requested from the authorities for the execution of the service and for the importation and use of necessary marine/land means, equipment and/or materials and their subsequent re-exportation.

Contractor shall be responsible for obtaining these permits. In any case, GEUS will give assistance for securing and carrying out the mandates of the relative documents or on request from contractor undertake to obtain necessary permits and licences from the Greenland Government, in such case contractor shall supply GEUS with all documents and information necessary.

Contractor shall apply for the necessary licences immediately after the award of the contract.

Art. 29 Compliance with laws

Contractor agrees to comply with all laws, rules, regulations, ordinances, judgements, orders and other official acts of any governmental authority recognised by GEUS which are now or may, in the future, become applicable to contractor, contractor 's business, equipment and/or materials and personnel engaged in the performance of the contract, or arising out of or incidental to such performance.

Art. 30 Intellectual property rights

In addition to any other indemnifying provisions contained herein, contractor represents and warrants that the use or construction of any and all procedures, equipment and/or materials or process furnished by contractor and used in the service do not infringe on any license, patent or other trade secret which has been issued or applied for, and contractor agrees to protect, defend,

indemnify and hold GEUS harmless from and against any and all claims, losses, costs, demands, damages, suits, judgements, penalties, liabilities, debits, expenses and causes of action and every other claim or litigation (including all costs thereof and attorney's fees) of every kind and character, whether known or unknown, whether predating the contract or not, made by or arising in favour of any patentee, licensee or claimant of any right or priority to such procedures, equipment and/or materials or process or the use or construction thereof, which may result or arise from furnishing or use of any such procedures, equipment and/or materials or process by contractor in connection with the service.

Art. 31 Force majeure

31.1 A party shall not be considered to be in default in the performance of its obligations to the extent that it proves that such performance has been prevented by force majeure, which means circumstances beyond the reasonable control of such party and which could not have been foreseen and/or reasonably overcome by the party such as but not limited to acts of God, action of the elements, war and strikes.

31.2 Neither lack of funds nor any legal strike, which is exclusively directed against contractor, shall be considered circumstances of force majeure.

31.3 A party claiming force majeure shall promptly give written notice to that effect to the other party stating the particulars of such force majeure. The performance of any obligation to the extent prevented by force majeure inclusive of the corresponding performance or payment from the other party shall be suspended while force majeure is operative, but shall be resumed as soon as possible after the termination thereof.

31.4 Should any act of force majeure cause a suspension for a period of more than ten (10) consecutive days, any of the two parties shall be entitled to terminate the contract.

Art. 32 Governing law and venue

The contract shall be governed by and interpreted in accordance with the laws of Denmark. All disputes arising out of or in connection with the agreement shall be amicably settled if possible. The ordinary courts of the Kingdom of Denmark shall finally settle all legal disputes, which cannot be amicably settled between the Parties. The parties agree on the Maritime and Commercial Court of Copenhagen considering the fact that the court is composed of professional judges and lay assessors, maritime and commercial experts.

Art. 33 Confidentiality and ethical business standards

33.1 Confidentiality

Contractor undertakes and agrees:

- To treat all material information related to the contract as strictly confidential and to take all reasonable and practicable steps to ensure and protect the confidentiality thereof;
- Not to exploit any material information supplied by GEUS;
- Not to use any material information or make copies or extracts or summaries thereof for any purpose, except the preparation and submission of tenders and supporting documents in connection with any GEUS-proposed contract, and any necessary correspondence, discussions or negotiations with GEUS during the term of the contract.

33.2 In the event of any damage to GEUS as a result of unauthorised disclosure of any data and/or information by contractor, contractor shall be liable to pay to GEUS an amount equal to the extent of the damage sustained by GEUS.

The amount, as conventionally established, is specified in the contract.

33.3 Ethical business standards

Contractor undertakes and agrees:

- Not to pay any commissions, fees or grant any rebates to any employees or officers of GEUS;
- Not to enter into any business arrangements with employees or officers of GEUS likely to result in conflicts of interest between their private financial activities and their part in the conduct of GEUS business;
- Not to engage in any outside interest or activity likely to detrimentally affect, or conflict with, GEUS's best interests;
- Not to favour any employees or officers of GEUS with gifts, transportation, entertainment or any other non-monetary favours or gratuities that are of more than nominal value or that might be construed to exceed customary courtesies extended in accordance with accepted ethical business standards.

33.4 The above provisions shall survive the expiration or termination of the contract.

Art. 34 Miscellaneous provision

The contract is non-exclusive and GEUS reserves the right to engage any other contractors to perform services similar to, or identical with the service.

Contractor shall afford such other contractors adequate opportunity to carry out their work and shall, if required, accomplish services in co-operation with these contractors and with GEUS.

Art. 35 Notices

All notices to be given with respect to the contract shall be considered as given to GEUS and to contractor, respectively, if given in writing and delivered personally or sent by registered or certified mail, return receipt requested, or by facsimile, telex or other form of telecommunication. Such notices shall be effective when delivered if delivered personally or when placed in the mail if mailed in the manner provided above.

The addresses of notice for GEUS and contractor shall be indicated in the special conditions. Either party advising the other in writing of its new address may change the addresses given.

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Commercial section

Special conditions for acquisition and processing of multibeam data

Special conditions for acquisition and processing of multibeam data

Art.1 Scope of contract

The service to be performed by contractor under the contract comprises the acquisition and processing of multibeam data and supply of the vessel, the necessary quality assurance system, labour, equipment and materials and as detailed in appendix B.

Art.2 Service commencement and contract duration

2.1 Contractor agrees to commence the service (i.e. data acquisition) on2008.

2.2 The duration of the contract shall be equal to the time necessary to perform the acquisition and processing of multibeam data off South Greenland. However, contractor shall complete the survey not later than October 1st, 2008.

Art. 3 Reports to be provided by contractor

Contractor shall deliver the reports described in appendix B to GEUS.

Art. 4 Compensation and methods of application

With reference to clause 18.1 of the general conditions and only if and where a day rate or prorate is applied the parties agree as follows:

4.1 Stand by

GEUS will pay contractor at the applied day rate set out in appendix A, as appropriate, per day, when contractor's vessel, personnel, equipment and/or materials – though operational and ready to operate – are on stand-by for any of the following reasons:

- a) The service is suspended owing to such factors (without limitation) as:
unavailability of permits to be proved by GEUS or adverse weather conditions;
- b) GEUS is not in a position to provide the program to be surveyed in due time;
- c) At GEUS's express request;
- d) Waiting for fishing or other vessels to leave the area;
- e) Clearing the survey area of fish traps or other type of obstacles;

- f) Travel time between survey areas;
- g) Scouting in dangerous waters.
- h) GEUS will pay contractor at the rate set forth in appendix A, as appropriate, per day or prorate thereof, in respect of operations, experimental work or other operations at sea as required by GEUS and when the geophysical and/or positioning equipment is/are required to be fully operational.

Art. 5 Area of operations

With reference to article 5 “area of operations” of the general conditions, the area of operations is off South Greenland.

The exact co-ordinates of the multibeam survey lines will be communicated by GEUS to contractor.

Art. 6 Invoicing

With reference to article 20 “invoicing” of the general conditions, contractor shall bill GEUS as follows:

- a) 100 % of the Mobilisation fee in appendix A upon completion of vessel mobilisation to site in the area of operations off South Greenland.
- b) Data acquisition, plus additional work and stand-by for the area of operations.
- c) 100 % of the Demobilisation fee in appendix A upon completion the survey until release of the survey vessel.
- d) Data processing and deliverance of data and documentation

All invoices shall be mailed to the following address:

Geological Survey of Denmark and Greenland
Øster Voldgade 10
DK-1350 Copenhagen K
Denmark
Att. Christian Marcussen

Art. 7 Payment

With reference to article 21 “payment” of the general conditions, the parties agree as follows;

7.1 Contractor’s invoices shall be settled within thirty (30) days from their receipt.
Demobilisation fee may be withheld until delivery of the last report that Contractor is obliged to deliver.

7.2 All payments due under the contract shall be made in Danish kroner (DKK).

Art. 8 Governing law and venue

With reference to article 32 “governing law and venue” of the general conditions, the parties agree that the contract shall be governed by the laws of Denmark and that venue and language of legal disputes shall be the Maritime and Commercial Court of Copenhagen, and English.

Art. 9 Notices

With reference to article 35 “notices” of the general conditions, all notices shall be addressed as follows:

Contractor:

GEUS - Geological Survey of Denmark and Greenland
Øster Voldgade 10
DK-1350 Copenhagen K
Denmark
Attn.: Jens Jørgen Møller
Telephone: +45 38 14 20 00 or +45 38 14 25 22
Telefax: +45 38 14 20 50
Email: jjm@geus.dk

Commercial section

Appendix A: Compensation

Multibeam data acquisition and processing pricing schedule:

Mob-/Demobilisation to the area of operations off South Greenland Lump Sum DKK

Day rate:

Acquisition and processing of xx.xxx km² data off South Greenland DKK/day

Standby DKK/day

Gravity data acquisition pricing schedule:

Mob-/Demobilisation to the area of operations off South Greenland Lump Sum DKK

Acquisition rate DKK/day

Processing DKK/km

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Technical section

Appendix B: Technical Specifications

1. Scope of work

1.1 Nature and extent of services

As part of activities in relation to the United Nations Convention on the Law of the Sea (UNCLOS) Article 76 GEUS intends to acquire and process a minimum of 25.400 km² of multibeam data off South Greenland. The main objective of the planned survey is to map the water depths in the area.

1.2 Timing of services

Acquisition must be carried out during the period from July to September 2008.

1.3 Minimum requirements

- 1.3.1 Personnel
- 1.3.2 Survey vessel and equipment
- 1.3.3 QC
- 1.3.4 HSE

1.4 Supervision of work

GEUS shall assign a project manager for the multibeam programme. GEUS must have the opportunity to have an onboard quality assurance representative to monitor and approve programme performance, if needed. The QA representative shall have full access to all relevant material, including initial tests to be approved before start of data acquisition.

1.5 Changes

Contractor and GEUS shall inform each other of all organisational and other changes relevant to the agreement and together evaluate circumstances likely to affect the overall performance of the project in order to minimise their negative impact.

2. Acquisition and processing

2.1 General acquisition parameters (to be included)

2.2 Quality parameters (to be included)

2.3 Contractor deliverables(to be supplemented)

2.3.1 Information to be delivered

Contractor shall deliver the following data within xx days after completion of the survey:

- General parameters
- Digital data on ESB2 Disc services, A master and a backup copy
- Raw data
- Processed full density data.
- Original processed data set
- Reduced data set
- Backscatter data
- Gravimeter
- Meta data
- Plot files
- Interim report
- Descriptive report

2.3.2 Daily report

Contractor shall deliver a daily report by 0800h (GMT) of the following day by email or fax. The report shall include information outlining the progress of the survey for that day, the cumulative progress to date as well as plans for the following day.

2.3.3 Weekly report

Contractor shall deliver a weekly report each Monday by 1200h (GMT) summarising the events of the preceding week, including but not be limited to the following:

- planned and actual scheduling
- performance, status, plans and comments
- summary of chargeable items (estimated cost, week and total to date)

2.3.4 Final report

Contractor shall deliver a draft of the final report within two weeks of the completion of the acquisition. GEUS shall approve the draft without delay so that five copies of the approved final report may be delivered to GEUS within four weeks of the completion of the acquisition.

The final report shall summarise the work, focusing on data quality and problems encountered. The report will serve as a reference for future work and must include recommendations to improve data quality. Technical details should be incorporated in the Appendices.

The final report shall include the following information:

1. General information
Survey location and programme maps, general descriptions, vessel and equipment used, problems encountered, enclosures including nominal geometry etc.
2. Crew composition
Organisational chart, key personnel, staff
3. Operational parameters, specifications and procedures
Technical parameters, data quality, format and flows, timing diagrams, operational modes and characteristics to include:
 - 3.1 Recording instrument
 - 3.2 Receiver
 - 3.3 Source
 - 3.4 Navigation
 - 3.5 Gravity
 - 3.6 Planning and QC
 - 3.7 HSE
 - 3.8 Permitting
4. Acquisition statistics
Production analysis by day and by line, time analysis (operational, standby, down)
5. Conclusion and recommendations
6. Appendices including
 - Appendix A – Daily and weekly reports
 - Appendix B – Line summary and line logs details
 - Appendix C – Operations diary
 - Appendix D – Delivered items list
 - Appendix E – Formats
 - Etc.

2.4 Crew composition

The crew composition shall be specified by contractor and shall be sufficient to support the entire operation. GEUS shall be notified about any change in key personnel.

2.5 Parameters, specification and working practices

2.5.1 Recording instrument

2.5.2 Multibeam instrument

2.5.3 Navigation

2.5.4 Onboard processing system

All field data have to be checked using the onboard processing system.

2.5.5 Gravity data

Technical section

Appendix C

Quality and Management Systems

Specification for acquisition and processing of multibeam data

Quality System Requirement

CONTRACTOR must have a management system that complies with the Quality Assurance requirements as describe in the DS. – ISO 9000 series, or equivalent (Form I), for the products and services covered by the CONTRACT.

Health, Safety and Environment Requirements

CONTRACTOR must produce a written declaration signed by the Managing Director to the effect that the CONTRACTOR has a formal system for managing health, safety and environment matters, including working environments.

Quality Assurance/Internal Control Declaration

	Y	N	N/A
1. The contractor has a documented and implemented Quality System	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The System encompass Quality Assurance/Internal Control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The Quality System is certified	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Internal audits carried out	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Last audit dated			
5 Audits by external bodies/companies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Last audit dated			
Carried out by.....			
6 Are there any corrective actions outstanding?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7 Is the responsibility for the Quality System vested with an independent function	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8 Contractor keeps an Environmental Accounting (Miljøregnskab)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9 Contractor has elected Safety Delegate(s)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10 Contractor has performed Risk Analysis of its activities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11 Contractor has carried out Environmental Impact studies/analysis pertaining to its activities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Quality System Responsible

Managing Director

Date:

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Technical section

Appendix D

Safety training and working environment

Personnel

- Contractor's personnel shall hold a valid certificate for Safety and Emergency Preparedness Training in accordance with industry standard.

Working Environment

- Contractor must document an implemented system to handle working environment matters.

Technical section

Appendix E

Quality control specifications (to be included)

Enclosure 3:

**Specification
of a multibeam survey
off South Greenland**

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1. Introduction

1.1. Objectives

The Geological Survey of Denmark and Greenland (GEUS), on behalf of the Danish Government, intends to acquire and process multibeam and gravity data in specific regions on the continental margin and adjacent slope and rise off South Greenland, in order to obtain multibeam bathymetry and backscatter data. These data are required to support a potential claim for extended jurisdiction by Denmark under the United Nations Convention on the Law of the Sea (UNCLOS) Article 76. There is a requirement for collection and processing of high quality, multibeam data in water depths of approximately 2000 to 4000 meters off South Greenland, in order to precisely define the location of the foot of the slope as defined under Article 76. Both acquisition of full-coverage and profile data are planned.

The specifications described herein are based in part on the International Hydrographic Organization's Standards for Hydrographic Surveys, Special Publication 44, Fourth Edition, April 1998, specifically for Order 2 surveys.

1.2. Description of survey area

See ANNEX B.

1.3. Definition

The term "hydrographer" as used through this document, refers to: (a) the chief of party or officer in charge.

1.4. Requirements

1.4.1. Ship

Provision of a survey vessel capable of acquiring deep-water multibeam swath bathymetry and multibeam sonar backscatter data in the designated areas off South Greenland. Accommodation for at least one representative from GEUS.

1.4.2. Multibeam

Provision of a hull mounted deep-water multibeam system(s) and topside electronics aboard the survey vessel. The multibeam system shall collect full-coverage bathymetry and backscatter and be optimized to work in depths between 2000 and 4000 meters. The multibeam package shall include:

- differential GPS and navigation system.
- vessel motion sensing system.
- capability to collect and process data needed for water column speed of sound and

refraction corrections. Capability to collect and process on-line sound speed corrections collected at transmit point.

- the ability to process data underway and produce onboard plots suitable for real-time quality control.

1.4.3. Survey system and personnel

The contractor will provide a complete survey system, including vessel, multibeam sonar system, operators and engineers, on-board data processing and QC capability and ancillary office capacity to support the survey program. The officer in charge will hold an IHO category A surveyor's license or equivalent. CV's from relevant personnel will be included in the tender.

1.4.4. Survey planning

The contractor, in consultation with GEUS, will take responsibility for survey planning.

2. Datum's and time

2.1. *Horizontal datum*

All positions must be referenced to the WGS84. This datum must be used throughout a survey project for everything that has a geographic position or for which a position is to be determined. Those documents used for comparisons, such as charts, junctional surveys, and prior surveys, must be referenced or adjusted to WGS84. In addition, all software used on a survey must contain the correct datum

2.2. *UTM coordinates*

Unless otherwise specified all processed as data described in ANNEX A must be related to WGS84 Universal Transverse Mercator (UTM) zone 21.

2.3. *Vertical Datum*

All sounding data must be corrected for tides related to Mean Low Water Spring (MLWS). Corrections will be supplied by GEUS prior to commencement of the survey.

2.4. *Time*

Coordinated Universal Time (UTC) shall be used for all time records

3. Position control

3.1. Horizontal position accuracy

With reference to IHO SP-44 the specification for hydrographic positioning is that the total error in position of soundings, and all other significant features, at the 95 percent confidence level, must not exceed 20 meters + 5 percent of the depth.

For multibeam surveys, due to the oblique sounding pattern, the position of a sounding may be at some distance from the vessel position. The accuracy requirement for the vessel position will depend upon how accurately the sounding is positioned relative to the vessel. That, in turn, will depend upon the characteristics of the multibeam system, depth of water, the accuracy with which heave, roll, pitch, heading, and latency are accounted for and applied, and the reliability with which the speed of sound profile is known.

3.2. Differential Global positioning system

DGPS will be the primary positioning system currently used for the hydrographic survey. DGPS corrections may be obtained using WASS/EGNOSS corrections if WASS/EGNOSS is in operation or by other means.

3.3. DGPS specifications

3.3.1. Elevation of satellites

GPS receiver(s) aboard the vessel will be configured such that satellites below 8 degrees above the horizon will not be used in position computations.

3.3.2. Age of DGPS corrections

The age of pseudo-range correctors used in position computation must not exceed 20 seconds; however, any horizontal positioning interpolation must not exceed the accuracy requirement in Section

3.3.3. Horizontal Dilution of Precision (HDOP)

Horizontal Dilution of Precision (HDOP) will be monitored and recorded, and should not exceed 4 nominally. Satellite geometry alone is not a sufficient statistic for determining horizontal positioning accuracy. Other variables, including satellite pseudo range residuals, are used in conjunction with HDOP to estimate DGPS horizontal accuracy.

3.3.4. Number of satellites

A minimum of four satellites must be used to compute all positions.

3.3.5. Offsets

Horizontal and vertical offsets between the GPS antenna and transducer(s) shall be observed and applied with a precision better than 0.1 m

3.3.6. Source of DGPS corrections

DGPS corrections obtained by any other means than WASS/EGNOSS require a description of the reference station used.

4. Tides and water level

Tides shall be applied. Corrections will be supplied by GEUS prior to commencement of the survey.

5. Depth sounding

5.1. Resolution and coverage

The multibeam sonar will have an effective beam width of no greater than 2 degrees in both the along-track and cross-track directions and lateral coverage of at least 3000 meters for depths greater than 1000 meters. Maximum cross-track swath opening angle must be ± 60 deg for bathymetric data. For backscatter data cross-track swath opening angle may be opened to ± 75 deg.

5.2. Sounding units

Depths shall be recorded in meters, with a precision of at least tenths of meters. Plotting units for final deliverables will be meters.

5.3. Accuracy and resolution standards

5.3.1. Accuracy standards

The accuracy of measured depths in the hydrographic survey applies to the systematic measurement of general water depths and to the least depths determined over any obstructions.

The total sounding error in a measured depth at the 95 percent confidence level, after systematic and system specific errors have been removed, shall not exceed:

$$\pm \sqrt{[a^2 + (b * d)^2]}$$

In depths greater than 100 meters, $a = 1.0$, $b = 0.023$, $d = \text{depth}$ (IHO S-44, Order 2).

The maximum allowable error in measured depth includes all inaccuracies due to residual systematic and system specific instrument errors; the velocity of sound in water; static vessel draft; dynamic vessel draft; heave, roll, and pitch; and any other sources of error in the actual measurement process.

The total sounding error is applicable to swath widths of at least 3.4 times the water depth (i.e., 60deg to both sides of nadir).

5.3.2. Multibeam Resolution Standards

The hydrographer shall maintain and operate the Multibeam sonar system, from data acquisition to processing, such that it detects shoals with a minimum size of detectable targets. The minimum size shall not exceed 10 percent of the depth for horizontal dimensions and 5 percent of the depth for vertical dimensions. Depths shall be determined and recorded with a vertical resolution no coarser than 10 centimetres. The hydrographer shall ensure that vessel speed is adjusted so that the bottom coverage 100% in the along track direction is maintained.

Sounding track lines shall generally be parallel. Sinuous lines and data acquired during turns shall *not* be included in the final processed data, and shall *not* be used to meet coverage requirements.

5.4. Coverage

5.4.1. 100% coverage

The hydrographer shall insure that the multibeam coverage is 100% within the defined area.

5.4.2. Line spacing

Line spacing shall be such that the portions of the swaths used as part of the delivered data set meet the accuracy and resolution requirements in Section 5.2 overlap to ensure that no gap in coverage exists due to the uncertainty in positioning and vessel motion.

5.5. Demonstration of Coverage

Regardless of coverage technique, the hydrographer shall demonstrate bottom coverage using a raster summary image, colour coded by depth. The raster image shall be created from fully corrected data that meet accuracy and resolution specifications (see Section 5, Depth Sounding) are cleaned of all anomalous soundings, and serve as the source for all smooth sheet soundings. Each coloured cell in the raster image shall be binned, line by line; using shoal biased filtering at a bin size that does *not* exceed 5 meters + 5 percent of the depth.

The submitted digital image file shall be in a standard geo-referenced image format.

5.6. Corrections to echo soundings

To meet the accuracy and resolution standards for measured depths specified in Section 5.2, observed echo sounder depths must be corrected for all departures from true depths attributable to the method of sounding or to faults in the measuring apparatus.

In recognition of the possibility that some discrepancies in sounding may not be detected until the post-processing phase of the survey, the determination and application of corrections to echo soundings must be accomplished and documented in a systematic manner. In addition, all corrections shall be applied in such a way that the on-line values may be removed and replaced with a revised set of correctors in post-processing.

5.6.1. Category of corrections

Corrections to echo soundings are divided into five categories, and listed below in the sequence in which they are applied:

5.6.1.1. Instrument error corrections

Instrument error corrections account for sources of error related to the sounding equipment itself.

5.6.1.2. Draft corrections

Draft corrections shall be added to the observed soundings to account for the depth of the echo sounder transducer below the water surface.

5.6.1.3. Appropriate corrections for settlement and squat

Appropriate corrections for settlement and squat shall be applied to soundings to correct the vertical displacement of the transducer, relative to its position at rest, when a vessel is underway.

5.6.1.4. Velocity of sound correctors

Velocity of sound correctors shall be applied to soundings to compensate for the fact that echo sounders may only display depths based on an assumed sound velocity profile while the true velocity may vary in time and space.

5.6.1.5. Heave, roll, pitch, heading, and navigation timing error

Heave, roll, pitch, heading, and navigation timing error (latency) corrections shall be applied to Multibeam soundings to correct the effect of vessel motion caused by waves and swells (heave, roll, pitch), the error in the vessel's heading, and the time delay from the moment the position is measured until the data is received by the data collection system (navigation timing error).

5.6.2. Instrument error corrections

Any instrumental error must be documented and applied for. The vertical (nadir beam) of the multibeam echo sounder must be checked against a known reference e.g. a calibrated single beam echo sounder. To ensure the proper operation of echo sounders, "confidence checks" shall be conducted periodically.

Comparisons should be conducted during calm sea conditions, preferably in areas with a relatively flat bottom. Any differences should be investigated, and if, after analysis, a corrector is necessary, it should be applied with an explanation of the cause of the difference.

5.6.3. Draft corrections

The corrections for draft account for the depth of the transducer face below the surface of the water. Draft corrections comprise a value for the draft of the vessel at rest, sometimes known as static draft, and settlement and squat corrections which compensate for the variation in draft that occurs when the vessel is making way. The sum of the static draft and the settlement and squat correctors is known as the dynamic draft. Draft is transducer-specific. When more than one transducer is fixed to a vessel, the hydrographer must exercise care to apply the proper draft correction for *each* transducer.

5.6.3.1. Static draft

The static draft, as an echo-sounding correction, refers to the depth of the transducer face below surface of the water when the vessel is *not* making way through the water. The required frequency of static draft measurements depends upon the range of variation in the vessel draft and the depths of water to be surveyed. The static draft shall be observed and recorded to the nearest 0.1 m.

Draft values must be observed and entered into the record before departing from and upon returning to port. In both cases, the draft should be determined by averaging the max/min or beginning/ending values if the differences do not exceed ± 0.2 m. Otherwise, the applicable draft should be determined in 0.1 m increments. If significant changes to a vessel's draft (greater than ± 0.1 m) occur, draft values shall be modified and applied accordingly.

If the static draft is monitored and logged using a pressure cell throughout the survey this correction for change in draft may be used and applied to the measured depths.

5.6.3.2. Settlement and squat

Transducers are generally displaced vertically, relative to their positions at rest, when a vessel is making way. Depth measurements are correspondingly affected by these vertical displacements. The displacements may be of sufficient magnitude to warrant compensation, especially when sounding at moderate to high speeds in shoal water. The factors accountable for this vertical displacement are called settlement and squat.

Settlement is the general difference between the elevation of a vessel when at rest and when making way

Squat refers to changes in trim of the vessel when making way and is generally manifested by a lowering of the stern and rise of the bow.

As part of the documentation a description (model or otherwise) of the vessels settlement and squat at relevant survey speeds must be included.

5.7. Velocity of sound corrections

To ensure that the overall depth measurement accuracy criteria specified in Section 5.2 are met, velocity of sound observations should be taken with sufficient frequency, density, and accuracy. The accuracy with which the speed of sound correction can be determined as a complex function of the accuracy with which salinity, temperature, and depth, or alternately, sound speed and depth, can be measured.

The sound speed profile in the survey areas must be measured and monitored at sufficient frequency and to an appropriate depth to assure that the bathymetric data provided meets the required depth accuracy specification. The sound speed profile should be determined with a calibrated system capable of measuring the speed of sound with errors no greater than 2 m/sec (at the 95% confidence level). A calibrated sound speed measuring system capable of measuring the sound-speed profile to at least 95% of the deepest anticipated depth in the survey area must be available, though collection of sound speed data to 95% of the full depth of the survey area will only be required before and after the completion of the surveys. The on-line sound speed collected at transmit point will be merged on time basis with the sound speed profile. On daily basis profiles shall be obtained to a water depth of at least 1000m. These profiles have to be used as top of the profiles with the full profile obtained before the survey. The top profiles may be obtained by either XBT's or XCTD's at an interval of no more than 12 hours or 200NM whichever greatest.

Sound speed at transmission point (on-line sound speed measurement) shall be obtained and used at all times as top of the profile to a water depth 2m below the transducer.

Regardless of the sound velocity determination system employed, an independent sound velocity measurement system must be used to establish a confidence check. Confidence checks shall be conducted at every profile measurement. A comparison between the profile measurements at the depth of the on-line sound speed sensor may be used as a confidence check.

5.8. Heave, roll, pitch, heading, and navigation timing error

Heave, roll, pitch, heading, and navigation timing error corrections shall be recorded in the data files and applied to all multibeam soundings and cross-track distances as applicable.

Heave, roll, and pitch. Heave shall be observed in no coarser than 0.05 m increments. Roll and pitch shall be observed in no coarser than 0.05 degree increments.

Heading shall be observed in no coarser than 0.1 degree increments.

Navigation timing error shall be observed in no coarser than 0.01 second increments.

5.9. Error budget analysis for depths

The hydrographer shall document in the Descriptive Report the methods used to minimize the errors associated with the determination of depth (corrections to echo soundings). Error estimate ranges for six of these errors (measurement error, transducer draft error, settlement and squat error, sound velocity error, heave error and tide/water level error) are presented below. These errors are inherent to hydrographic surveying and all have practical minimums that are usually achievable only under ideal circumstances or with highly specialized equipment. In addition, some errors may be dependent on depth (e.g. sound velocity). Maximum allowable errors are specified to ensure that all errors sources are properly managed. It should be noted that if the

maximum value for each error source is used in an error budget (i.e. root-sum-squared), the result shall be within the prescribed accuracy standard. The minimum and maximum values discussed below are at the 95% confidence level (i.e. 2 sigma).

5.9.1. Measurement error

Measurement error: This includes the instrument error for the sounding system, the effects of imperfectly measured roll/pitch and errors in detection of the sea floor due to varying density of the bottom material. The maximum allowable error is 0.30 meter plus 1 % of the depth.

5.9.2. Transducer draft error

Transducer draft error: This error is controlled by variability in vessel loading, and the techniques used to measure/monitor transducer draft. This error is depth independent with an expected minimum of 0.05 meter and an allowable maximum 0.15 meter.

5.9.3. Settlement and squat error

Settlement and squat error: Conventional methods of determining settlement and squat are limited by sea surface roughness and proximity of a suitable location to the survey area. This error is also depth independent although the effect of settlement and squat is greater in shallow water. The practical expected minimum is 0.05 meter and the allowable maximum is 0.20 meter.

5.9.4. Sound velocity error

Sound velocity error: The factors associated with this error include (1) the ability to accurately measure sound velocity or calculate sound velocity from temperature, conductivity and pressure, (2) the spatial and temporal changes of sound velocity throughout the survey area and (3) how the sound velocity profile is used to convert measured time to depth. In addition, this error encompasses depth errors associated with refraction for the multibeam systems. The allowable maximum is 0.30 meter plus 0.5% of the depth.

5.9.5. Heave error

Heave error: This error is directly dependent on the sea state and the sensitivity of the heave sensor but is not dependent on depth. The expected minimum is 0.05 meter and the allowable maximum is 0.20 meter.

5.9.6. Tide/water level error

Tide/water level error: This error is not to be accounted for in this survey.

5.10. Quality control

5.10.1. Multibeam sonar calibration

Prior to commencing the survey operation, the hydrographer shall conduct a system accuracy test to quantify the accuracy, precision, and alignment of the multibeam system. Testing shall include determination of residual biases in roll, pitch, heading, and navigation timing error. These values will be used to correct the initial alignment and calibrate the multibeam system. System accuracy testing should be conducted in an area similar in bottom profile and composition to the survey area, and during relatively calm seas to limit excessive motions and ensure suitable bottom detection. In addition, system accuracy tests should be conducted in depths equivalent to the deepest depths in the survey area. Static transducer draft, settlement and squat corrections, sound velocity corrections, and tide corrections shall be determined and applied to the data prior to bias determination.

The order in which these biases are determined may affect the accurate calibration of the multibeam system. The hydrographer should determine the biases in the following order: navigation timing error, pitch, roll, and heading. Variations from this order, or simultaneous determination of all values, must be explained and justified.

Pitch and navigation timing error biases should be determined from two or more pairs of reciprocal lines over a 10°–20° smooth slope, perpendicular to the depth curves. The length of the lines must ensure that at least 200 swaths are collected. The lines should be run at different speeds, varied by up to 5 knots, for the purpose of delineating the along track profiles when assessing time delay. Navigation timing error bias could also be determined from running lines over a distinct feature (i.e., shoal) on the bottom, as long as the feature is pinged by the vertical (nadir) beam.

Roll bias should be determined from one or more pair of reciprocal lines over a flat bottom. The length of the lines must ensure that at least 200 swaths are collected. Lines should be run at a speed which will ensure significant forward overlap.

Heading bias should be determined from two or more adjacent pairs of reciprocal survey lines, made on each side of a submerged object or feature (i.e., shoal), in relatively shallow water. Features with sharp edges should be avoided. Adjacent swaths should overlap by 10–20 percent while covering the shoal. Lines should be run at a speed which will ensure significant forward overlap.

Once calibration data have been processed and final system biases determined, the new corrections shall be used in a performance check to ensure that the new system biases are adequate. The hydrographer shall discuss procedures and results in report. Copies of all system alignment, accuracy, calibration reports, and performance checks shall be included in the final report.

System accuracy testing shall be repeated whenever changes (e.g., sensor failure, replacement, re-installations, re-configurations, or upgrade; software changes which could potentially affect data quality) are made to the system's baseline configuration, or whenever

assessment of the data indicates that system accuracies do not meet the requirements in Section 5.2.

5.10.2. Positioning System Confidence Checks

Confidence checks of the primary positioning system shall be conducted and recorded in the survey records at least prior and after the survey. The position check may be conducted in port in South Greenland. GEUS may supply coordinates for the positioning check in a port in South Greenland.

5.10.3. Cross-lines

5.10.3.1. General

The regular system of sounding lines shall be supplemented by a series of cross-lines for verifying and evaluating the accuracy and reliability of surveyed depths and plotted locations. Cross-lines shall be run across all planned sounding lines at angles of 90°. The preferred area in which to run cross-lines is in an area of gently sloping bottom.

5.10.3.2. Multibeam cross-lines

The cross-lines shall be run at an interval as described in Annex B.

Comparisons shall be made between main scheme lines and cross-lines at 1% of all crossings (or 25 crossings, whichever is greater) distributed throughout the data both spatially and temporally. At these crossings the nadir or near-nadir depths of main scheme lines shall be compared to each of the nearest unsmoothed soundings obtained from the cross-lines. The hydrographer shall perform a separate statistical analysis as a function of beam number for each of the main scheme/cross-line intersections used for comparison. Include a statement about the results in the Descriptive Report, and include a summary plot of each crossing.

5.11. Multibeam Sun-Illuminated Digital Terrain Model (DTM) Images

The hydrographer shall create two sun-illuminated DTM images. These sun-illuminated DTM images are the preferred method for detection of depth artefacts associated with errors in bottom detection algorithms, vessel motion compensation, navigation timing, water level correctors and false bottom detections.

Each image shall depict data illuminated from orthogonal directions, using a light source with an elevation no greater than 45 degrees. At a minimum, an 8 bit colour depth shall be used for compilation of the sun-illuminated images. The two sun-illuminated images shall be created from fully corrected data that meet accuracy and resolution specifications are cleaned of all anomalous soundings, and serve as the source for all smooth sheet soundings. Data shall be binned, line by line, using shoal biased filtering at a bin size not to exceed 5 meters + 5 percent of the depth.

The submitted digital image file shall be in a standard geo-referenced image format.

6. Gravity data

6.1. *Requirements to gravimeter*

The gravity data should be collected with a marine gravimeter, e.g. Lacoste and Romberg or similar type, capable of providing gravity measurements at an accuracy better than 2 mgal r.m.s. (1 mgal = 10^{-5} m/s²) after filtering. The filtering length (full width) will be no longer than 5 min. The drift of the gravimeter during marine observations will be less than 5 mgal/month. The contractor will indicate the performance and reliability of the proposed gravity survey system. In case of shorter errors or gaps in the gravimetric data collection, while operating with multibeam bathymetry, GEUS will not request a resurvey. However, as overall objectives 95% of all planned bathymetric survey lines longer than 5 km must have useable gravity data.

6.2. *Confidence check*

The marine gravity measurements will be tied to harbour reference gravity points before and after the bathymetric/gravimetric survey, ideally in South Greenland (GEUS will provide the necessary information). If the tie-ins are more than 1 week prior or after the actual survey, the contractor will demonstrate the performance of the gravimeter to be sufficiently stable to give a bias accuracy of better than 2 mgal during the survey period. The gravity reference point values must be given in absolute gravity system or IGSN71. A land gravimeter will, if necessary, be used to tie into reference gravity points not immediately located at pier.

7. Backscatter data

7.1. *Collection of backscatter data*

For all multibeam data a backscatter data set shall be collected and delivered in a documented format. Either as part of the multibeam data set or in separate backscatter data files. The data files shall be delivered in a format that can be imported to Caris SIPS.

7.2. *Backscatter mosaic*

A backscatter mosaic must be created and draped on top of the bathymetric data. The methods used to create the backscatter mosaic shall be documented.

8. Data delivery

8.1. *Media for data delivery*

All digital data shall be delivered on USB2 disc devices. The delivery shall consist of a master and an identical backup copy.

8.2. *Raw data*

All of the digital output from the multibeam sonar during data acquisition, and ancillary data not already integrated into the multibeam data stream including full orientation and position data, sound velocity profile information, tidal information and the integration parameters used

including (but not limited to) installation offsets, misalignment angles and clock time differences. Positional information will include, at least: number and geometry of satellites used in position computations; age of pseudo-range corrections used in position computation, and; horizontal dilution of precision associated with each position computation. In addition to data provided with sonar data telegrams, separate files containing the tide data and sound speed data applied to all multibeam soundings will also be provided. Tidal data will be supplied by GEUS prior to the survey. The data format and all data element descriptions (e.g., date/time referenced to UTC, tide relative to MLWS to nearest cm, etc.) will be described.

8.3. *Processed full density data*

Aboard ship, during the data acquisition phase, all the raw data, including multibeam and ancillary integrated sensors must be examined and errors removed. Data will be reduced for position, elevation, orientation, water column sound speed and refraction effects and provided in a cleaned fully integrated form. All soundings and ancillary raw and reduced data must be provided with quality flags, indicating whether the data has been rejected or deemed to be outside deliverable survey specifications. Cleaned, reduced data will be provided on appropriate media in FAU format (Annex A) WGS84/UTM zone 30.

8.4. *Conservation of multibeam data*

All data must be conserved in the dataset. Deleted data must be flagged in accordance with Annex A.

8.5. *Reduced data set*

A set of gridded data will be produced from the processed sounding data, from which two colour-coded shaded relief maps will be delivered. The shaded relief models will be illuminated from orthogonal directions with a sun elevation no greater than 45 degrees. Data will be gridded at a grid size that is approximately twice the mean horizontal footprint of the beam at nadir (e.g., a 1.5 degree system at 1000 m would be gridded at ~50 m). This implies that the data set will be divided into regions of common depth and gridded at different scales depending on depth. The number of gridding regions will be determined in consultation with GEUS. Other representations that achieve the same resolution limits may also be acceptable. Gridded data will be delivered in digital files on appropriate media as both FAU grids and ASCII XYZ format.

8.6. *Backscatter data*

For all multibeam data, raw backscatter data and reduced estimates of the seabed backscatter strength must be provided. The methods used to reduce the backscatter data will be fully documented. Geo-referenced maps of backscatter shall be provided at same scale as specified in paragraph 8.10.1.3.

A geo-referenced image file with the backscatter data draped on top of the bathymetric data shall be part of the delivery.

8.7. Gravimetric observations

Gravity data should be collected on all straight-line bathymetric tracks of at least 5 km length and constant speed. The raw marine gravity data will be collected and stored at 10 sec intervals or less. The contractor will provide GPS coordinates from the ship navigation system and bathymetric data depth vertically below ship extracted from multi-beam data at a similar interval for the processing of gravity data into marine free-air and Bouguer anomalies.

Processing of data will be done with zero-phase filtering, providing track no, UTC, latitude, longitude, filtered gravity, free-air anomalies (GRS80 ellipsoid) and marine Bouguer anomalies (standard density 2.67 g/cm³). A detailed processing report should include details on filtering and harbour gravity ties.

In case gravity harbour ties will require a major cost effort in terms of extra ship time, GEUS may be willing to accept the substitution on one or more harbour ties with ties (cross-overs) with existing marine surveys, providing such surveys are recent (i.e., GPS navigation has been used), demonstrated to have an accuracy of 1.5 mgal r.m.s. or better, and a well-defined and well-described gravity reference system. It is up to the GEUS to verify the quality of such data, and GEUS will give its consent for the substitution of harbour ties in advance. GEUS will be willing to help in providing information on suitable tie-in data sources from the national Danish gravity data base.

8.8. Metadata

Metadata will be provided for all bathymetric, backscatter and gravity data files.

8.9. Plot files

All data and digital plot files shall be provided on appropriate digital media in a completely documented format. The contractor will also provide a detailed listing of all files submitted, their size, and format.

8.10. Interim report

An interim report, including raw and processed data and draft colour shaded relief maps and backscatter maps, shall be delivered to GEUS within one week of completion of operations.

8.11. Descriptive report

The Descriptive Report is required for the hydrographic survey sheet completed, after field data acquisition and processing of the survey has been completed.

The primary purposes of a Descriptive Report are to:

- 1) help in evaluation of the survey;
- 2) assist the compilers producing or revising charts covering the area in which the survey has been conducted;
- 3) document various specifications and attributes related to the survey and its by-products;

4) provide a legal description of the survey standards, methods, and results. The Descriptive Report is archived as a historical and legal record for the survey.

The Descriptive Report supplements hydrographic sheets and sounding records with information that cannot be depicted or described in the digital data, or shown clearly in graphic form. The Descriptive Report describes the conditions under which the survey was performed, discusses important factors affecting the surveys adequacy and accuracy, and focuses upon the results of the survey. It contains required information on certain standard subjects in concise form, and serves to index all other applicable records and reports.

The following information is required in each Descriptive Report in the order listed below:

COVER SHEET with a clear indication of the area covered at a scale shown at a resolution equivalent to the DTM size. The cover sheet may be delivered in digital form. If delivered digitally the format must be in a standard geo-referenced image format.

TITLE SHEET see Annex C). The “Hydrographic Title Sheet” may be referred to for information pertaining to the survey.

The “General locality” will be dictated by the GEUS.

The “Start end date of survey” entries are the inclusive dates of the fieldwork.

The “Horizontal and vertical datum” and “Vertical measurement system” are dictated.

The “Min/max northing/easting and min/max latitude/longitude must describe the area covered.

For “Vessel name”, enter the name of the survey vessel.

For “Nationality”, enter the ship home port state.

The name(s) listed after “Surveyed by” are the personnel who supervised sounding operations and/or data processing.

The instrument section, enter the brand and type of equipment used as well as calibration dates.

The “Remarks” section should contain any additional information that will identify the project or clarify the entries above. Other Descriptive Reports or special reports containing information or data pertinent to the survey that are not listed in Section E of the Descriptive Report text should be referenced here. Note the time zone used during data acquisition (e.g., All times are recorded in UTC). List the name and address of the contractor and any subcontractors.

DESCRIPTIVE REPORT TEXT. Print the text on one-sided A/4 paper with left-hand margins of 3cm to permit binding. Do not use oversized sheets. Text shall be Times New Roman, with a font size of 12. Include all information required for complete understanding of the field records. If references are made to hydrographic features on any sheets, give the latitude, longitude and

datum of the feature. Discussions and explanations should be written in a clear and concise manner.

A digital copy of the Descriptive Report shall be provided in Word format.

Pages shall be numbered consecutively from the first page of text, continuing through the Approval Sheet (page numbers as footer, centred on page). Include a Table of Contents with page numbers.

Avoid using geographic names in the text of the Descriptive Report that do *not* appear on the nautical charts unless otherwise stated by the contractor.

A. AREA SURVEYED

Include a coverage graphic inclusive of the survey area. The information related to the survey should be clearly shown and highlighted in some way to draw attention to its location within the project area.

B. DATA ACQUISITION AND PROCESSING

B1. Equipment

In this section of the Descriptive Report list by manufacturer and model number only the major systems used to acquire survey data or control survey operations (e.g., multibeam sonar, vessel attitude system, positioning system, sound velocity system). The calibration dates of the equipment used must be included. Include a brief description of the vessel (e.g., length overall and draft). A detailed description of the systems used to acquire survey data or control operations shall be included in the **Data Acquisition and Processing Report** (for details see 9.9.1.1).

Include in a narrative description, with figures when useful, of any deviations from the vessel or equipment configurations described in the **Data Acquisition and Processing Report** (for details see 9.9.1.1).

B2. Quality Control

Discuss the internal consistency and integrity of the survey data. State the percentage (dictated by GEUS) of cross-line miles as compared to main scheme miles. Evaluate their general agreement. If the magnitude of the discrepancy varies widely over the sheet, make a quantitative evaluation of the disagreements by area. Explain the methods used to reconcile significant differences at crossings, and give possible reasons for cross-line discrepancies that could not be reconciled.

Discuss any unusual conditions encountered during the survey which would downgrade or otherwise affect the equipment operational effectiveness. Discuss any deficiencies that would

affect the accuracy or quality of sounding data. Document these conditions; including how and when they were resolved.

Describe any other factors that affected corrections to soundings, such as sea state effects, and unusual turbidity, salinity, or thermal layering in the water column.

B3. Corrections to Echo Soundings

Discuss any deviations from those described in the **Correction to Echo Soundings** section of the **Data Acquisition and Processing Report** (for details see 9.9.1.1).

Discuss the results of any patch test conducted after the initial patch test that affect the survey data and were not included in the **Data Acquisition and Processing Report**. Comment on the reason a new patch test was conducted.

C. VERTICAL AND HORIZONTAL CONTROL

In the Descriptive report it should be stated that corrections for tide were delivered by GEUS and applied.

State the horizontal datum and projection used for this survey. Briefly discuss the control stations used during this specific survey if other corrections than WASS/EGNOSS DGPS corrections are used. Explain in detail any difficulties that may have degraded the expected position accuracy.

D. RESULTS

Provide information of significant scientific or practical value resulting from the survey. Unusual submarine features should be described. Discuss any environmental conditions encountered, which have a direct bearing on the quality and accuracy of the hydrographic data. If special reports have been submitted on such subjects, refer to them by title, author, and date of preparation or publication.

E. APPROVAL SHEET

The Chief of Party or Lead Hydrographer shall furnish, on a separate sheet, a signed statement of approval for the survey and all related records. The approval sheet shall contain the following:

- Approval of Descriptive Report, digital data, and all accompanying records. This approval constitutes the assumption of responsibility for the stated accuracy and completeness of the hydrographic survey.
- A statement as to whether the survey is complete and adequate for its intended purpose or if additional work is required.

- The amount and degree of personal supervision of the work.
- Additional information or references helpful for verifying and evaluating the survey.

If appropriate, other personnel responsible for overseeing or directing operations on this survey sheet may also sign the Approval Sheet.

SEPARATES TO BE INCLUDED WITH THE SURVEY DATA

The following “**SEPARATES TO BE INCLUDED WITH THE SURVEY DATA**” supplementing the Descriptive Report shall be submitted with each survey. The Separates shall be bound, organized and clearly labelled. The Separates should be included in the digital Descriptive Report file, but may be submitted digitally as separate files, if available.

I. ACQUISITION AND PROCESSING LOGS

Include all acquisition and processing logs from the present survey. Include positioning confidence checks and multibeam checks.

II. SOUND VELOCITY PROFILE DATA

Include a table, which identifies the specific sound velocity profiles used during the survey. List the positions and dates of all casts used; the maximum cast depth; and the dates/times for which the profiles were applied. Refer to the location where the digital sound velocity files are located, and include a directory listing of the files. If appropriate, describe how the survey area was zoned to account for sound velocity variations from differing water masses. Printouts of individual sound velocity profiles are not required.

Include confidence check results. Include copies of sound velocity profiler calibration report(s), if calibration occurred after submission of the **Data Acquisitions and Processing Report**.

III. SURVEY SPECIFICATION

Include a copy of the survey specification. Include all changes/modifications which apply to the survey.

IV. CROSSLINE COMPARISONS

Include the summary plot analysis as a function of beam number for the main scheme/cross-line intersections as required in Section 5.10.3.

8.11.1. Descriptive Report Supplemental Reports

8.11.1.1. Data Acquisition and Processing Report

This report is separated into three sections, **Equipment, Quality Control, and Corrections to Echo Soundings**. These sections shall contain a detailed discussion on the project specific information addressed below.

A digital copy of the main text of the Data Acquisition and Processing Report shall be provided in Word format.

Include a cover sheet and title sheet which contain the following general information:

Cover Sheet. Include the type of survey(s), state, general locality and year. (Annex D)

Title Sheet. This contains additional descriptive information relative to the project. See Annex C for details.

A. Equipment

Describe the major operational systems used to acquire survey data or control survey operations. Include the manufacturer, firmware version and model number, operational settings and how the equipment was used. Include a description of the vessel(s) used.

Specifically discuss Multibeam and backscatter systems and operations in this section. Include range scales, number of beams or min/max angles, resolution, along track coverage, and quality assurance tools used during data acquisition. If applicable, explain the calibration or determination of correctors, the dates of most recent calibrations, state whether or not checks were made on their accuracy and describe any non-standard procedures used.

Discuss the computer hardware and software used for all data acquisition and processing. Describe acquisition and processing methods, procedures, and parameters used. Provide a complete list of all software versions and dates.

B. Quality Control

Provide a description of the data processing routines for converting raw sounding data to the final smooth sounding values. Include a description of the methodology used to maintain data integrity, from raw sounding data to final soundings. Processing flow diagrams are helpful. Any methods used to derive final depths such as cleaning filters, sounding suppression/data decimation parameters, binning parameters, and processing algorithms shall be fully documented and described in this section.

Discuss the methods used to minimize the errors associated with depth determination (see Section 5.9).

Methods and standards used to examine backscatter records should be noted and a brief description of processing procedures should be provided. Include the methods for establishing proof of swath coverage and the criteria for selecting contacts.

C. Corrections to Echo Soundings

This section addresses the methods used for the determination of all corrections to echo soundings that apply to the entire project. Describe the methods used to determine, evaluate, and apply the following corrections to echo soundings:

- Instrument corrections.
- All vessel configuration parameters, offsets, layback, etc include diagrams, pictures, or figures of the equipment as installed onboard.
- Static and dynamic draft measurements.
- Heave, roll, pitch biases, and navigation timing errors. State the manufacturer, model, accuracy, and resolution of heave, roll, and pitch sensor(s). Discuss accuracy and alignment test procedures and results. Include copies of system alignment, accuracy, and calibration reports.
- Include the source of tide or water level correctors supplied by GEUS and used for data processing and final sounding reduction.

D. Approval Sheet

The Chief of Party or Lead Hydrographer shall furnish, on a separate sheet, a signed statement of approval for all information contained within the **Data Acquisition and Processing Report**.

If appropriate, other personnel responsible for overseeing or directing operations on this project report may also sign the Approval Sheet.

8.11.1.2. Vertical and Horizontal Control Report

The **Vertical and Horizontal Control Report** is a report which shall be submitted before, or not later than, the submission of the **Interim Report**.

A digital copy of the main text of the Vertical and Horizontal Control Report shall be provided in Word format.

Include a cover sheet and title sheet which contain the following general information:

Cover Sheet. Include the type of survey(s), state, general locality and year.

Title Sheet. This contains additional descriptive information relative to the project. Include project number, survey registry numbers to which this report applies (with associated dates of survey and locality) reference to the survey specification, vessel(s) and Chief of Party/Lead Hydrographer. See Annex C for details.

A. Vertical Control

The **Vertical Control** section of the project shall include the tide documented and supplied by GEUS.

B. Horizontal Control

The **Horizontal Control** section of the project shall document Hydrographic Position Control activities that took place as part of the project. State the source that has been used for DGPS corrections.

For horizontal control stations established by the field unit, describe the survey methods used to establish the station, and state the standards of accuracy used. Include position accuracy plots. If horizontal control stations have been established by the field unit, list:

- The latitude to the nearest 1/1,000th of a second.
- The longitude to the nearest 1/1,000th of a second.
- The station elevation (ellipsoidal height).
- The geodetic station name and year it was established. Briefly, describe the methods and adequacy of positioning system confidence checks.

C. Approval Sheet

The Chief of Party or Lead Hydrographer shall furnish, on a separate sheet, a signed statement of approval for all information contained within the **Vertical and Horizontal Control Report**.

If appropriate, other personnel responsible for overseeing or directing operations on this project report may also sign the Approval Sheet.

8.11.1.3. Cartographic Specifications and Conventions

8.11.1.3.1. *Projection*

The Universal Transverse Mercator projection shall be used. WGS84 latitude and longitude lines shall be shown by continuous lines fine enough so that soundings will not be obscured. Labels for meridians and parallels shall be in degrees, minutes, and decimal minutes and are placed in the sheet margins beyond the limits of hydrography.

8.11.1.3.2. *Plotting Scale*

The smooth sheets should be plotted at a scale of 1:100.000.

8.11.1.3.3. *Soundings*

Soundings and related hydrographic detail needed to compile nautical charts are important observations of a hydrographic survey. It is essential that the final corrected soundings plotted on the smooth sheet be accurately and graphically displayed in a uniform manner. The soundings shall be actual corrected soundings. Gridding, averaging, or other sounding manipulation shall not be conducted.

Sounding numerals shall be between 1.8 (preferred) and 2.0 mm high and uniform across the smooth sheet. At this size, legible reproductions can be made at reduced scales. The centre of the sounding numeral or group of numerals is the position of the sounding.

8.11.1.3.4. *Sounding Units and Conversion*

All soundings on the smooth sheet shall be plotted in units of meters.

When rounding corrected and converted soundings, the following procedures shall apply:

- Depths should be truncated to the nearest meter.
- Spacing of Plotted Soundings

The spacing and density of soundings on smooth sheets shall be such that each depth curve is delineated adequately and the configuration of the bottom is fully revealed. The smooth sheet soundings are generally spaced uniformly at 4-7 millimeters apart. Soundings shall be clearly legible and not plotted over adjacent soundings.

8.11.1.3.5. *Selection of Soundings and Processing*

Soundings must be selected from valid filtered soundings from the hydrographic records to plot on smooth sheets using a shoal-biased selection routine.

With a Multibeam system, a relatively high percentage of smooth sheet soundings originating from only a few beams may indicate the presence of systematic or system specific errors in the acquisition or processing systems. The hydrographer shall construct a histogram showing the count, by beam number or beam angle, of the selected soundings. The histogram and the hydrographer's analysis of the results shall be included in Section B of the Descriptive Report. If necessary, the data shall be re-processed and the smooth sheet re-drawn using the newly selected soundings.

When sounding lines overlap or cross, the shoaler soundings shall be plotted. If the difference is significant, then the data must be analyzed to determine the cause of the difference.

The selected data set shall be tagged in a manner such that the selected data can be re-traced to the Multibeam data set. The attribute or tag shall include, but is not limited to, XY (latitude, longitude, WGS84), Z (depth in meters), year, day number, and time.

8.11.1.3.6. *Depth Curves*

The depth curves are indispensable for a comprehensive interpretation and examination of a hydrographic survey. The best gauge of the survey's completeness, adequacy, and accuracy is to be able to draw closely spaced depth curves with an assurance that the submarine relief is depicted accurately.

Depth curves shall be drawn based on soundings selected using the shoal-biased selection routine noted above. Depth curve intervals required on survey smooth sheets are specified in Annex F. The standard depth curves shall be plotted in the prescribed colours. The supplemental depth curve shall be added where necessary and shall be drafted in red ink.

Depth curves are broken into long dashes where not adequately defined by the soundings (e.g., extremely flat monotonous bottoms where the plotted soundings defy the drawing of a meaningful curve).

8.11.1.3.7. *Geographic Names*

Geographic names shall not be placed on the smooth sheet.

8.11.1.3.8. *Title Block*

The information to be entered in the title block (Figure 8.2.1) of the hydrographic smooth sheet is extracted from the Title Sheet in the Descriptive Report. Title blocks shall be oriented with their base parallel to the sheet edge. Approximate dimensions

for the title block are a height of 15 cm and a width of 20 cm. The hydrographer shall sign the smooth sheet in the title block.

Survey data or notes shall not, under any circumstances, be shown inside the title block. The smooth sheets must be laid out so there is sufficient space for the title block. No particular portion of a sheet is favoured over another for the title block.

9. Education and experience

9.1. Education

It is a requirement that at least the Hydrographer or Party chief hold a hydrographic certificate category A or equivalent.

9.2. Experience

CV for all relevant personnel involved in survey data collection or processing data shall be included.