

ICES

Guidelines for Multibeam Echosounder Data

(Compiled September 2006)

If you are considering producing a hydrographic survey please read the following information first. Your survey could be used to compile new or updated nautical charts and so help improve safety for mariners. Your survey does not have to be carried out to full charting standards and all data collected is potentially of use. Even without a full search for dangers, a modern survey can improve on our knowledge of the seabed.

Some advice on how to help us to get the best out of your survey follows below. But even if you are unsure about these requirements, we would still like to receive a copy of your survey. It may reveal changes that should be shown on the chart as a “less water reported” legend, and/or may lead to a full survey being carried out.

Hydrographic and bathymetric data centres such as the UK Hydrographic Office’s (UKHO) Seabed Data Centre (SDC) (see Annex B for contact details) are always happy to give help and advice on hydrographic data gathering requirements in order to increase the usefulness of hydrographic survey data.

Just a few minor changes to how your data is gathered and presented can make it much more useful for charting and other purposes.

1.0 RECEIVING DATA

Hydrographic and bathymetric data centres require the following information to be supplied by the data supplier together with the data.

1.1 *Data Standard*

This guideline is designed for use by agencies working outside of the immediate area of hydrographic surveys for charting. Many agencies collect swathe (i.e. multibeam or interferometric) echosounder data in the course of their operations at sea, and much of this data can often be of great use for navigational purposes, especially in areas of poor survey coverage. Although all such data is of use, and hydrographic offices such as the UKHO would welcome the receipt of it, its usefulness can be greatly enhanced if data is collected to a suitable standard and sufficient information is provided to permit the receiving hydrographic office to assess the data. With this in mind, the following information is provided to help agencies provide data that may be fully utilised in future navigational products.

1.2 Format Description

Capability may vary from office to office. For example the UKHO is able to accept processed swathe data in the following formats:

- Caris HIPS Project
- Kongsberg Maritime “Neptune” Project
- IVS “Fledermaus” PFM
- GSF
- ASCII

Raw Data files

All raw data should be supplied where feasible. It is useful to keep this separate to the processed data. The UKHO is able to accept raw swathe data in a variety of formats, including;

- Kongsberg Maritime “Merlin” format (.all files)
- XTF
- GSF
- Atlas
- Elac
- Geoacoustics
- Hypack
- LADS
- SHOALS

Caris HIPS VCF

If Caris HIPS has been used to process the data, then any VCF or HVF files would be very useful.

Delivery Media

Capabilities will vary but as an example the UKHO is able to accept data on various electronic media (including FTP). The media should be appropriate to the size of the data set.

- For datasets of 20GB or more, we recommend USB2 portable hard disk(s). These can be returned to the sender within 2 weeks.
- For datasets of 1GB to 20GB, we recommend DVD or DAT.
- For datasets of less than 1GB, we recommend CD or DVD.

1.3 Collection Details

When supplying data, the following are required to allow proper assessment and use of swathe bathymetry;

Vessel Offsets

The X,Y,Z offsets between each sensor and the vessel reference point (RP) should be measured, recorded and input to the navigation computer before the start of survey. The RP is conventionally placed either at the approximate centre of gravity (CoG) of the vessel or at the motion sensor.

Positioning

Before commencing survey work the survey positioning system should be checked for accuracy using known survey points on land. This should ideally be done before the multibeam calibration. All position data must be logged during the survey. Usually this is in a combined file with the raw multibeam data.

Motion Sensor Data

During installation the motion sensor should be corrected for alignment errors in pitch and roll. This can either be done using land survey techniques while the vessel is dry docked, or the sensor can be “zeroed out” while the vessel is at a tight mooring alongside. The correction values should be recorded and entered into the appropriate software. This should be done before the multibeam system is calibrated. Whilst surveying all motion sensor data must be logged. Usually this is in a combined file with raw multibeam data.

Heading Data

During installation the heading sensor should be checked for gross errors and any alignment errors (the difference between the heading of the sensor and the heading of the vessel). These can be checked while the vessel is alongside at a tight mooring using land survey techniques. The correction value should be recorded and entered into the appropriate software. Whilst surveying all heading data must be logged. Usually this is in a combined file with raw multibeam data.

Multibeam Data

Before commencing a survey the multibeam system must be calibrated for timing and alignment errors (latency, pitch, roll & yaw) by carrying out a patch test (see Annex A). The results from the patch test should be recorded and entered into the navigation software. During survey all the raw multibeam data must be logged. Usually this is in a combined file with raw position, motion sensor and heading sensor data.

Sound Velocity in Sea water (SV)

The speed of sound in sea water (SV) must be measured in the survey area at intervals dependent on the environment being surveyed. At a bare minimum the SV should be measured at least once every day. But if working in an environment with a suspected variable SV (such as near the mouth of a river) then more frequent measurements should be taken, preferably at least every 4 hours or if the sound velocity is deemed to have changed by 1 m/s or more. This data must be entered in to the navigation software to allow for online refraction correction of the multibeam system. Depending on the navigation software used these files can be embedded in the raw multibeam logged files or logged as a separate file.

Tidal Data

Tidal information is required at the survey site. Preferably this is measured by one or more tide gauges (depending on the size of the area) deployed in the survey area for the duration of the survey. If this is not possible then a gauge at a nearby port could be used and the tidal data extrapolated using co-tidal information. Tide height should be recorded at 10 minute intervals with the high and low waters also being recorded. Some gauges can self compensate for air pressure changes, but if using a bottom mounted pressure gauge, air pressure readings must be recorded at the same interval as the tide gauge. This can be used when processing the tide gauge data to compensate for air pressure changes. Care must be taken as to the units of measurement such as atmospheres or kPa.

If a hard copy plot and/or .dwg drawing is available, please also supply that, as it helps UKHO to check that the digital data is complete. Drawings may also include useful non-bathymetric detail, such as coastline and details of construction projects. Please record any differences between the digital data and the drawing, especially if depths on the drawing have been edited, but the edits have not been applied to the digital data.

2.0 VALUE ADDED SERVICE

When processing and quality controlling data, hydrographic and bathymetric data centres of the ICES community shall strive to meet the following guidelines

2.1 *Quality Control*

The quality control procedures followed by the Data Centres will typically identify problems with the data and/or metadata. The Data Centre will resolve these problems through consultation with the originating data supplier. Other experts in the field or other Data Centres may also be consulted.

Ideally, the accuracy of both the depth and position of soundings should meet IHO S44 Order 1 requirements (see references) and the density of the data should be such that the minimum target sizes stated in IHO S44 Order 1 are always detected. A report should describe how the data was gathered and processed. It is particularly useful if the report can include:

- A list of the equipment and software used, and the personnel involved.
- How positioning equipment was set up and used
- How the echo-sounder transducer was set up and levelled
- How tides were measured, how the tide pole or tide gauge was levelled and how depths were reduced to chart datum. NB a levelling diagram is a useful method of confirming that datum adjustments have been carried out correctly.

Error Budget

If a fully developed error budget based on the specifications and experience of the system has been developed, this will also be extremely useful in the assessment of the data. See Reference - IHO Standards for Hydrographic Surveys.

2.2 Problem Resolution

The quality control procedures followed by the Data Centres will typically identify problems with the data and/or metadata. The Data Centre will resolve these problems through consultation with the originating Principal Investigator (PI) or data supplier. Other experts in the field or other Data Centres may also be consulted

2.3 History Documentation

Report of Survey (ROS)

If a report of survey has been produced (regardless of format), this will also be extremely useful in the assessment of the data. A template ROS can be supplied from UKHO if requested – see Annex B.

3.0 PROVIDING DATA AND INFORMATION PRODUCTS

When addressing a request for information and/or data from the User Community, the hydrographic and bathymetric data centres of the ICES community shall strive to provide well-defined data and products. To meet this objective, the Data Centres will follow these guidelines

3.1 Data Description

When delivering Multibeam Survey data the following items are required. :

Vessel Offsets : The X,Y,Z offsets between each sensor and the vessel reference point should be supplied.

Geodetic / Tidal Information : The datum, spheroid and projection used for the survey should be provided. The tidal datum should be described, along with how this ties into other datums (i.e. levelled to UK Ordnance Datum). Any levelling diagrams and benchmark information is useful.

Notable Features : Comments should be provided if at all possible on any notable features in the data, e.g.:

- shoal depth values that may represent buoys, shoals of fish, side echoes off quay walls, electrical noise, etc.
- details of wreck investigations.
- charted dangers not found during the survey.

Alignment Error Data : All recorded values for the motion and heading sensor alignment errors should be provided along with the values obtained from the multibeam patch test.

Processed Data Files : All processed data files should be supplied along with the relevant sound velocity files and processed tide files. Information outlining the directory structure, number and size of files should be supplied to ensure that no data is missing. The data should not be gridded in any way – the actual soundings should be supplied.

3.2 Data History

A data history document will be supplied with the data to include the following:

- A description of data collection and processing procedures as supplied by the data collector (as specified in Section 1.1 and 1.3)
- Quality control procedures used to check the data (as specified in Section 2.1, see below)
- Any problems encountered with the data and their resolution
- Any changes made to the data and the date of the change

Any additional information of use to secondary users which may have affected the data or have a bearing on its subsequent use should also be included.

3.3 Referral Service

ICES member research and operational data centres produce a variety of data analysis products and referral services. By dividing ocean areas into regions of responsibility, and by developing mutually agreed guidelines on the format, data quality and content of the products, better coverage is obtained. By having the scientific experts work in ocean areas with which they are familiar, the necessary local knowledge finds its way into the products. Data and information products are disseminated as widely as possible and via a number of media including mail, electronic mail and bulletin boards.

If the Data Centre is unable to fulfil the client's needs, it will endeavour to provide the client with the name of an organisation and/or person who may be able to assist. In particular, assistance from the network of Data Centres within the ICES Community will be sought.

3.4 Data to be submitted

The guidance above is to be followed wherever possible. However, if all the above requirements cannot be met this should not prevent the data from being submitted. All data collected is potentially of use especially in areas where existing data is sparse and/or old.

REFERENCES

IHO Standards for Hydrographic Surveys 4th Edition April 1998 Special Publications
No 44 <http://www.iho.shom.fr/publicat/free/files/S-44-eng.pdf>

Annex A - Suggested Patch Test Procedure

Latency Test - (Sharp Target in Shallow Water). Produce two overlaid longitudinal profiles (of different colours) clearly showing the target at nadir after a latency correction has been determined and applied. The two profiles should be obtained by performing two co-linear and co-directional survey lines (one at slow speed and one at high speed) directly over a sharp target. The report should briefly detail the method and result of the calibration and should clearly state that the observations were undertaken with all MBES latency and attitude corrections set to zero.

Pitch Test – (Sharp Target in Deep Water). Produce two overlaid longitudinal profiles (of different colours) clearly showing the target at nadir after both pitch and latency corrections have been determined and applied. The two profiles should be obtained by performing two co-linear survey lines (both at standard survey speed) on reciprocal headings directly over a sharp target. The report should briefly detail the method and result of the calibration and should clearly state that the observations were undertaken with all MBES attitude corrections set to zero, but with the deduced latency correction applied.

Roll Test – (Flat seabed in Deep Water). Produce two cross-profiles (of different colours) clearly showing the same section of seabed after pitch, latency and roll corrections have been determined and applied. The two profiles should be obtained by performing two co-linear survey lines (both at standard survey speed) on reciprocal headings over a flat section of seabed. The report should briefly detail the method and result of the calibration and should clearly state that the observations were undertaken with the deduced latency and pitch corrections applied but with all other MBES attitude corrections set to zero.

Yaw Test – (Sharp target in Deep Water). Produce two co-registered contour plots (of different colours) clearly showing the target at a large off-track distance after latency, pitch, roll and yaw corrections have been determined and applied. The two data sets should be obtained by performing two parallel, co-directional survey lines with 25% overlap. The first line should have the target close to the starboard extremity of the swath. The second line should have the target close to the port extremity of the swath. The report should briefly detail the method and result of the calibration and should clearly state that the observations were undertaken with the deduced latency, pitch and roll corrections applied but with all other MBES attitude corrections set to zero.

Pitch/Roll Cross-Correlation Test (Wobble Test) – (Flat Seabed in Deep Water). Sail the vessel at survey speed in such a direction relative to the sea and swell so that pitch and roll are maximised. Adjust the IMU misalignment value (in the motion sensor software) around the Z-axis so as to subjectively minimise any degradation (wobble) on the outer beams (this wobble is due to pitch/roll cross-correlation). The report should briefly detail the method and result of the calibration and should clearly state that observations were undertaken with the deduced latency, pitch, roll and yaw corrections applied.

Annex B – Contact Details – UK Hydrographic Office

Digital survey data (and associated information) should be addressed to:

Seabed Data Centre
United Kingdom Hydrographic Office
Admiralty Way
Taunton
Somerset
TA1 2DN
United Kingdom