

EM Technical Note

Multibeam survey planning - The key to success



KONGSBERG

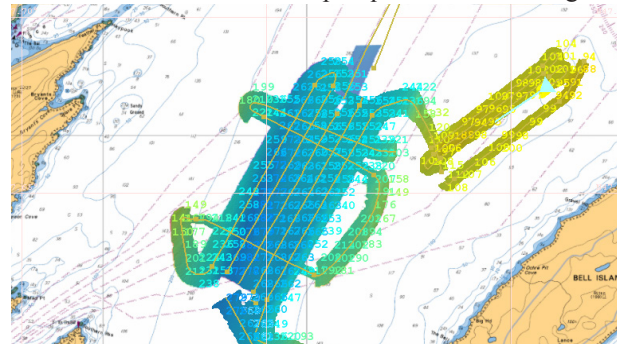
Fact: Proper survey planning saves you time and money

The what, the why, the how of multibeam survey planning

When planning the survey lines islands, coastlines, shoals and other obstacles within the survey area that may have influence on safety or efficiency of the survey must be taken into account. Nautical charts in digital format and/or aerial photos are extremely important as background data. The achievable coverage of the multibeam echo sounder and the overlap required between neighbouring lines is usually used to determine the line spacing.

A survey plan will normally define the following factors:

- The survey area (use background charts and/or aerial photos)
- Bottom conditions
- The survey lines
- The direction and order of the survey lines
- The survey lines required for system calibration
- The location and timing for sound speed profiles.



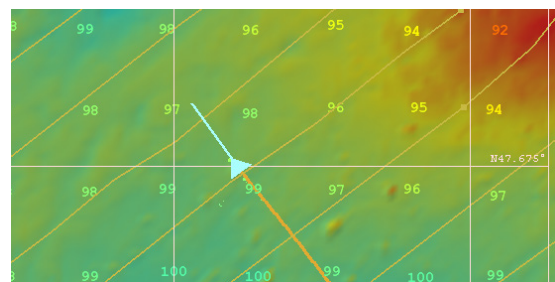
Example of survey after calibration patch test

A fully comprehensive survey plan is most useful in areas of deep waters or where the depth and hence coverage is fairly constant. In shallow waters where the depth changes rapidly and may not even be known, a comprehensive plan may not be as useful, especially if the survey is to be run with a small and agile vessel. A defined survey area boundary plus a few pre-planned lines for calibration may then be enough. Actual coverage is obtained on the spot instead of being used to determine the survey lines.

The SIS Planning module allows a survey to be split into sub-surveys or jobs. The survey area boundary may be defined as a polygon with any number of corners, as may areas which are not to be entered. Automatic line clipping at the polygon boundaries and automatic generation of parallel lines is supported. During the survey, planned lines may be activated to generate steering information for the bridge and helmsman's display. The purpose of the Planning module is thus to provide help before and during the survey.

Factors to consider

- A survey is normally planned taking the following into account:
 - The geography and extension of the survey area
 - Suitable areas for calibration patch tests
 - Echo sounder coverage
 - Seafloor topography
 - Sound speed variations
 - Weather conditions
- The requirements for calibration of the positions (time delay), heading, roll and pitch sensors must be considered, and how and where to gather sound speed profiles.
- Coverage capability determines line spacing, and as it varies with bottom reflectivity, this must be estimated. Usually 10% overlap between lines is sufficient, but if large variations in bottom reflectivity is expected, or reflectivity is unknown, it may be necessary to increase the overlap. The overlap must also be increased if the vessel's roll is excessive.
- If there are steep slopes on the bottom, it is strongly advised to run along these slopes, not up or down them. This is beneficial for keeping coverage reasonably constant along the survey lines, thus making survey planning easier. However, the main reason for this advice is that the echo sounder performance will usually be poorer when running up or down a slope rather than along. This is because less acoustic energy is reflected towards the transducer from steep slopes, causing poorer detections and the possibility of false detections in sidelobes. Sidelobe detections is however very rare in the Kongsberg multibeam echo sounders due to the advanced signal processing implemented. Note that if circumstances require that survey lines are run up or down slope, reduction of vessel speed may be required to allow the echo sounder to track the bottom continuously. During the survey, planned lines may be activated to generate steering information for the bridge and helmsman's display. The purpose of the Planning module is thus to provide help before and during the survey.
- Coverage capability is also affected by weather conditions and possibly also by vessel speed. Heavy seas and possibly vessel speed lead to increased noise level, and may also cause aeration on the Sonar Head or the transducer array.



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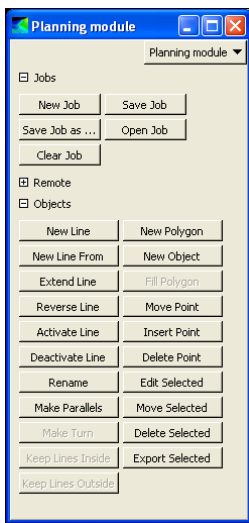
• Aeration is a function of sea state, but also of the heading with respect to the wave direction and the vessel speed. It is strongly advised that one builds a record of coverage and aeration problems versus sea state, heading with respect to wave direction, and vessel speed. This record may be helpful in ensuring that surveys can be performed efficiently with a minimum of line rejections and corresponding reruns and infills.

• Any drift rates of roll, pitch and heading should also be recorded to enable efficient planning of calibration intervals. If calibration is required before a survey, a suitable calibration area must be identified before reaching the survey area.

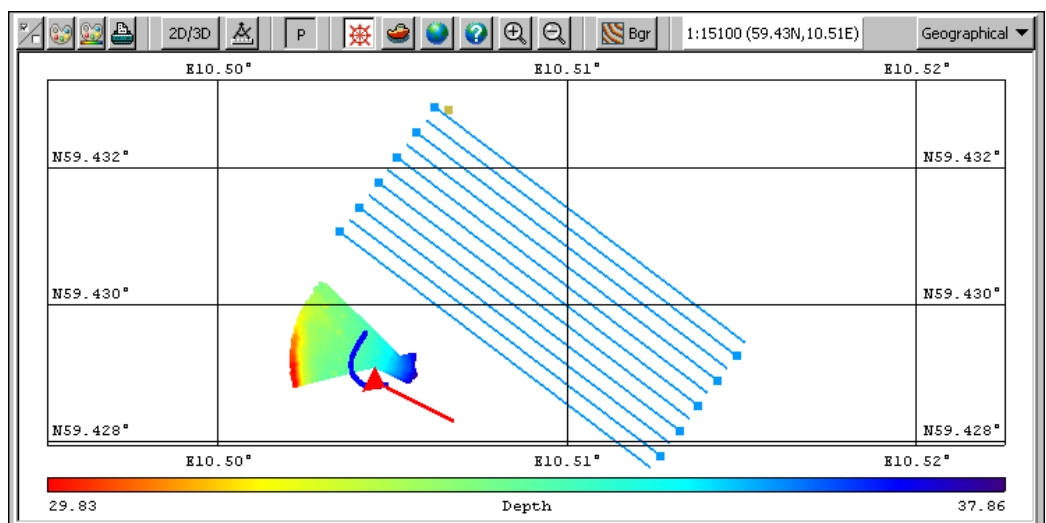
• A sound speed profile must always be taken within the survey area and loaded into SIS before the survey is started. In some areas the profile will vary, mostly due to fresh water inflows from rivers or currents from areas with different salinity. Surface sound speed variation may be strongly affected by solar warming. If variations can be expected, where and when sound velocity profiles are to be taken must be planned, and the survey line schedule adjusted to take this into account.

• If the measured sound speed value at the Sonar Head or the transducer array depth is continuously measured, it is recommended to compare this to what is observed by the profiling instrument to evaluate the need for observing a new profile.

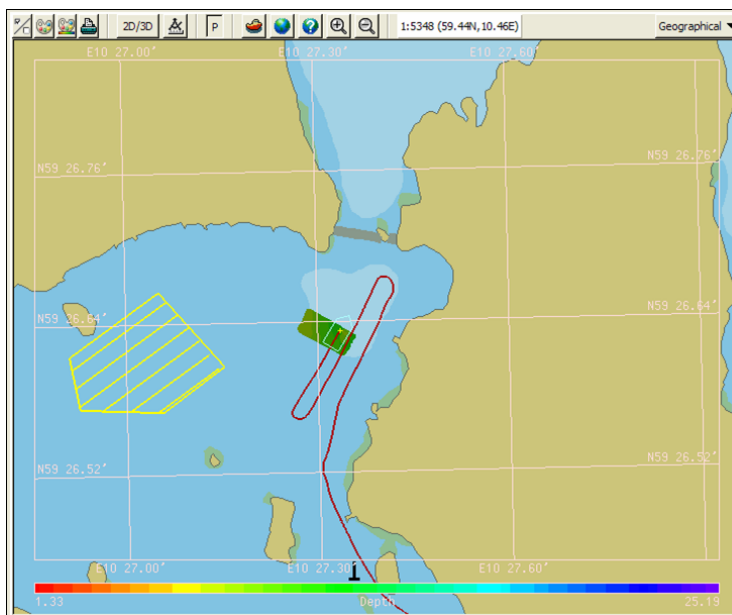
• Note that in some cases the coverage capability of the echo sounder cannot be fully utilized, because remaining errors in roll and sound speed profile measurements, which are critical for maintaining the accuracy of the outer beams, become too large. The ray bending effect (Snell's law) may also reduce the online coverage since the energy can bend inwards.



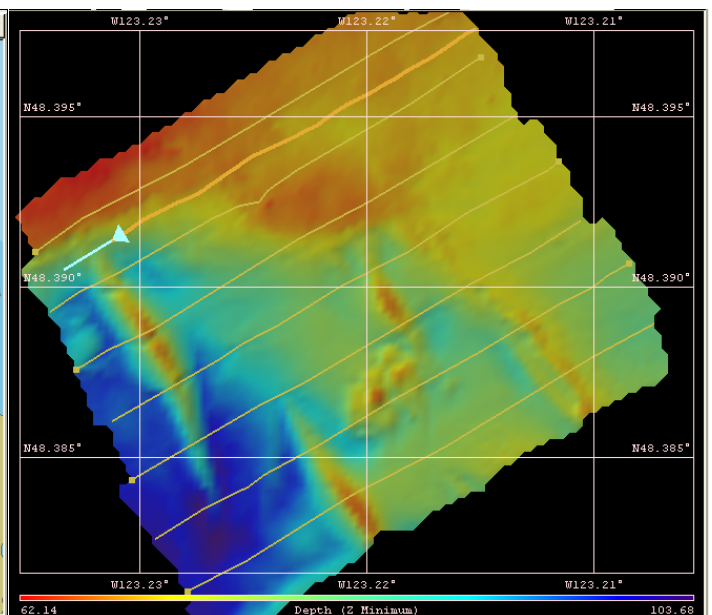
The Planning module in SIS



Planned survey lines in the Geographical window in SIS



Planned survey lines inside a polygon (S-57 background)



Completed multibeam survey in SIS

January 2014

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