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Title:	**Recommended operating guidelines (ROG) for acoustic ground discrimination systems (AGDS)**
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Recommended operational guidelines for acoustic ground discrimination systems

1. Single-beam Acoustic Ground Discrimination Systems (AGDS)

Acoustic Ground Discrimination Systems (AGDS) analyse the output signal from a single-beam echosounder and extract data on signal strength and rate of decay. These measurements are interpreted as acoustic properties of the seafloor, loosely termed 'roughness' and 'hardness'. Although the echosounder ensonifies an area of the seafloor that depends on the beam angle of the transducer as well as water depth, the data are essentially point data collected along the survey vessel's track. Thus, the resolution of the system is determined more by track spacing than any other consideration. This means that AGDS are coarse resolution remote sensing systems, but they have advantages over swath systems in being relatively cheap, easily deployed on vessels of all sizes and producing low volumes of data. Further details of these designs can be found in the MESH Review of AGDS (http://www.searchmesh.net/default.aspx?page=1442) and the Procedural Guidelines in the Natura 2000 Marine Monitoring Handbook (Foster-Smith *et al*. 2001) (available at http://www.nhbs.com/).

1.2 Pre-installation and mobilisation

It is likely that each AGDS will have its own echosounder, although they can be adapted to different sounders. AGDS may be a permanent fixture on a research or fishing vessel and hard-wired into the ship's echosounder. If AGDS are to be deployed from vessels of opportunity then portable systems with dedicated sounders are required. Vessels suitable for work should have adequate cabin space for electronic equipment. Small vessels are adequate for sheltered inshore waters, although AGDS can perform well in quite rough conditions. There are no particular hazards for operators of AGDS, particularly since they consume little power. The usual method is to mount the transducer on a pole strapped to the side or the bow of the boat. For pole mounting observe the following:

- The pole can be of galvanised steel of a suitable diameter and thickness for the boat. The pole can be quite thin (as little as 3 cm diameter) for small craft with low draft, but wider and thicker for large vessels with a deep draft;
- The transducer should be below the depth of aeration, making allowances for roll (usually in excess of 1 m for small vessels and deeper for large vessels);

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- Ensure that aeration is not introduced through the hollow pole by blocking the ends if necessary;
- The poles can be attached to the vessel sides by ratchet straps. The pole does not need to be exactly vertical, but should not be removed during the course of a survey; if this is not possible, care should be taken to reposition the pole as near to the same configuration each day;
- The pole must be fixed as firmly as possible to the side of the boat and it is important to brace the pole with a strap or line from the bow of the boat to a point on the pole at least 30 cm from the transducer. If the strap is too close to the transducer, aeration may follow the strap to the transducer's depth;
- If the dGPS used with the system is portable, then the antenna can be mounted on top of the pole to reduce positional error;
- Ensure all cables are kept safe and away from walkways, etc;
- Power consumption is low and the AGDS can be run either directly from a DC source or via an inverter (depending on the system). The system may however, require a sine wave inverter rather than a square wave inverter for the signal processor to work;
- Some sources of error are hard to trace. It is not unknown for strange electrical circuits to be set up through NMEA connections to ship's dGPS. If in doubt, use an independent system you can rely on;
- Modern AGDS are very small and portable and can even be transported by air as part of luggage allowance.

1.2 Test and verification protocols

Some ground types give variable responses depending upon the direction a vessel travels over seabed features. For these reasons, it is important to standardise data from day to day and even during the day. There is some debate about the best way to carry out standardisation and the following may offer some guidance:

- Keep tracks parallel and compare adjacent tracks;
- Run some tracks transversely across main tracks;
- Run tracks over a known area with clearly defined ground types at the start and finish of every day's survey;
- Overlap some tracks from one day to the next.

It is usually obvious, from looking at the data in a GIS coloured to show the values, when values are inconsistent. If the tracks seem very variable, the data should be discarded and the set-up of the equipment checked and the configuration altered accordingly.

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1.3 Recommended Operation Guidelines (ROG) and quality control procedures

- AGDS vary considerably as to reliability and repeatability. Some give consistent results while others are more inherently variable and/or sensitive to conditions. It is important that the system has been commissioned by the manufacturer and the signal processor is properly matched to the sounder and transducer;
- AGDS can work in quite rough conditions and still return valid values, although opinion varies as to exactly what effect surface disturbance has. Values do seem to vary during a survey, however, although the exact cause is hard to pinpoint. It is likely that changes in salinity, thermoclines and high turbidity may affect the values;
- AGDS can work at quite high vessel speeds, depending on vessel and deployment. Although reported to work up to 20 knots, a recommended maximum speed is 10 knots;
- The equipment should be regularly checked during operation to ensure that fastenings have not moved, the pole remains secure, straps have not frayed and seaweed has not caught around the transducer;
- Check that the ship's sounder does not interfere with the AGDS. If it does, then the ship's system must either switch to a different frequency or be turned off. If necessary, the AGDS echosounder screen should be repositioned so that the skipper can see it for navigational purposes. This is particularly likely to be needed on small vessels;
- The operators should frequently check the data logging and display system to ensure that data are still being collected and that they appear reliable;
- Although the system can work with tracks criss-crossing (as happens if the data are logged when the vessel is tracking during the course of some other task), it is far better to devote time to tracking so that the lines are roughly evenly spaced and straight;
- Tracking can be done in conjunction with other acoustic work (e.g. side-scan, swath) as long as there is no acoustic interference between the systems;
- The operators should keep a check on the heterogeneity of the ground (as indicated by logged values where these are displayed in real time). Varied ground may dictate that planned track spacing may need to be altered. Decreasing track spacing will help overcome some of the problems of interpretation of AGDS data over heterogeneous ground;
- It is strongly recommended that the AGDS data collection team contains someone who will also be ground truthing the survey so that there is transference of experience of the acoustic ground types between these two parts of the survey.

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1.4 Data storage and backup recommendations

The data storage requirements for AGDS are relatively modest. It is unlikely that a RoxAnn™ survey will require more than 2 MB per day, while QTC™ may require more space if full features are recorded. The data should be backed up on a day-to-day basis and, if possible, processed to reveal trends in the data that might help the planning of the following day's survey.

1.5 Recommended logging information

The main information to be logged is contained in the metadatabase (LINKS). It is important, however, that a running paper log is kept of conditions; this can be referred to when trying to source variability in the results. The reader is referred to the documents linked in the Introduction to understand variability. Any change in conditions or performance of the ship and interruptions to power supply should be noted.

1.6 Demobilisation notes

For storage, wash and check cables for nicks as small leaks can create intermittent shorts that can be very difficult to detect.

1.7 Training and safety

Some experience with mounting the pole to the side of the vessel may be advisable. Otherwise, there are no special skills required to operate the equipment. As stated previously, the equipment is lightweight and the power requirements are low, so that no special safety precautions are required other than those usually required for normal running of a vessel.

1.8 AGDS analysis

Editing and post-processing of AGDS data sets can be quite time consuming. These are referred to in the linked documents. Operators should be familiar with these since it is important to work up the data to create interpolated surfaces of the acoustic values during extended surveys. This enables operators to plan changes in the survey strategy, re-survey areas where the system has not performed satisfactorily and add in extra tracks where needed.

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