

Title:	Recommended operating guidelines (ROG) for sub-bottom profiling (Chirp)
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Recommended operating guidelines for sub-bottom profiling (Chirp)

A sub-bottom acoustic profiler can be used for mapping recent habitats by analysis of seafloor reflection, and fossil habitats by analysis of the sub-surface geology.

A sub-bottom acoustic profiler consists of a set of transducers mounted in a towfish or in the hull of the ship, and onboard equipment for the power supply for the transducers and data recording/analysis. Hull-mounted transducers are commonly installed and checked by manufacturers or experienced engineers, while towed systems will require, as a minimum, an experienced operating or installation engineer. Input from navigation equipment is also necessary to feed positional data into the processing stream to be stored in, or together with, the digital acoustic data files.

Pre-installation checks are very important, though some checks such as those concerning the crane and deck space are not needed for hull-mounted devices. Acoustic profilers also exist in remotely operated vehicles (ROVs). For such devices the recommended operation guidelines for ROVs are applicable, together with a few of those presented below.

1.1 Pre-installation checks

Check towfish and tow cable for general wear and other damage. Do a 'dry' test of all equipment; i.e. let the towfish ping a few times and store the recorded data file on disk. If the navigation equipment is available, check that positional data are properly picked up by the profiler equipment.

The onboard equipment of any acoustic profiler has to be installed in a dry place, such as the bridge or a laboratory, protected from rain and splash.

The electrical requirement is not usually different from normal electric devices. Power requirements would standardly be 220-240 volts AC, but 115 volts AC is also possible depending upon the country of use. The same holds true for socket types; this should always be checked. Good practice is to have a socket adaptor to accommodate European and UK-type sockets. Sometimes an AC-power transformer may be necessary to match the AC voltage requirements. This may also be the case if the equipment requires DC voltage. Power requirements should be checked prior to mobilisation. In addition, it is good practice to ensure a UPS (uninterrupted power supply) is installed between the power source and equipment to protect from current surges.

The onboard power generation of small, non-research orientated vessels may not be sufficient to power the equipment. This is especially so for the power supply for the towfish, which may require more electrical current (Amperes). This also needs to be checked and if necessary a more powerful generator capable of providing the necessary requirements should be used.

The navigational equipment necessary for the transfer of positional data to the profiler does not normally require additional electrical power. As with power requirements, if in doubt this should be checked.

The towfish of many acoustic profilers is quite heavy, typically 50-250 kg, requiring an onboard crane or A-frame to hoist it into the water. For the towfish to function in the normal operational mode, either the hoisting device has to be able to be 'locked' so that the fish is towed by its hoisting cable, or the fish must be towed by a separate towing cable which should be tied to an appropriate point on the vessel. For successful operation, make sure the fish can be towed in the correct manner in accordance with its design; i.e. with enough free space between the fish and the ship, in or out of the ship's wake. This may involve installation of an outrigger for towing from the side of the ship.

Ensure adequate cable length – signal carrying, power carrying, load bearing – to achieve the appropriate distance between the towfish and the support vessel.

Acoustic profiling can easily be done 24 hours a day. However, this does require sufficient crew members to be on duty during the night since the hoisting gear might have to be used.



Figure 1. Towfish of a Chirp sub-bottom profiler system (weighing 190 kg).



Figure 2. Example of an appropriate crane for towing.



Figure 3. The support vessel needs to be of an adequate size but, as shown, a small half-decker may be adequate. Note that the deck has ample room for the towfish and an electrical power supply.

1.2 Mobilisation protocols and vessel storage requirements

If at this stage any of the pre-installation checks have not been undertaken, they should be made during mobilisation.

Surface or 'top-side' electronics (besides generators) should be installed in a dry, enclosed place away from rain and splash, and well within the temperature and humidity limits set by the manufacturer. Connections between the navigation and

profiler equipment should be tested to ensure that positional data are processed correctly.

Make sure the towfish can be handled and towed in the correct way. Connect the towfish to its power supply and ensure the cable is long enough.

Test the equipment by switching it on and checking that all functionality is available.

The deck space should be large enough to store and handle the towfish and to house an electrical power generator, if required. The boxes used for transportation of the equipment and towfish may also have to be stored on the deck, though it is preferable to place them either below deck or leave them in a secure location on land. It is not advisable to leave spare parts in the boxes on deck. In countries where conditions are either very cold or very hot, far outside the temperature ranges recommended for idle equipment, boxes may not be watertight.

1.3 Test and verification protocols

Before normal operations commence, test all connections by running a series of test lines, preferably over a previously surveyed area. Any problems with towing the fish should become apparent at this stage. The towfish should be towed in accordance with the manufacturer's recommendations, usually fully submerged, either a few metres below the sea surface or a few metres above the seafloor.

The following checks should be performed:

- Measure the offset in 'in-line' and 'cross-line' direction; i.e. the distance from towfish to antenna used by the navigation equipment. Measure this distance in the direction of the ship's axis (the in-line direction) and perpendicular to it (cross-line direction);
- Check that the time (and date) delivered by the navigation equipment matches exactly that of the recording PC;
- Check the recorded signal; i.e. run a short sub-bottom profile and check the record makes sense;
- Check the frequency content of the outgoing signal and verify sufficient penetration and resolution. Remember that there is a trade-off here: high vertical resolution usually means low penetration;
- If the data will be used for analysis of the reflection coefficient (e.g. of the sea bottom reflection), a quantitative quality check of the reflected data must be performed;
- Check the level of noise in the data and see whether it can be reduced. For instance, if the fish is towed over the aft A-frame, it may be in the ship's wake. This should be avoided. See if the fish can be towed below the wake or from the side of the ship. Noise can also originate from electric and acoustic sources on the ship; e.g. power generators and echosounders may interfere with sub-bottom profiler signals.

1.4 Operating guidelines

The most common way of undertaking an acoustic survey is by surveying a set of straight lines. The lines can run parallel and perpendicular to one another. Recommended operational speeds are usually within 3-5 knots. Check this with the manufacturer's guidelines. Always stay well below the maximum speed (usually 7-8 knots). On a calm sea the tugging on the towfish will be less than in rough conditions. To avoid poor data quality in poor sea conditions, try towing the fish below the wave base. 'Rough conditions' are in this case loosely determined by the wave height; i.e. in the order of 1.5-2 m. Above this limit the survey should be interrupted for down time because of poor data quality and the danger of damaging the towfish while hoisting it back on deck. The ping rate should be chosen to ensure sufficient horizontal resolution; this will normally be in the order of 2-8 pings per second.

1.5 Quality control procedures

Data quality should be constantly monitored by examining the acoustic profile on the screen (usually of the data storage computer). The quality of the positional data from the navigation equipment should also be monitored. Gradual deterioration of the data quality can indicate roughening sea state or perhaps gradual failure of the data cable to the towfish. Sudden deterioration usually means either cable breakage or a noisy machine on the ship was turned on.

1.6 Data storage and backup recommendations

To get an idea of the data storage requirement on disk: a typical survey with a ping rate of 4 per second, 40 ms of recorded signal per ping, a sampling frequency of 20 kHz and 4 bytes per sample will require approximately 44 MB per hour (43.9 MB per hour not including the file and ping headers).

During the survey, acquisition software (which may double as the interpretation software) will create many other files which should be backed up along with the survey data. Backups should preferably be made to an external disk several times during a survey and at least at the end of the survey before demobilisation.

1.7 Recommended logging information

The start and end time, date and positions of survey lines should be recorded in a log book or log file on disk. All changes in the survey parameters (e.g. recording length, ping rate, frequency content of the out-going signal, offset) should also be recorded. Likewise, changes in data quality, sea state and weather conditions (at least once a day) should also be noted.

1.8 Demobilisation

No special recommendations are made for demobilisation. When on land, use fresh water to wash off the salt in and on the towfish and transducers.

1.9 Training

Using and operating a sub-bottom profiler requires some experience and training. This can either be given by personnel of the manufacturer (in the case of equipment being brand new) or by surveying with more experienced personnel. Usually, a few surveys will suffice to become competent.

Interpretation of the acoustic profiles (i.e. recognising the reflecting surfaces and knowledge of the pitfalls) requires experienced and fully qualified personnel. Usually, interpretation is done by a geophysicist/geologist, together with grab samples, cores or drillings for ground truthing.

1.10 Safety precautions

No special safety recommendations are made, except for obvious deck operations: personal protective equipment should be worn – gloves, hard hats, safety boots and life jacket when handling the towfish; and regard for electrical power sources.