4. PROCEDURE FOR CALIBRATION OF ECHO SOUNDERS

4.1 Purpose

This procedure shall ensure that echo sounders collecting acoustical data to be used for estimates of fish stocks and other, at any given time is able to deliver numerical values with a given precision.

4.2 Area of application

This procedure covers steps to be taken in order to ensure stable and well-documented tools for the preparation and execution of acoustical measurements of fish stocks from ocean going research vessels. This procedure mainly covers the correction of instruments parameter settings for deviation in the echo sounder systems sensitivity regarding target strength, echo integration and the transducers directivity diagram.

4.3 Definitions

In this context, echo sounders are EK60, containing both the logging part ER60 and the post processing part BI60. ER60 is a digital instrument that pre-processes data and gives out numerical values for target strength, TS, from single targets and integrated values for selectable depth intervals. All targets detected in a volume given by the depth interval, is transformed to a projected area and presented as an area backscattering coefficient, $s_A$. By definition the target strength is given by the ratio between reflected sound intensity, $I_o$, from a target and the sound intensity transmitted towards the target, $I_i$, referred to 1 m distance. This is regarded as identical to the ratio between the backscattering cross section, $\sigma$, for the target and the surface of a sphere with a 1 m radius. The target strength can be expressed on a decibel form in the following way:

$$TS = 10 \log \left( \frac{I_o}{I_i} \right) = 10 \log \left( \frac{\sigma}{4\pi} \right) \quad (\text{dB})$$
The area backscattering coefficient that a target represents on a given depth, \( r \), when placed on an acoustical axis is given by the formula:

\[
\sigma_A = \frac{\sigma}{\psi r^2} 1852^2 (m^2 / nmi^2)
\]

where \( \psi \) is the solid angle for the equivalent beam. Calibration means to “Determine by measurement or comparison with a standard the correct value of a reading off an instrument or the correct value for the setting of a control button”. In this context the instrument is adjusted such that the start value is consistent with a known standard. Standard targets being used are usually metal spheres with known target strength (reference spheres).

4.4 Background

Stock assessment of fish and other kinds of biomass using hydro acoustical instruments sets strict requirements for accuracy and stability of the equipment. A relatively small deviation in percentage in the instruments sensitivity can lead to large errors in the calculation of the fish stock. It is therefore of utmost importance that the instruments state and stability is checked at frequent and regular intervals.

4.5 Critical factors

- Personnel and competence.
- Location for the calibration (protected against wind and waves, sufficient water depth).
- Stable anchoring or berthing of vessel/instrument platform.
- Weather conditions (strong winds causes air bubbles in the upper water layers, and heavy rain with large amounts of fresh water running out in the sea can create non favourable environment for calibration).
- Reliable standard targets (reference spheres).
- Presence of fish in the vicinity of the standard target can disturb the measurements.
- Functional positioning equipment for the standard targets.
- Accurate documentation of the measurements.
### 4.6 Description

<table>
<thead>
<tr>
<th>Responsibility</th>
<th>Stage</th>
<th>Action/activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head of Section for electronic instrumentation</td>
<td>1</td>
<td>When the annual cruise program for the RV fleet is developed, taken in to account that the vessels hydro acoustical instruments must be calibrated at least 3 times pr. year, (winter, spring and fall). The cruise planning committee must be informed about this.</td>
</tr>
<tr>
<td>Cruise leader/ instrument chief</td>
<td>2</td>
<td>Before an acoustical survey cruise is commenced, the need for calibration shall be considered. In general calibration should be performed in front of every acoustical survey cruise. <em>This is particularly important if there has been made any modifications or replacement of vital components such as transducer or transceiver.</em></td>
</tr>
<tr>
<td>Cruise leader/ instrument chief</td>
<td>3</td>
<td>Allocate the required time for calibration and point out a suitable location.</td>
</tr>
<tr>
<td>Instrument chief</td>
<td>4</td>
<td>Check if the anchoring location has the sufficient water depth and that the location is protected against wind and waves.</td>
</tr>
<tr>
<td>Instrument chief</td>
<td>5</td>
<td>Before anchoring pull a line under the vessel to enable the suspension lines to be pulled from one side to the other.</td>
</tr>
<tr>
<td>Instrument chief</td>
<td>6</td>
<td>Measure seawater temperature, salinity and sound velocity on the location. Normally a CTD sonde is used to measure these parameters for the whole water column.</td>
</tr>
<tr>
<td>Instrument chief</td>
<td>7</td>
<td>Place the 3 calibration winches such that they are as close as possible in the corners of an even sided triangle with the transducer in the middle. Confer with the vessel General Arrangement (GA) as necessary.</td>
</tr>
<tr>
<td>Instrument chief</td>
<td>8</td>
<td>The three lines shall meet in a single point where the calibration sphere is attached. Before the sphere is set out in the sea, the sphere, all knots and loops on the lines close to the sphere shall be washed with dishwashing soap in order to avoid that air bubbles attach themselves.</td>
</tr>
<tr>
<td>Instrument chief</td>
<td>9</td>
<td>The sphere is centred in the beam in a “safe” distance from the near filed. A distance of 10 - 30 m is sufficient.</td>
</tr>
</tbody>
</table>
| Instrument chief | 10 | The form «Kalibrering med referansekule» - DRIFTSJOURNAL 1, shall be filled in as accurate as possible. Detailed description of the activities are given in the Simrad ER60 Operator manual and “Instructions for
the calibration of EK 60” (under revision).

### Instrument chief 11
Before any adjustments of parameter settings are done, the existing settings shall be checked by measuring the TS and \( s_A \) with the sphere on the acoustical axis.

### Instrument chief 12
The echo sounder’s parameter settings for transducer sensitivity for TS shall be adjusted until the start value is in accordance with the standard.

### Instrument chief 13
When the sphere is on the acoustical axis, a theoretical \( s_A \) shall be calculated for the actual sphere depth, using the formula given in para 1.3. Transducer sensitivity for \( S_v \) (volume backscattering strength) shall be adjusted such that the printed \( s_A \) values are in accordance with the theoretical value for the reference.

### Instrument chief 14
Before departing the location for the calibration, the calibration equipment shall be demounted and stored in a secure manner.

### Instrument chief 15
The new parameter settings for the transducer/receiver menu shall be put in a separate form and be displayed in the instrument room. A copy of the form Driftsjurnal 1, «Kalibrering med referansekule» shall be archived on board. The original shall be delivered to the head of section.

### 4.7 Results
Only small deviations (< 0.3 dB) in parameter settings should be expected from time to time as long as there has not been any replacements of parts or modifications of the equipment. If the results deviates more than 0.3 dB, the cause(s) for such a deviation must be identified. If no errors can be found, a recalibration has to take place as soon as possible.

### 4.8 Quality control
The best indication on good quality is that the equipment is stable over a long period of time. The long-term stability of each individual transducer should therefore be monitored carefully.

### 4.9 Major changes
This procedure is fitted for the calibration of specific equipment (EK60/ER60). If such equipment is replaced or upgraded, this procedure must be updated accordingly.