



INTRODUCTION TO THE COLLECTION OF EXPERT REPORTS AND GUIDELINES

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The GO-SHIP program was developed to provide a sustained coordination mechanism for global repeat hydrography as outlined in the GO-SHIP strategy published in 2009 (available online at: http://www.go-ship.org/Docs/IOCTS89_GOSHIP.pdf). Central to this coordination is ensuring that measurements made by different groups are comparable, compatible, and of the highest quality possible. Under the guidance of the GO-SHIP committee and following the original work of Joyce (1991), the following measurement standards, or expectations, have been developed as goals for the data quality desired from GO-SHIP reference sections.

1. STANDARDS FOR CTD SENSORS

Temperature	Accuracy = 0.002°C. Precision = 0.0005°C (ITS90).
Salinity	Accuracy = 0.002 g kg ⁻¹ (TEOS-10) depending on frequency and technique of calibration. Precision = 0.001 g kg ⁻¹ (TEOS-10), depending on processing techniques. ¹
Pressure	Accuracy = 3 decibar (dbar) with careful laboratory calibration. Precision = 0.5 dbar, dependent on processing. ²
O₂	Accuracy [†] = 1%. Same for precision.
<i>Notes:</i>	<p>† If no absolute standards are available for a measurement then accuracy should be taken to mean the reproducibility presently obtainable in the better laboratories.</p> <p>¹ Although conductivity is measured, data analyses require it to be expressed as salinity. Conversion and calibration techniques from conductivity to salinity should be stated.</p> <p>² Difficulties in CTD salinity data processing occasionally attributed to conductivity sensor problems or shortcomings in processing may actually be due to difficulties in accounting for pressure sensor limitations.</p>

2. STANDARDS FOR WATER SAMPLES

Salinity	Accuracy of 0.001 is possible with Autosol™ salinometers and concomitant attention to methodology, <i>e.g.</i> , monitoring Standard Sea Water. Accuracy with respect to one particular batch of Standard Sea Water can be achieved at better than 0.001 PSS-78. Autosol precision is better than 0.001 PSS-78. High precision of approximately 0.0002 PSS-78 is possible following the methods of Kawano (this manual) with great care and experience. Air temperature
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	stability of $\pm 1^\circ\text{C}$ is very important and should be recorded. ¹
O₂	Target accuracy is that 2 sigma should be less than 0.5% of the highest concentration found in the ocean. Precision or reproducibility (2 sigma) is 0.08% of the highest concentration found in the ocean.
NO₃	approximately 1% accuracy ^{†,2} and 0.2% precision, full scale.
PO₄	approximately 1-2% accuracy ^{†,2} and 0.4% precision, full scale.
SiO₂	approximately 1-3% accuracy ^{†,2} and 0.2% precision, full-scale.
DIC	Accuracy [†] = 1-2 $\mu\text{mol kg}^{-1}$
Alkalinity	Accuracy [†] = 2-3 $\mu\text{mol kg}^{-1}$
pCO₂	Accuracy [†] = 3 μatm ; optimal 1 μatm
pH	Accuracy [†] = 0.005 pH units.
³H	Accuracy [†] 1%; precision 0.5% with a detection limit of 0.05 tritium unit (TU) in the upper ocean of the northern hemisphere and 0.005 TU elsewhere.
δ ³He	accuracy [†] /precision = 1.5 ‰ in isotopic ratio; absolute total He of 0.5% with less stringent requirements for use as a tracer (e.g., He plume near East Pacific Rise).
CFCs	Approximately 1-2% accuracy [†] and 1% precision, blanks at 0.005 pmol kg^{-1} with best technique.
SF₆	Target precision for SF ₆ = 1.5% or 0.02 fmol kg^{-1} (1 $\text{fmol} = 10^{-15}$ mole), whichever is greater, with overall accuracies of about 3% or 0.04 fmol kg^{-1} .
Carbon Isotopes	¹⁴ C: Accuracy [†] = 4-5 ‰; ¹³ C: Accuracy [†] = 0.03-0.04 ‰.
<i>Notes:</i>	<p>† If no absolute standards are available for a measurement then <i>accuracy</i> should be taken to mean the <i>reproducibility</i> presently obtainable in the better laboratories.</p> <p>¹ Keeping constant temperature in the room where salinities are determined greatly increases their quality. Also, room temperature during the salinity measurement should be noted for later interpretation, if queries occur. Additionally, monitoring and recording the bath temperature is also recommended. The frequent use of IAPSO Standard Seawater is endorsed. To avoid the changes that occur in Standard Seawater, the use of the most recent batches is recommended. The bottles should also be used in an interleaving fashion as a consistency check within a batch and between batches.</p> <p>² Developments of reference materials for nutrients are underway that will enable improvements in the relative accuracy of measurements and clearer definition of the performance of laboratories when used appropriately and the results are reported with the appropriate meta data.</p>

T. Joyce. 1991. *Introduction to the collection of expert reports compiled for the WHP programme*. WHP Operations and Methods, WOCE Operations Manual, WHP 91-1. Available online at: http://cchdo.ucsd.edu/manuals/pdf/91_1/introjoy.pdf