

WHP Operations and Methods - July 1991

Introduction To the Collection of Expert Reports
Compiled for the WHP Programme

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The WOCE Hydrographic Programme Office (WHPO) is responsible for the coordination of the international effort of high-quality hydrographic sampling in WOCE, described in the International Implementation Plan for WOCE (WCRP-11, July 1988). With the guidance of the WHP Planning Committee, it has circulated the standards, or expectations, for data quality for the WHP. These have been published in several documents (WCRP-11, vol. 1, pp. 2.1-2.3), (Joyce, 1988), and (WOCE Newsletter, No. 6, October 1988). These standards for (conductivity - temperature - depth) CTD sensors and bottle measurements are reproduced here with some minor modifications in Tables 1 and 2.

Table 1
One-time WHP Standards for CTD sensors

T:	accuracy of 0.002°C; precision 0.0005°C (ITS ₉₀).
S:	accuracy of 0.002 PSS-78, depending on frequency and technique of calibration; precision 0.001 PSS-78, depending on processing techniques. ¹
P:	accuracy 3 decibar (dbar) with careful laboratory calibration; precision 0.5 dbar, dependent on processing. ²
O₂:	accuracy [†] 1%; same for precision. ³
Notes:	
[†]	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.
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.
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.
³	Existing polarographic sensors have been found to meet these requirements but better sensors need to be developed.

Table 2
One-time WHP Standards for Water Samples

T:	High resolution deep-sea reversing thermometers (DSRTs) are available and with careful calibration and reading may be capable of 0.004-0.005°C accuracy and 0.002°C precision. Digital DSRTs do not require long soaking times and, potentially, can serve as a means for calibration and performance checks. Their development, and in particular their long-term stability, will be closely monitored. Carefully documented and monitored use of multiple CTD sensors have the potential to eliminate the standard use of DSRTs.
S:	0.002 accuracy 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 0.001 PSS-78. Autosol precision is better than 0.001 PSS-78, but great care and experience are needed to achieve these limits on a routine basis as required for WOCE. For example, laboratories with air temperature stability of ± 1°C are necessary for optimum Autosol performance. ¹
O₂:	accuracy [†] <1%; precision 0.1%. Some laboratories presently achieve 0.5% accuracy, [†] which is recommended for WOCE measurements. ²
NO₃:	approximately 1% accuracy [†] and 0.2% precision, full scale. This standard is probably appropriate to WHP.
PO₄:	approximately 1-2% accuracy [†] and 0.4% precision, full scale.
SiO₂:	approximately 1-3% accuracy [†] and 0.2% precision, full-scale. ³
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.
³He:	accuracy [†] / precision 1.5 per mille in isotopic ratio; absolute total He of 0.5% with less stringent requirements for use as a tracer (<i>e.g.</i> , He plume near East Pacific Rise).
CFCs:	approximately 1-2% accuracy [†] and 1% precision, blanks at 0.005 pmol/kg with best technique.
¹⁴C:	accuracy [†] and precision 3 per mille via beta-counting on 200-liter samples; 5-10 per mille with Accelerator Mass Spectrometer (AMS).
⁸⁵Kr:	detection limit of 1% of surface concentration; precision of 4% decreasing to 25% for samples near the detection limit.
³⁹Ar:	minimum detectable amount about 5% of surface value; precision of 5% of surface value.
²²⁸Ra:	5% accuracy [†] and precision.
¹⁸O:	may be used in high latitudes; these should be measured with accuracies [†] of 0.02 per mille.

Notes on Table 2

- [†] If no absolute standards are available for a measurement then *accuracy* should be taken to mean the *reproducibility* presently obtainable in the better laboratories.
- 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. 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 ampoules should also be used in an interleaving fashion as a consistency check within a batch and between batches.
- ² Improvements due to new techniques make such accuracy possible. Further development of these techniques and subsequent adoption is strongly recommended.
- ³ Strong opinion exists that laboratory temperature fluctuations cause significant errors, because 1°C laboratory fluctuation yields approximately 1% change in SiO₂.

Four working groups were established by the WHP Planning Committee to provide details on methods and operations for the attainment of the WHP standards, as well as to provide guidance on other methodology for the shipboard program. These working groups were the following:

- * Calibration (procedures and standards)
- * *In situ* measurements
- * Standard methods and algorithms
- * Underway measurements

This report contains the results of these working groups. It is prepared in a "notebook binder" format so that new methods or updates to the present material can be distributed by the WHPO when they become available. While the WHP does not require that every sampling group and laboratory adopt these procedures, they are presented so that the oceanographic community will have some technique or method by which to gauge their own procedures. If their procedures are capable of meeting or exceeding the standards for the WHP program, then there is no need to change. Should procedures fail to meet WHP standards, however, the enclosed material is offered as a guide. Authorship of each individual section is presented not only to give credit to the contributor but also to provide a person to contact to answer specific queries. The WHPO would also be very interested in receiving information on new procedures which could be added to clarify the material contained in this manual or to be distributed as a new section in a subsequent update of this document.

Requirements for reporting of WHP data have been set forward in a separate document, (WHPO 90-1). Compliance with these data reporting requirements is required of all groups participating in the WHP.

References

Joyce, T. M., 1988. The WOCE Hydrographic Program. *Eos Trans. AGU*, **69**(5), pp 68-70.

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WOCE Implementation Plan, WCRP-11, July 1988. Vol 1, pp. 2.1-2.3.