Insitu Pressure Calibrations On WOCE-Level

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Introduction

The NIOZ-CTD systems are based on Seabird CTD's. A lot of time and money is spent to calibrate the sensors properly. This is done mainly for 2 reasons. The first is quality assurance. Good science starts with high quality data. The second reason is perhaps a bit unexpected. It is an economical one and it is called speed. A few years ago it took months to process a CTD data-set up to WOCE-level and that is very expensive in terms of labor. Main reason was doubt about the calibrations. They were carried out as good as possible, but the remaining uncertainty was still too big. In order to tackle this problem it was decided to invest in better calibration-equipment as soon as it appears on the market. The first big jump forward we made was the use of one of the first reference thermometers of Seabird: the SBE-35. During Inmartech 1996 in Southampton these results were presented. All doubts and discussions about temperature calibrations were killed in one single action. With an AUTOSAL Salinometer it was already possible to calibrate the conductivity-sensor easily and onboard, but for the calibration of the pressure-sensor it was necessary to rely on the pre- and post-cruise laboratory calibrations. In principle this is good enough, because the Paroscientific pressure is a very good and very stable sensor, but the wish to have an independent calibration (independent from Seabird, Paroscientific or NOAA) on board during our cruises remained. We used ERPM's manufactured by SIS from Germany, but the accuracy of these Instruments was too low for a proper calibration. It monitors the Paroscientific sensor for malfunctioning only.

It was pleasant to hear from SIS that they were developing a new generation ERPM's with a much higher accuracy. Perhaps it was possible to calibrate from now on all CTD-sensors in situ so during the cruise on WOCE-level. That is the ultimate speed goal: CTD-measurements database-ready on board.

Pressure-sensors

The WOCE-requirement for pressure measurements is 0.02% of the reading. This figure originates from the WHP-manual, but in terms of metrology it is poor defined. Not stated is whether this is based on 1, 2 or 3 s.

Inside of most Seabird CTD's (SBE-9) a Paroscientific pressure sensor is mounted. This sensor has an uncertainty of 0.02% of the reading. So it meets the WOCE-requirement. This figure is based on personal communication with Seabird and is conservative. In earlier days the Paroscientific pressure-sensors were calibrated at NOAA, but due to budget-cuts the NOAA calibration facility was closed. Seabird is developing a pressure calibration facility now and it is almost ready. The expected uncertainty by then is about 0.01% so twice as good as today.

Mentioned above is the use of electronic reversing pressure meters for "checking" purposes and the hope that the new generation of pressure meters could be of use for real calibrations. The accuracy specifications of both types are:

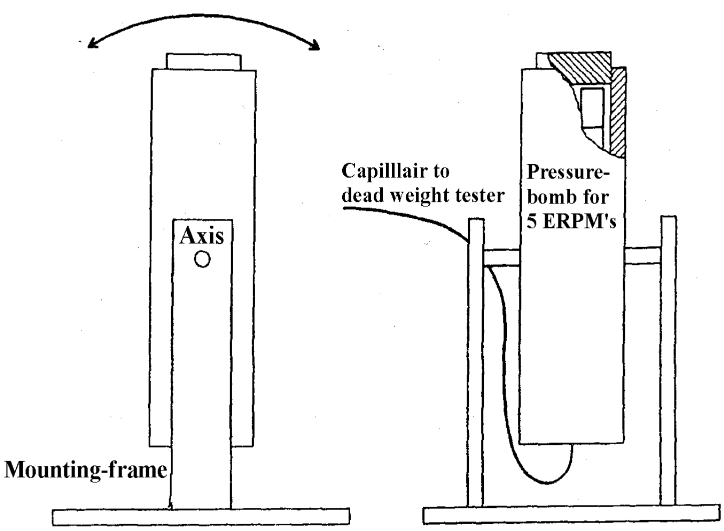
RPM-6000 (traditional type)	0.3% of full scale
RPM-6000 X (new generation)	0.1 % of full scale

Earlier experiences with the traditional ERPM's learned that 0.3% was very conservative. The instruments appeared to be better then specified. The expectancy was that the 0.1 % of the new ones was too pessimistic as well. There was a small concern about the pressurecalibration-facility from SIS. It was developed to calibrate the traditional type so it may be not good enough for the new generation ERPM's. Therefore it was necessary to develop a calibration-method for these new ERPM's. Two problems had to be solved. The first problem was a proper pressure standard: a socalled dead weight tester. Dead weight testers are very expensive both to buy them and to keep them OK. The Dutch laboratory of standards, the Nmi, was able to solve this problem. They had (and still have) a pressure calibration facility with an uncertainty (based on 2 s) of 0.008% available for a reasonable price. The second problem was how to attach an ERPM to the dead weight tester and how to initiate a measurement. This was solved by developing a pressure-container that can be reversed exactly like a rack mounted on a watersampler.

Facility and procedure for the calibration of ERPM's

Figure #1 is a drawing of this container. It can take 5 ERPM's. The calibration procedure is straightforward. Load the container with armed ERPM's. Fill the container with water, close it with the lid and de-air it with the (small) de-air valve. Increase the pressure with the dead weight tester. Enforce an overshoot to simulate an upcast so a calibration point is always reached from the high end. Turn the container upside down and wait for a minute. Turn it back and depressurise it. Open the container and read the values from the displays of the ERPM's. With the same dead weight tester the Paroscientific pressure sensor of the CTI) was (re)calibrated, because of the lower uncertainty of the Nmi-facility.

Figure #1



Calibration and field results

In figure #2 to #4 field results obtained during a cruise in the Bay of Biscay in August 1998 are presented in 3 different ways using the original factory-calibrations and the Nmi/N10Z calibrations. Presented are ALL the measurements, there was not a single rejection. In figure #2 the "raw" results show a systematic difference between the sensors of about 2.5 dbar at high values. Figure #3 shows the contribution to the quality by the Nmi/NIOZ-calibrations of the ERPM. In figure 44 the combined result is presented: a difference between "standard" and "sensor" of far less then 1 dbar for ALL in situ calibrations. This result is obtained onboard, meaning during the cruise.

Figure #2
(Psis, P 6538 factorycal. - Pctd, factorycal.) vs. pressure

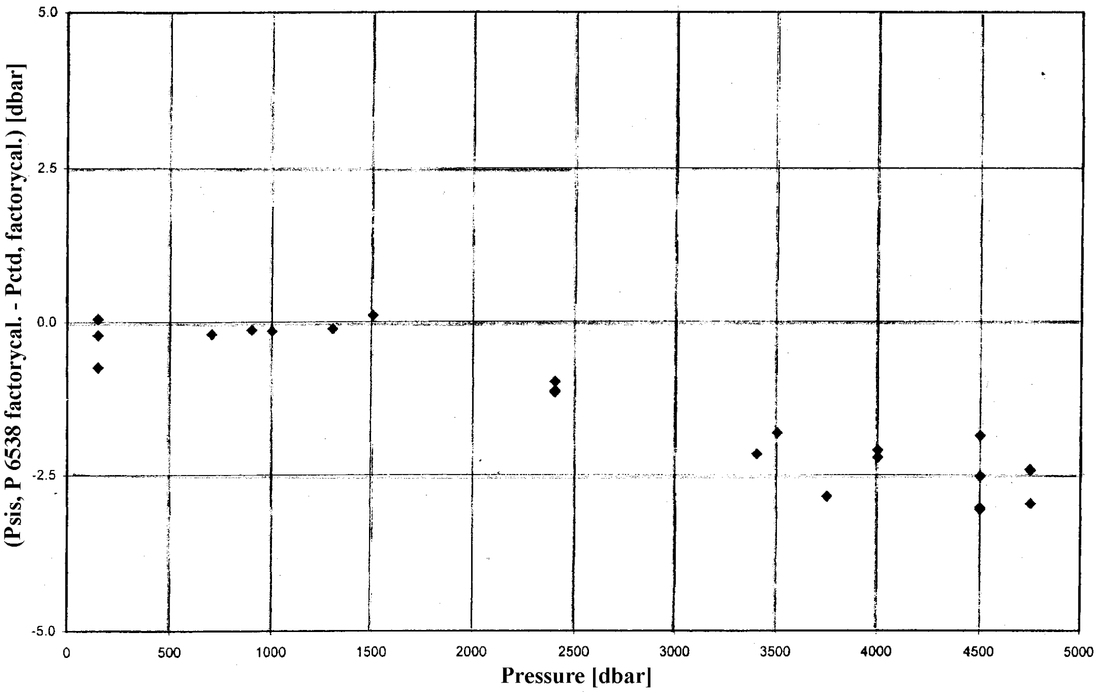
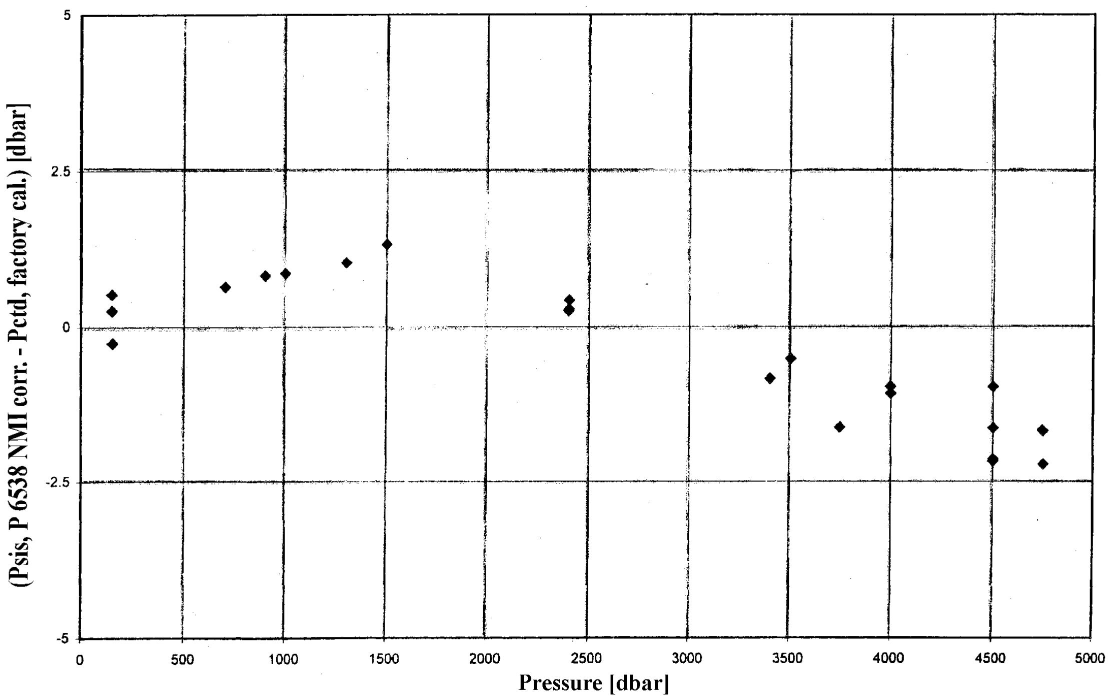
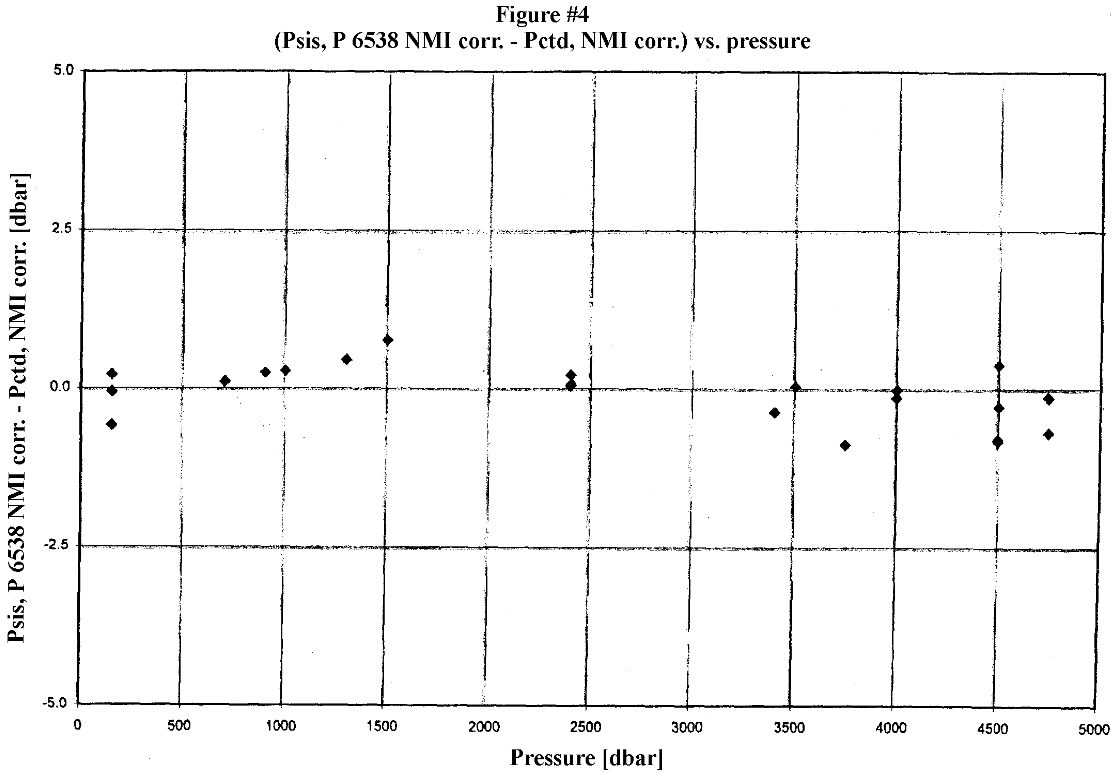


Figure #3
(Psis, P 6538 NMI corr. - Pctd, factory cal.) vs. Pressure





Conclusions

- Both the Paroscientific pressure Sensor and the RPM-6000 X meet their specifications.

- With careful calibration it is possible to increase the performance of both sensors.

- It is possible to meet the WOCE-requirements already on board during a cruise.