

Comments on Shoichi Kizu OSD T7 Fall Rate

Lockheed Martin Sippican

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The following are comments that we at Lockheed Martin Sippican have regarding the paper titled "Comparison of the fall rate and structure of recent T-7 XBT manufactured by Sippican and TSK" written by Shoichi Kizu et al.

1. P. 1813 line 3: "The measurement is terminated when the wire runs out and breaks" should be replaced with something to the effect of: "The measurement is terminated when the probe's rated depth is reached, although data of entirely unvalidated accuracy can still be received until the wire runs out and breaks. Probe behavior after the rated depth is unknown because of wire stretch, wire tension slowing the probe, etc."
2. P. 1815 lines 10 - 13 discuss results from Wijffels et al '08. We have not reviewed this source, but generally it seems that many different sources obtain many different results that depend on many different factors. Perhaps the statement should be qualified. Here is potential alternative verbiage:
 - a. Was "Wijffels et al. (2008; hereafter W08) showed that the magnitude of the mean depth error was greater than 3% at 800m depth and 5% at 400m depth for some periods, with considerable variation according to the probe types and years. Those are well excess of the manufacturers' accuracy claim of 2%."
 - b. Suggested alternative: "Several different studies have been performed to assess XBT fall rate with differing results. One study by Wijffels et al. (2008; hereafter W08) showed that the magnitude of the mean depth error was greater than 3% at 800m depth and 5% at 400m depth for some periods, with considerable variation according to the probe types and years. If true, then these errors are well in excess of the manufacturers' accuracy claim of 2%."
3. P. 1820 lines 4 – 8 discuss the procedure for comparing probe & CTD depths. It seems the CTD-to-XBT comparison results are highly dependent upon the temporal and spatial differences between CTD casts and probe drops. We wonder how CTD casts alone compare over similar temporal and spatial separations. For example, in his presentation at the XBT Fall Rate workshop in Hamburg, Germany, August 2010, GopalKrishna cites CTD comparisons and found the differences to be of the same order as differences between CTDs and XBTs. We believe these uncertainties should be mentioned here and studied in significantly more detail in the future.
4. P. 1826 line 11 discusses the possibility that the different internal nose design might cause wobbling during probe descent. Although the forward body used on the Sippican T7 probe is not axisymmetric about the axis of rotation, the center of mass is located on the axis of rotation. Additionally, the principle axis of inertia in the direction of descent is along the axis of rotation. This gives the forward body a moment of inertia about the axis of rotation causing natural stability of the forward body when rotating. Therefore the forward body itself is inherently stable.
5. P. 1829, line 8: We would like to provide some of the missing details about our routine checks, which are as follows:

- a. Nose samples are weighed and all must be 575 ± 1 grams. The nose dimensions are also checked to comply with tolerances specified per drawings. If any of the nose samples do not pass, then the entire Lot is screened.
 - b. Afterbody samples have physical dimensions checked to comply with drawing tolerances. If any sample fails to comply, then the entire Lot is screened.
 - c. Incoming wire samples are inspected for leaks during elongation and dereeling in simulated sea water.
 - d. Wire for each probe is ± 1.5 g.
 - e. All probe components but the nose and wire are very close to neutrally buoyant. Therefore slight weight variations of these components in air do not impact the probe drop rate in water.
6. P. 1829 line 11 discusses the likelihood of probe shape being changed. Our products are maintained under Configuration Management control such that when changes are proposed, they are first reviewed and then recorded if approved.
7. P. 1829 line 16 points out that TSK uses wire weight adjustment in air to compensate for nose weight variance. The probes provided by Lockheed Martin Sippican for this study were exactly according to normal production, which does not perform a similar compensation. If desired LMS could perform such compensation exclusively for probes to be used in future studies, but this compensation should be performed based on the combined weight in water.
8. In Appendix A, p.1831, line 15, the following countries should be deleted from the list of TSK countries: Myanmar, Estonia, Latvia, Lithuania, Philippines, Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyz, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan.

Reply to comments by the Lockheed Martin Sippican:

We sincerely appreciate your careful reading and various comments on our article. We also thank you for disclosing much information about the manufacturing process of the instrument. We hope our replies in the following are satisfactory.

Replies to specific comments:

>1. P. 1813 line 3: “The measurement is terminated when the wire runs out and breaks”
>should be replaced with something to the effect of: “The measurement is terminated when
>the probe’s rated depth is reached, although data of entirely unvalidated accuracy can still
>be received until the wire runs out and breaks. Probe behavior after the rated depth is
>unknown because of wire stretch, wire tension slowing the probe, etc.”

Clearly, our description was not complete. We modified the statements in this revision. It depends on system. I suppose old systems generally did not run like that, according to the old articles. And, some old Japanese popular recording systems did not terminate until the operator commanded.. But we know recent systems terminate acquisition at the rated depths.

> 2. P. 1815 lines 10 - 13 discusse results from Wijffels et al '08. We have not reviewed this
>source, but generally it seems that many different sources obtain many different results
>that depend on many different factors. Perhaps the statement should be qualified. Here is
>potential alternative verbiage:
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>400m depth for some periods, with considerable variation according to the probe types and
>years. If true, then these errors are well in excess of the manufacturers’ accuracy claim of
>2%.”

We modified the sentence to state that there is variation of estimates and added “if true” phrase.

> 3. P. 1820 lines 4 – 8 discuss the procedure for comparing probe & CTD depths. It seems
>the CTD-to-XBT comparison results are highly dependent upon the temporal and spatial
>differences between CTD casts and probe drops. We wonder how CTD casts alone
>compare over similar temporal and spatial separations. For example, in his presentation at
>the XBT Fall Rate workshop in Hamburg, Germany, August 2010, GopalKrishna cites
>CTD comparisons and found the differences to be of the same order as differences
>between CTDs and XBTs. We believe these uncertainties should be mentioned here and
>studied in significantly more detail in the future.

We recognize well that any field tests cannot be free from natural variability of the ocean. Because we could not observe the change of temperature profile with multiple CTD casts in our sea test, we had no possibility of discussing it in more detail. But we think the systematic differences found between the CTD and XBT of either manufactures cannot be explained by the natural variability. We need to be careful when estimating the probe-to-probe variance, however, as you mentioned.

> 4. P. 1826 line 11 discusses the possibility that the different internal nose design might
>cause wobbling during probe descent. Although the forward body used on the Sippican T7
>probe is not axisymmetric about the axis of rotation, the center of mass is located on the
>axis of rotation. Additionally, the principle axis of inertia in the direction of descent is
>along the axis of rotation. This gives the forward body a moment of inertia about the axis
>of rotation causing natural stability of the forward body when rotating. Therefore the
>forward body itself is inherently stable.

We just discussed that possibility without concluding anything about this point. We do not even think that axisymmetric structure can fully avoid possibility of wobbling. The probes should experience random perturbation (or torque) from the turbulent water during descent. When small wobble is initiated, various points could contribute to the later motion of the probe: probe length, its weight balance, spin rate, gravity, buoyancy, periods of eddy separation from the fins, etc. Franco Reseghetti showed a very interesting video clip that captured an LMS Deep Blue falling in the water, at the Hamburg XBT meeting in August 2010. It clearly showed that the falling probe follows spiral motion rather than just spinning around the axis. Then we infer but do not conclude that the difference in inner structure may induce some difference in the fall motion. We obviously need a sophisticated hydrodynamic model or well-controlled

experiments to further extend this discussion.

- > 5. P. 1829, line 8: We would like to provide some of the missing details about our routine checks, which are as follows:
 - > a. Nose samples are weighed and all must be 575 ± 1 grams. The nose dimensions are also checked to comply with tolerances specified per drawings. If any of the nose samples do no pass, then the entire Lot is screened.
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 - >c. Incoming wire samples are inspected for leaks during elongation and dereeling in simulated sea water.
 - >d. Wire for each probe is ± 1.5 g.
 - >e. All probe components but the nose and wire are very close to neutrally buoyant.
 - >Therefore slight weight variations of these components in air do not impact the probe drop rate in water.

Thank you for giving the information. Those helped us and should help future studies about the topic. We included those points in the revised manuscript.

- > 6. P. 1829 line 11 discusses the likelihood of probe shape being changed. Our products are maintained under Configuration Management control such that when changes are proposed, they are first reviewed and then recorded if approved.

We may have been rash about this point in the original manuscript. We modified or omitted some sentences in the paragraph. We did not intend to accuse your control on manufacture process. But our results clearly show that the fall-rate difference between the two companies' T-7 is sizably larger than that in their weights. And we knew that most of the routine numerical checks are for weights. We wonder if the manufacturers can describe how accurately or quantitatively the dimensions are maintained in the history.

- > 7. P. 1829 line 16 points out that TSK uses wire weight adjustment in air to compensate for nose weight variance. The probes provided by Lockheed Martin Sippican for this study were exactly according to normal production, which does not perform a similar compensation. If desired LMS could perform such compensation exclusively for probes to be used in future studies, but this compensation should be performed based on the

>combined weight in water.

Thank you for giving clear description. Of course we understand that the weight adjustment by the TSK in the air is not perfect. It is obviously the weight of the probe in the water that is more important. We included your point to clarify the difference between the QC of the two companies.

> 8. In Appendix A, p.1831, line 15, the following countries should be deleted from the list
>of TSK countries: Myanmar, Estonia, Latvia, Lithuania, Philippines, Armenia, Azerbaijan,
>Belarus, Georgia, Kazakhstan, Kyrgyz, Moldova, Russia, Tajikistan, Turkmenistan,
>Ukraine, and Uzbekistan.

The information is updated in this revision. We also noted that the sales territories may change in the future, too.