Carter Scientific Solutions

LabMaster NEO
Instrument Performance Report

Report Prepared by Dr. Brady Carter –
Carter Scientific Solutions

Overview

Over the course of my 25 years working with water activity instrumentation, I have frequently encountered skepticism from users regarding the published specifications for accuracy and repeatability. Many question whether these values are truly achievable, often viewing them as exaggerated claims driven by marketing. This skepticism is understandable, given that promotional materials tend to highlight ideal conditions rather than real-world performance. To address this concern, I conducted an independent evaluation of a water activity instrument to assess its actual performance. I selected the LabMaster NEO, manufactured by Novasina, a Swiss company recognized for its quality water activity instrumentation. Widely regarded as the benchmark in the field, the LabMaster NEO claims an accuracy of ±0.003 and a repeatability of ±0.001, the highest available in the market. My testing has confirmed that not only can the LabMaster NEO meet the published accuracy and repeatability but actually exceeds it. This level of precision provides end-users, particularly in critical applications such as pharmaceuticals, food manufacturing, and research, with exceptional confidence in their quality assurance processes, ensuring stable and reproducible results under real-world conditions.

Testing Procedure

To evaluate the performance of the LabMaster NEO water activity instrument, repeated measurements were conducted using Novasina SAL-T standards, saturated salt slurries formulated to produce precise and stable water activity values. These standards are only available from Novasina and are manufactured to the highest standards. They are also reusable when properly stored and are widely accepted for instrument calibration and verification.

Five SAL-T standards were selected to span the full water activity range:

- **SAL-T 11** (0.113 a_w)
- **SAL-T 58** (0.5757 a_w)
- **SAL-T 75** (0.753 a_w)
- **SAL-T 84** (0.843 a_w)
- **SAL-T 97** (0.973 a_w)

All measurements were performed at a controlled temperature of 25 °C. For each standard, a single sample was measured 10 times consecutively, with the instrument chamber opened between each reading

to reset the equilibration process. This approach ensured that each measurement represented a full equilibration cycle, simulating real-world use.

Testing was conducted using a single LabMaster NEO instrument, equipped with two different NEO resistive electrolytic sensors. Each set of measurements was repeated with the second sensor to assess sensor-to-sensor consistency.

The instrument was operated in slow mode, the most stringent stability setting available on the LabMaster NEO. For this mode, the test will not end until the difference between consecutive test values is no more than 0.001 a_w for the span of 6 minutes. It is important to note that end-of-test settings can significantly influence measurement accuracy and should be carefully considered when evaluating water activity instrumentation (1).

Definitions of Accuracy and Repeatability

In this study, accuracy is defined as the closeness of a measured value to the known standard value. It is expressed as the average difference between the measured values and the water activity of the SAL-T standards. Because accuracy requires a reference value independent of the measurement system, it can only be determined using standards with known water activity. Therefore, accuracy cannot be directly assessed for typical samples (e.g., food products) whose water activity is unknown without measurement.

Repeatability refers to the consistency of repeated measurements under identical conditions. It is quantified as the standard deviation of the 10 consecutive readings for each standard and reported as a ± range. Repeatability can be used to construct a 95% confidence interval for the expected variability in measurements. While repeatability is distinct from reproducibility, which involves variation across instruments or laboratories, the use of two sensors in this study provides insight into sensor-level reproducibility within a single instrument.

For each SAL-T standard, the mean of the 10 readings was used to assess accuracy, while the standard deviation of those readings was used to quantify repeatability.

Testing Results

The results of the repeated measurements for each SAL-T standard are summarized in Table 1. These data demonstrate that the LabMaster NEO instrument consistently achieved accuracy and repeatability values equal to or better than the manufacturer's published specifications across the full water activity range. All values are reported to four decimal places, in accordance with the resolution of the LabMaster NEO.

For each SAL-T standard, the measured water activity values closely matched the certified reference values, with minimal deviation. The calculated repeatability—expressed as the standard deviation of 10 consecutive readings—was consistently within or below the reported ±0.001 range. Similarly, the accuracy—defined as the average difference between the measured and reference values—was within or better than the stated ±0.003 specification.

Detailed measurement data for all standards and both sensors are provided in the Appendix.

Table 1. The average water activity, repeatability, and accuracy recorded for each SAL-T standard. The reported accuracy for the LabMaster NEO is +/-0.003 and the reported repeatability is +/-0.001.

STANDARD	WATER ACTIVITY	REPEATABILITY	ACCURACY
SAL-T 0.11 a_w	0.1120	0.0005	0.0010
SAL-T 0.58 a_w	0.5752	0.0009	0.0008
SAL-T 0.75 a_w	0.7527	0.0006	0.0005
SAL-T 0.84 a_w	0.8434	0.0010	0.0009
SAL-T 0.97 a_w	0.9726	0.0008	0.0007

References

1. Carter, B.P. 2022. Water activity test time: It's the sample, not the instrument. Novasina Application Note 007188.00.

Appendix - Testing Tables

0.11 Standard - NEO -ENS ae2206005 - Repeatability 0.0003. Accuracy 0.0006

REP	STANDARD AW	WATER ACTIVITY	TEMP	DIFFERENCE FROM STANDARD
1	0.113	0.1122	25	0.0008
2	0.113	0.1122	25	0.0008
3	0.113	0.1119	25	0.0011
4	0.113	0.1119	25	0.0011
5	0.113	0.1129	25	0.0001
6	0.113	0.1128	25	0.0002
7	0.113	0.1126	25	0.0004
8	0.113	0.1125	25	0.0005
9	0.113	0.1124	25	0.0006
10	0.113	0.1123	25	0.0007

0.58 Standard - NEO -ENS ae2206005 - Repeatability 0.0005. Accuracy 0.0012

REP	STANDARD AW	WATER ACTIVITY	TEMP	DIFFERENCE FROM STANDARD
1	0.5757	0.5755	25	0.0002
2	0.5757	0.5749	25	0.0008
3	0.5757	0.5745	25	0.0012
4	0.5757	0.5745	25	0.0012
5	0.5757	0.5744	25	0.0013
6	0.5757	0.5745	25	0.0012
7	0.5757	0.5746	25	0.0011
8	0.5757	0.574	25	0.0017
9	0.5757	0.574	25	0.0017
10	0.5757	0.5739	25	0.0018

0.75 Standard - NEO -ENS ae2206005 - Repeatability 0.0003. Accuracy 0.0003

REP	STANDARD AW	WATER ACTIVITY	TEMP	DIFFERENCE FROM STANDARD
1	0.753	0.7531	25	0.0001
2	0.753	0.7529	25	0.0001
3	0.753	0.7527	25	0.0003
4	0.753	0.753	25	0.0000

5	0.753	0.7523	25	0.0007
6	0.753	0.7528	25	0.0002
7	0.753	0.7523	25	0.0007
8	0.753	0.7525	25	0.0005
9	0.753	0.7522	25	0.0008
10	0.753	0.7528	25	0.0002

0.84 Standard - NEO -ENS ae2206005 - Repeatability 0.0006. Accuracy 0.0016

REP	STANDARD AW	WATER ACTIVITY	TEMP	DIFFERENCE FROM STANDARD
1	0.843	0.8458	25	0.0028
2	0.843	0.8452	25	0.0022
3	0.843	0.8451	25	0.0021
4	0.843	0.8445	25	0.0015
5	0.843	0.8446	25	0.0016
6	0.843	0.8442	25	0.0012
7	0.843	0.8443	25	0.0013
8	0.843	0.8444	25	0.0014
9	0.843	0.844	25	0.0010
10	0.843	0.8442	25	0.0012

0.97 Standard - NEO -ENS ae2206005 - Repeatability 0.0009. Accuracy 0.0007

REP	STANDARD AW	WATER ACTIVITY	TEMP	DIFFERENCE FROM STANDARD
1	0.973	0.9744	25	0.0014
2	0.973	0.9735	25	0.0005
3	0.973	0.9734	25	0.0004
4	0.973	0.9732	25	0.0002
5	0.973	0.973	25	0.0000
6	0.973	0.9728	25	0.0002
7	0.973	0.9726	25	0.0004
8	0.973	0.972	25	0.0010
9	0.973	0.97169	25	0.0013
10	0.973	0.9717	25	0.0013

Carter Scientific Solutions

0.11 Standard - NEO -ENS ae2410155 - Repeatability 0.0004. Accuracy 0.0014

REP	STANDARD AW	WATER ACTIVITY	TEMP	DIFFERENCE FROM STANDARD
1	0.113	0.1124	25	0.0006
2	0.113	0.1122	25	0.0008
3	0.113	0.1121	25	0.0009
4	0.113	0.1115	25	0.0015
5	0.113	0.1115	25	0.0015
6	0.113	0.1114	25	0.0016
7	0.113	0.1116	25	0.0014
8	0.113	0.1113	25	0.0017
9	0.113	0.1114	25	0.0016
10	0.113	0.1111	25	0.0019

0.58 Standard - NEO -ENS ae2410155 - Repeatability 0.0004. Accuracy 0.0003

REP	STANDARD AW	WATER ACTIVITY	TEMP	DIFFERENCE FROM STANDARD
1	0.5757	0.5768	25	0.0011
2	0.5757	0.5762	25	0.0005
3	0.5757	0.576	25	0.0003
4	0.5757	0.576	25	0.0003
5	0.5757	0.5758	25	0.0001
6	0.5757	0.5759	25	0.0002
7	0.5757	0.5758	25	0.0001
8	0.5757	0.5757	25	0.0000
9	0.5757	0.5755	25	0.0002
10	0.5757	0.5758	25	0.0001

0.75 Standard - NEO -ENS ae2410155 - Repeatability 0.0010. Accuracy 0.0007

REP	STANDARD AW	WATER ACTIVITY	TEMP	DIFFERENCE FROM STANDARD
1	0.753	0.7529	25	0.0001
2	0.753	0.7526	25	0.0004
3	0.753	0.7527	25	0.0003
4	0.753	0.7526	25	0.0004
5	0.753	0.7524	25	0.0006
6	0.753	0.7522	25	0.0008
7	0.753	0.7556	25	0.0026
8	0.753	0.7524	25	0.0006
9	0.753	0.7522	25	0.0008
10	0.753	0.7528	25	0.0002

Carter Scientific Solutions

0.84 Standard - NEO -ENS ae2410155 - Repeatability 0.0007. Accuracy 0.0006

REP	STANDARD AW	WATER ACTIVITY	TEMP	DIFFERENCE FROM STANDARD
1	0.843	0.8443	25	0.0013
2	0.843	0.8439	25	0.0009
3	0.843	0.8427	25	0.0003
4	0.843	0.8427	25	0.0003
5	0.843	0.8427	25	0.0003
6	0.843	0.8427	25	0.0003
7	0.843	0.8424	25	0.0006
8	0.843	0.8424	25	0.0006
9	0.843	0.8422	25	0.0008
10	0.843	0.8424	25	0.0006

0.97 Standard - NEO -ENS ae2410155 - Repeatability 0.0004. Accuracy 0.0007

REP	STANDARD AW	WATER ACTIVITY	TEMP	DIFFERENCE FROM STANDARD
1	0.973	0.9733	25	0.0003
2	0.973	0.9724	25	0.0006
3	0.973	0.9722	25	0.0008
4	0.973	0.972	25	0.0010
5	0.973	0.9719	25	0.0011
6	0.973	0.9722	25	0.0008
7	0.973	0.9726	25	0.0004
8	0.973	0.9724	25	0.0006
9	0.973	0.9721	25	0.0009
10	0.973	0.9726	25	0.0004