

If the procedure cannot be worked as written, the user has the responsibility to stop work and resolve all concerns with the PI/designee or safety, as appropriate, prior to proceeding with the work.

2.3 Identification

The humidity meters are identified by manufacturer, model number, and serial number, if applicable. When not supplied with a serial number, the instruments will each be assigned a permanent number that will be recorded in the scientific notebook or scientific notebook supplement, when that instrument is calibrated.

Calibration of the humidity meter will involve checking the probe reading against certified ready dosed salts.

2.4 Calibration

2.4.1 Standards

Calibration of the humidity meter will be performed using commercially obtained ready dosed salts packages (see sect 2.5) that are delivered with Certificates of Analysis. Standards are identified by the manufacturer, lot number and expiration date and shall be recorded. A minimum of two standards shall be used for calibration of these probes.

2.4.2 Frequency

The humidity probes will be calibrated prior to initial use in the collection of qualified data and on a frequency identified by the PI or designee and based on manufacturer's recommendations. At regular intervals defined below (sect 2.7), a calibration check to establish the accuracy of the recent data collection quality shall be conducted. If the user of the instrument observes any irregularities in the instrument, it shall be recalibrated. If the instrument cannot be successfully recalibrated, tag the instrument documenting the concern and follow the procedure in Subsection 2.4.4.

2.4.3 Acceptance Criteria

Acceptance criteria for the meter calibration and calibration check results are given in subsequent sections. If the probe cannot meet the calibration acceptance criteria, the ready dosed salts should be replaced and a subsequent re-calibration or calibration check attempted. If the instrument still does not meet the acceptance criteria, it will be removed from service and tagged according to NP 12-1, *Control of Measuring and Test Equipment*. The acceptance criteria used to approve or reject the calibration results will be listed in the applicable scientific notebook or scientific notebook supplement.

2.4.4 Corrective Action

If during the calibration or calibration check of a humidity probe that has been use to collect data is found out of tolerance, a Corrective Action Request (CAR) will be issued to document the results and impacts related to the change in the performance. Corrective action would include an evaluation to any measurements collected or a re-evaluation of the calibration check interval. Results of all activities related to the out-of-tolerance will be summarized in the CAR.

2.5 Preparing the Salt Solutions

Prepare the salt solutions 24 hours prior to performing a calibration or calibration check to allow the salt solutions to reach equilibrium humidity.

The salt solution should be prepared in clean salt chambers provided with the calibrator. Each salt solution will be prepared using deionized water (DI) per the table below:

Salt	%Relative Humidity	DI water (mL)	Salt (g)
LiCl *	11	12	15
MgCl ₂	33	3	30
NaCl	75	10	20
K ₂ SO ₄	97	10	30

NOTE:

- 1) Never add water to dry LiCl salt, the salt may heat up so rapidly that it splashes out of the chamber.
- 2) The LiCl solution should be stored in the incubator to prevent the solution from falling below 18°C.

The DI water will be added to the clean salt chamber and then the desired amount of salt, adding the salt in small quantities into the chamber, stirring constantly. The solution will be saturated, cover the chamber until ready to use.

The salt solutions maintain their characteristics for 12 months; therefore once a salt solution has been prepared its expiration date will be 12 months from date of preparation. In addition, the salt chambers will be labeled accordingly with the date of preparation and expiration date.

2.6 Vaisala Humidity Meter Calibration

Prior to being placed into service, all humidity meters will be calibrated to the appropriate working range.

- 2.6.1 For all calibrations, two ready dosed salts shall be used. These mixtures are a zero percent relative Humidity (RH) concentration (e.g. 11% RH, LiCl) and a span concentration with a %RH concentration equal to or less than the upper limit (e.g. 97% RH, K₂SO₄) of the selected instrument range, such that the two standards bracket the as read %RH concentration.
- 2.6.2 Insert the thermometer into the 13.5mm hole, allow to equilibrate, and record the temperature.
- 2.6.3 Insert the probe into a suitable hole of the LiCl salt chamber. Do not allow the probe to immerse in the salt solution. Allow 10-30 minutes for the humidity reading to stabilize. Record the humidity reading and if applicable, the electrical output voltage of the humidity probe being calibrated. The humidity reading should correspond to the Greenspan's Calibration Table (See Appendix A) within the defined tolerance limits of the probe being calibrated. If the reading exceeds the Appendix A requirements, adjust the DRY, offset on the humidity meter. Recording of the electrical output in addition to the display reading is necessary if the instruments electrical output will be connected to a data acquisition system.
- 2.6.4 Repeat steps, 2.6.1 and 2.6.3 with the K₂SO₄ salt chamber. If the reading exceeds the Appendix A requirements by an amount greater than the defined tolerance limits of the probe being calibrated, adjust the WET, offset on the humidity meter.
- 2.6.5 Note the date and results of the calibration in the appropriate scientific notebook or scientific notebook supplement. If any adjustments were made to the humidity meter, record these results as well. Upon completion of the calibration, the entry in the scientific notebook or scientific notebook supplement will be copied and submitted to the Records Center.

2.6.6 Label the humidity meter per the requirements in NP 12-1, *Control of Measuring and Test Equipment* Section 2.3.1.

2.7 Vaisala Humidity Meter Calibration Check

At regular intervals, not to exceed one year, the calibration of the humidity probe will be checked and recalibrated, if necessary.

- 2.7.1 For calibration checks at least two ready dosed salts will be used that have a %RH concentration (e.g. 33% RH, MgCl₂ and 75% RH, NaCl) within the normal range of the probe.
- 2.7.2 Insert the thermometer into the 13.5mm hole, allow to equilibrate, and record the temperature.
- 2.7.3 Insert the probe into a suitable hole of the desired salt chamber. Do not allow the probe to immerse in the salt solution. Allow 10-30 minutes for the humidity reading to stabilize. Record the humidity reading and if applicable, the electrical output voltage of the humidity probe being calibrated. The humidity reading should correspond to the Greenspan's Calibration Table (See Appendix A) and if applicable, the electrical output voltage of the humidity probe being calibrated if the instruments electrical output will be connected to a data acquisition system.
- 2.7.4 Repeat steps 2.7.2 and 2.7.3 with the other desired salt chamber.
- 2.7.5 Record the date and measured as-found value in the appropriate scientific notebook or scientific notebook supplement. Upon completion of the calibration check, the entry in the scientific notebook or scientific notebook supplement will be copied and submitted to the Records Center.
- 2.7.6 If the calibration check measurement differs by $\pm 5\%$ from the Table in Appendix A, the humidity meter must be recalibrated according to the steps outlined in Section 2.6 above and follow the procedure in section 2.4.4.
- 2.7.7 Label the humidity meter per the requirements in NP 12-1, *Control of Measuring and Test Equipment* Section 2.3.1.

2.8 References

- Vaisala Humidity Calibrator HMK15 User's Guide, 2006

3.0 Records

The following QA records generated through implementation of this procedure shall be prepared and submitted to the WIPP Records Center in accordance with NP 17-1, "Records".

QA Record

- Scientific Notebook
- Scientific Notebook Supplement

4.0 Appendices

Appendix A: Greenspan's Calibration Table

Appendix A

Greenspan's Calibration Table ¹

°C	LiCl	MgCl ₂	NaCl	K ₂ SO ₄
0	*	33.7 ±0.3	75.5 ±0.3	98.8 ±1.1
5	*	33.6 ±0.3	75.7 ±0.3	98.5 ±0.9
10	*	33.5 ±0.2	75.7 ±0.2	98.2 ±0.8
15	*	33.3 ±0.2	75.6 ±0.2	97.9 ±0.6
20	11.3 ±0.3	33.1 ±0.2	75.5 ±0.1	97.6 ±0.5
25	11.3 ±0.3	32.8 ±0.2	75.3 ±0.1	97.3 ±0.5
30	11.3 ±0.2	32.4 ±0.1	75.1 ±0.1	97.0 ±0.4
35	11.3 ±0.2	32.1 ±0.1	74.9 ±0.1	96.7 ±0.4
40	11.2 ±0.2	31.6 ±0.1	74.7 ±0.1	96.4 ±0.4
45	11.2 ±0.2	31.1 ±0.1	74.5 ±0.2	96.1 ±0.4
50	11.1 ±0.2	30.5 ±0.1	74.4 ±0.2	95.8 ±0.5

- 1) Greenspan, L.: Journal of Research of the National Bureau of Standards – A Physics and Chemistry Vol. 81A, No. 1 January-February 1977, pp 89-95

*If the LiCl solution is used or stored in temperatures below 18°C, its equilibrium humidity changes permanently. The solution should be stored in the incubator to prevent the solution from falling below 18°C.

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